



**Transport**  
Roads & Maritime  
Services

# Berry to Bomaderry

Princes Highway upgrade

**Technical paper:**  
**Terrestrial flora and fauna**

**NOVEMBER 2013**



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# Roads and Maritime Services

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Berry to Bomaderry upgrade

Technical paper: Terrestrial flora and fauna

November 2013

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**Roads and Maritime Services**

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# Contents

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Glossary of terms and abbreviations.....	iv
Executive summary.....	vi
1 Introduction.....	1
2 Methodology.....	5
2.1 Previous surveys and assessments.....	5
2.2 Current surveys and assessments.....	5
2.3 Database and literature review.....	6
2.4 Taxonomy and nomenclature.....	8
2.5 Flora surveys.....	8
2.6 Fauna surveys.....	10
2.7 Threatened and migratory species likelihood of occurrence criteria.....	14
2.8 Temporary construction ancillary facility sites.....	15
2.9 Limitations.....	15
3 Existing environment.....	17
3.1 Landscape context.....	17
3.2 Land use.....	17
3.3 Vegetation communities and habitat.....	17
3.4 Threatened ecological communities.....	64
3.5 Threatened species and endangered populations.....	65
3.6 Migratory species.....	73
3.7 Critical habitat.....	75
3.8 Fauna movement corridors.....	75
3.9 Groundwater dependant ecosystems.....	79
3.10 SEPP 44 – Koala habitat protection.....	79
3.11 SEPP 14 – Coastal wetlands.....	79
4 Potential impacts.....	80
4.1 Loss of vegetation and flora habitat.....	80
4.2 Loss of fauna habitat.....	84
4.3 Habitat fragmentation, edge effects and barrier effects.....	92
4.4 Weeds.....	94
4.5 Pests and pathogens.....	95
4.6 Impact on relevant key threatening processes (TSC Act and EPBC Act).....	95
4.7 Cumulative impacts.....	96
4.8 Koala habitat.....	96
4.9 Coastal wetlands.....	97
5 Assessments of significance.....	99
5.1 TSC and EPBC Act assessments of significance.....	99
5.2 Potential impacts on threatened ecological communities.....	100
5.3 Potential impacts on threatened flora species.....	101
5.4 Potential impacts on threatened fauna.....	101
6 Managing potential impacts on biodiversity.....	104
6.1 Safeguards and management measures.....	104
6.2 Mortality.....	107
6.3 Weeds.....	107



6.4	Offset strategies .....	108
7	Conclusion .....	109
7.1	General terrestrial biodiversity .....	109
7.2	Threatened biodiversity .....	109
8	References.....	110
Appendix A	Flora and fauna species inventories	
Appendix B	Threatened species and populations likelihood of occurrence	
Appendix C	Hollow-bearing tree and stag inventory	
Appendix D	TSC Act Assessment of significance	
Appendix E	EPBC Act assessments of significance	

### List of tables

Table 2-1:	Cumulative flora survey effort from 2007 to 2013
Table 2-2:	Cumulative fauna survey effort from 2007 to 2013
Table 2.3:	Likelihood of occurrence assessment criteria
Table 3-1	Poor to good condition Currumbene Batemans lowland forest
Table 3-2	Moderate to good condition Shoalhaven sandstone forest
Table 3-3	Poor to moderate condition Illawarra gully wet forest
Table 3-4	Poor to moderate condition Riverbank forest
Table 3-5	Poor condition South Coast Grassy Woodland
Table 3-6	Moderate condition Reedland
Table 3-7	Poor condition Acacia scrub
Table 3-8	Poor condition Grassland
Table 3-9	Planted vegetation
Table 3-10	Open forest
Table 3-11	Riparian corridors
Table 3-12	Woodland
Table 3-13	Aquatic and semi aquatic
Table 3-14	Scrubland/Planted
Table 3-15	Exotic Closed Grassland
Table 4-1	Area of each vegetation community and type impacted or avoided by the proposal
Table 4-2	Area of each main fauna habitat and corresponding vegetation community and type impacted by the proposal
Table 4-3	Area of each native and derived vegetation community impacted by the upgrade of the three main Princes Highway upgrade projects between Mount Pleasant and Bomaderry
Table 5-1	TSC Act assessments of significance summary
Table 5-2	EPBC Act assessments of significance summary

## List of figures

- Figure 1 Overview
- Figure 2-1 Flora survey effort including 2007 to 2013
- Figure 2-2 Fauna survey effort in 2013.
- Figure 2-3 Fauna survey effort between 2007 and 2009
- Figure 3-1-22 Vegetation mapping and fauna features
- Figure 4 Threatened flora records from the NSW Atlas of Wildlife (OEH 2013)
- Figure 5 Threatened fauna records from the NSW Atlas of Wildlife (OEH 2013)
- Figure 6 Migratory fauna species records from the NSW Atlas of Wildlife (OEH 2013)
- Figure 7-1 Wildlife corridors and SEPP 14 wetlands from the South Coast Regional Conservation Plan (SCRCP) at a broad locality scale
- Figure 7-2 Wildlife corridors and SEPP 14 wetlands from the South Coast Regional Conservation Plan (SCRCP) at a study area scale

# Glossary of terms and abbreviations

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<b>Term</b>	<b>Meaning</b>
CAVS	Census of Australian Vertebrates
IBRA	Interim Biogeographic Regionalisation of Australia
CEMP	Construction Environmental Management Plan
DECCW	Department of Environment, Climate Change and Water (NSW). Now OEH
DPI	Department of Primary Industries (NSW)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Cwlth)
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW)</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)</i>
EPA&A Regulation	<i>Environmental Planning and Assessment Regulation 2000</i>
FM Act	<i>Fisheries Management Act 1994</i>
GDEs	Groundwater dependent ecosystems
ILGW	Illawarra lowlands grassy woodland in the Sydney Basin Bioregion
JAMBA	Japan-Australia Migratory Bird Agreement
LGA	Local Government Area
Locality	10 kilometre radius of the subject site to define database search areas
MNES	Matters of National Environmental Significance
NPWS	NSW National Parks and Wildlife Service
OEH	Office of Environment and Heritage
PEA Act	Protection of the Environment Administration Act 1991 (NSW)
PEI	Preliminary environmental investigation
PEI study area	The study area of previous terrestrial flora and fauna surveys and assessments by Biosis (2009)
Proposal	All elements of the proposal of approximately 11.5 kilometres of the Princes Highway between Schofields Lane (south of Berry) and Cambewarra Road, Bomaderry
PMST	Protected Matters Search Tool database for matters protected under the EPBC Act
REF	Review of environmental factors
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
RFEFCF	River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROTAP	Rare or Threatened Australian Plants (Briggs and Leigh, 1995)

<b>Term</b>	<b>Meaning</b>
RMS	Roads and Maritime Services of NSW
SCIVI	South Coast - Illawarra Vegetation Integration by Tozer et al. (2010)
SIS	Species Impact Statement as defined under the TSC Act
SRCMA	Southern Rivers Catchment Management Authority
Subject site (direct)	The area to be directly affected by the proposal (ie the concept design development footprint) and excluding the subject site (indirect)
Subject site (indirect)	The areas of the proposal which are likely to be affected by indirect impacts incorporating a fifty metre buffer to, but excluding the subject site (direct)
Subject species	Threatened species listed under either or both the EPBC and TSC Acts that are known or considered likely to occur in the locality
Subject TEC	Threatened ecological community listed under either or both the EPBC and TSC Acts that are known or considered likely to occur in the locality
Study area	A 200 metre buffer to the combined subject site (direct and indirect) to account for an assessment of biodiversity constraints to locating temporary construction ancillary facilities where impacts would be avoided
TEC	Threatened ecological community
Threatened biodiversity	Threatened species, populations and ecological communities, or their potential habitats, as listed under the TSC Act EPBC Act
TSC Act	Threatened Species Conservation Act 1995
VMP	Vegetation Management Plan

# Executive summary

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Roads and Maritime Services of NSW is undertaking an assessment under Part 5 of the *Environmental Planning and Assessment Act 1979* for the upgrade of approximately 11.5 kilometres of the Princes Highway between Schofields Lane (south of Berry) and Cambewarra Road, Bomaderry (the proposal).

The proposal is one of a series of upgrades to sections of the Princes Highway which aims to provide at least a four-lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW South Coast.

The proposal is predominantly located on the western margin of the Shoalhaven floodplain and low undulating rises that have been substantially cleared for agriculture. Patches of native vegetation and isolated remnant trees are scattered throughout the majority of this highly modified rural landscape. The low rises in the study area extend west to the well vegetated and steep slopes of the Cambewarra Range.

The proposal crosses a number of creeks including Flying Fox Creek, Jaspers Brush Creek, Wileys Creek, Tandingulla Creek, Tullian Creek, Abernethys Creek and several unnamed drainage lines that descend from the low hills and ranges in the west to the Shoalhaven floodplain in the east.

Conservation reserves that occur either in or just outside the locality include the Cambewarra Range Nature Reserve, the Seven Mile Beach National Park, Comerong Island Nature Reserve, Red Rocks Nature Reserve and the Bomaderry Creek Regional Park. None of these reserves directly adjoin or would be directly impacted by the proposal.

Biosis has carried out terrestrial ecological surveys and assessment of the proposal as part of the environmental assessment for the proposal undertaken in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979*.

The terrestrial ecological field investigations for the proposal were conducted during February 2007, November 2008, May 2009 and March 2013. Surveys were carried out using a combination of habitat-based assessment, trapping, Anabat recording, spotlighting and targeted sampling techniques. The current study area includes the construction footprint for the proposal, areas likely to be indirectly impacted and additional areas that would be considered for some temporary construction ancillary facilities.

Aquatic ecology field investigations and assessment for the proposal are detailed in the *Princes Highway upgrade - Berry to Bomaderry Upgrade. Technical Paper: Aquatic Ecology and Water Quality Management* (Cardno Ecology Lab 2013) provided at Appendix F of the review of environmental factors for the proposal.

## Threatened ecological communities

Two threatened ecological communities River-flat eucalypt forest on coastal floodplains and Illawarra lowlands grassy woodland were recorded in the study area. These vegetation communities are listed under the *Threatened Species Conservation Act 1995* (TSC Act) with the majority of both considered to be in poor condition. The proposal would impact on a total of 1.27 hectares of River-flat eucalypt forest on coastal floodplains including direct impacts to 0.53 hectares and indirect impacts to 0.74 hectares of the community. The proposal would impact on a total of 0.31 hectares of Illawarra lowlands grassy woodland including direct impacts to 0.3 hectares and indirect impacts to 0.01 hectares of the community. Impact assessments were carried out for each of these and it was determined that the proposal is unlikely to have a significant impact upon either of the ecological communities.



## Flora

A total of 26 plant species and one flora population listed on the TSC Act and/or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), or their habitat, have been previously recorded within a 10 kilometre radius of the study area. No threatened plant species were recorded in the study area during the surveys undertaken for the proposal, however, based on the proximity of previous records and the presence of identified habitat, potential habitat may exist within the study area for four threatened plant species including: *Cryptostylis hunteriana*; *Genoplesium baueri*; *Pterostylis gibbosa*; and *Thesium australe*. In summary the proposal would impact on:

- A total of 4.12 hectares of potential habitat for *Pterostylis gibbosa* including direct impacts to 1.74 hectares and indirect impacts to 2.38 hectares of native plant communities that vary from poor to good condition.
- A total of 5.6 hectares of potential habitat for *Cryptostylis hunteriana* including direct impacts of 1.98 hectares and indirect impacts to 3.92 hectares of native plant communities that vary from moderate to good condition.
- A total of 1.8 hectares of potential habitat for *Genoplesium baueri* including direct impacts of 0.24 hectares and indirect impacts to 1.56 hectares native plant community in moderate to good condition.
- A total of 7.62 hectares of potential habitat for *Thesium australe* including direct impacts to 2.95 hectares and indirect impacts to 4.67 hectares of native plant communities that vary from poor to good condition.

Assessments of significance were carried out in accordance with the requirements of the TSC Act and the EPBC Act for each of these threatened plant species and determined that the proposal is unlikely to have a significant impact upon any of these species and as such:

- A Species Impact Statement is not required.
- A referral to the Commonwealth Minister for Environment, Heritage and Water is not considered necessary for any EPBC Act listed flora species.

## Fauna

Fauna habitat within the study area ranges from predominantly cleared areas which have low to moderate habitat value to fragmented small patches of native vegetation. Both cleared areas and patches of remnant and regrowth native vegetation do however support important habitat features such as tree hollows, riparian vegetation, fallen logs and feeding resources.

Searches of the Atlas of NSW Wildlife (OEH, 2013) for the locality have identified previous records for a total of 63 fauna species listed under the TSC Act and/or EPBC Act, with potential habitat (exclusive of records) identified for an additional seven EPBC Act listed fauna species from the PMST (DSEWPac, 2013) for the locality. Of the relevant 70 threatened fauna species subject to this assessment (excluding marine and pelagic species of fauna) 21 species have a dual listing under the TSC and EPBC Acts, two species are solely listed under the EPBC Act and 47 species are solely listed under the TSC Act.

Based on the field surveys, including targeted searches between 2007 and 2009 for some species; general surveys in 2013; habitats present in the study area; current disturbance regimes; and the number and distribution of previous records, these assessments have determined that:

- There is a low likelihood for 43 of these species to be present in the study area.
- There is a medium likelihood for 15 of these species to be present in the study area, including one species previously recorded.
- There is a high likelihood for 12 of these species to be present in the study area, including seven species previously recorded.

Assessments of significance were carried out in accordance with the requirements of the TSC Act and the EPBC Act for 27 threatened animal species and determined that the proposal is unlikely to have a significant impact upon any of these species.

Forty five migratory fauna species listed under the EPBC Act are considered relevant to the current assessment as they have known or potential habitat in the study area. Known and/or potential habitat in the study area for these species would be likely to be affected by direct and indirect impacts from the proposal, however, this known and/or potential habitat is not considered important for these species.

Assessments of significance carried out in accordance with the requirements of the TSC Act and the EPBC Act for threatened fauna species and consideration of migratory fauna against the EPBC Act have concluded:

- A Species Impact Statement is not required.
- A referral to the Commonwealth Minister for Environment, Heritage and Water is not considered necessary for any EPBC Act listed threatened fauna species.
- A referral to the Commonwealth Minister for Environment, Heritage and Water is not considered necessary for any EPBC Act listed migratory fauna species.

### Wildlife corridors and connectivity

Within the study area roadside native vegetation is limited to small disjunct patches of native and exotic vegetation cover and groundcover. The proposal is not likely to substantially impact on any local or regional wildlife corridors due to the existing degree of clearing and fragmentation.

### Mitigation and management

The RMS 'Biodiversity Guidelines' (RTA 2011) provide guidance on addressing biodiversity management during the planning, construction, operation and maintenance of projects in view of the following key aims:

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

By applying these principles, important ecological features in the local area, identified in Biosis (2009), have been avoided during the options and route selection stage and the proposal has been designed, where feasible and reasonable, to minimise impacts on flora and fauna habitat.

Following the implementation and consideration of measures to avoid potential impact to the general biodiversity values and potential habitat for threatened biodiversity, the proposal is still likely to result in some impacts. In summary the likely impacts would mainly be associated with the following processes:

- Vegetation clearance and loss of flora and fauna habitat.
- Edge effects.
- Mortality of individuals during both the construction and operational phases.
- Introduction and/or spread of weeds.

RMS' 'Biodiversity Guidelines' (RTA 2011) have been used in the formulation of management measures to reduce, minimise and mitigate potential impacts to general and threatened terrestrial biodiversity values as a result of the proposal. The key measures to manage potential impacts to biodiversity values are summarised below:

- Minimise the extent of vegetation clearing.
- Implement exclusion zones to protect threatened Ecological Communities and threatened species habitat.
- Develop a Vegetation Management Plan, incorporating a weed management plan to prevent the spread of noxious weeds, and re-establishment of native vegetation.
- Undertake any clearing according to the pre-clearing process set out in RMS' Biodiversity Guidelines (RTA 2011). Pre-clearing surveys should include:
  - Hollow-bearing tree / stag-watching survey of trees to be removed.
  - Targeted surveys for the Green and Golden Bell Frog, microchiropteran bats and forest owls in areas identified as providing potential breeding or roosting habitat.
  - Installation of nest boxes.
- Undertake surveys for the Microchiropteran bats at any bridges and culverts scheduled for removal.
- If microchiropteran bats are recorded roosting within bridges or culverts prior to construction, develop and implement a Microbat Management Plan.
- Provide nest boxes to mitigate impacts of removing hollow bearing trees.
- Incorporation of fauna friendly features into bridge design at Wileys Creek, Jaspers Brush Creek and Flying Fox Creek, where feasible and reasonable to maintain vegetation connectivity and fauna movement corridors.

The assessment criteria from RMS' 'Guideline for Biodiversity Offsets' (RMS 2011b) have been considered and an offset is not required as a result of the proposal.

# 1 Introduction

---

Roads and Maritime Services of NSW (RMS) is undertaking an assessment in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the upgrade of approximately 11.5 kilometres of the Princes Highway between Schofields Lane (south of Berry) and Cambewarra Road, Bomaderry (the proposal) as shown in **Figure 1**.

The proposal is one of a series of upgrades to sections of the Princes Highway which aims to provide at least a four-lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW South Coast.

Part 5 of the EP&A Act requires an environmental assessment to be undertaken for the proposal. This assessment is documented in a review of environmental factors. The purpose of the review of environmental factors is to describe the proposal, to document the likely impacts of the proposal on the environment and to detail protective measures to be implemented. Specifically, the assessment of environmental impacts of the proposal must be undertaken in the context of clause 228 of the 'Environmental Planning and Assessment Regulation 2000' (EP&A Regulation), the *Threatened Species Conservation Act 1995* (TSC Act), the *Fisheries Management Act 1994* (FM Act), and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Preliminary environmental investigations (PEI) including ecological studies and field work have been undertaken over the same route as the proposal (Biosis 2009). The PEI form part of the corridor or route selection studies that also encompassed the Gerringong upgrade and Foxground and Berry bypass projects.

The features of proposal are detailed in the review of environmental factors for the proposal and, in summary, include the following:

- Upgrade of the existing highway, including widening from two lanes to a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers generally, or concrete barriers where space is constrained, such as at bridge locations).
- Provision for widening of the highway (if required in the future) to six lanes within the road corridor between Schofields Lane and around Pestells Lane.
- Tie-in to the Berry bypass to the north of the proposal.
- Grade-separated facilities<sup>1</sup> at:
  - Jaspers Brush Road and Strongs Road.
  - Morschels Lane and Devitts Lane.
- A grade-separated half interchange at:
  - Pestells Lane and Meroo Road.
- Protected right turn bays at:
  - Mullers Lane (northbound).
  - Croziers Road (southbound).
  - Between Strongs Road and Turners Lane at about chainage 23200 (northbound).
  - Between Strongs Road and Turners Lane at about chainage 24050, adjacent to Silo's Winery (southbound).
  - Lamonds Lane (northbound).
  - Boxsells Lane (southbound).

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<sup>1</sup> Unlike a standard grade separated interchange which has full length on-ramps and off-ramps, a grade separated facility has deceleration lanes to a connecting road that links to an overpass or underpass. Grade separated facilities have been used along the Pacific Highway and are informally referred to as Type S interchanges.

- South of Abernethys Lane at about chainage 28590 (northbound).
- U-turn facilities at:
  - Mullers Lane (to travel southbound)<sup>2</sup>.
  - Croziers Road (to travel northbound).
  - Between Strongs Road and Turners Lane at about chainage 23200 (to travel southbound).
  - Between Strongs Road and Turners Lane at about chainage 24050, adjacent to Silos Winery (to travel northbound).
  - Lamonds Lane (to travel southbound).
  - South of Abernethys Lane at about chainage 28590 (to travel southbound).
- A large cutting at Strongs Road, Jaspers Brush of around 300 metres long and up to a maximum of ten metres deep in addition to various smaller cuttings along the proposal.
- Eight bridges over waterways<sup>3</sup>:
  - Creek crossing No. 1 – Unnamed drainage line at chainage 19350, a three span concrete structure around 44 metres long and three metres high.
  - Creek crossing No. 2 – Unnamed drainage line at chainage 19800, a single span concrete structure around 33 metres long and four metres high.
  - Creek crossing No. 3 – Flying Fox Creek, a single span concrete structure around 18 metres long and seven metres high.
  - Creek crossing No. 4 – Jaspers Brush Creek, a three span concrete structure around 44 metres long and six metres high.
  - Creek crossing No. 5 – Wileys Creek, a five span concrete structure around 76 metres long and five metres high.
  - Creek crossing No. 6 – Tandingulla Creek, a three span concrete structure around 44 metres long and three metres high.
  - Creek crossing No. 7 – Tullian Creek, a three span concrete structure around 44 metres long and five metres high.
  - Creek crossing No. 8 – Abernethys Creek, a three span concrete structure around 76 metres long and two metres high.
- Major drainage and flood mitigation structures:
  - Flood mitigation bridge – located just south of O’Keefes Lane at chainage 21200, a three span concrete structure around 45 metres long and 3.5 metres high.
  - Overflow channel – 300 metre long channel located upstream of the alignment to allow flood waters to follow the existing drainage path (between chainage 22320 and 22650).
  - Pestells Lane culverts – eight cell box culvert, with each cell around 2.5 metres wide, 1.5 metres high and 130 metres long.
- A northbound heavy vehicle inspection bay at Jaspers Brush, staffed as needed and locked when not in use.
- Modifications to the connections between local roads and the highway, including Strongs Road, Jaspers Brush Road, Morschels Lane, Devitts Lane, Pestells Lane, Meroo Road and Abernethys Lane.

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<sup>2</sup> The u-turn facility within the proposal area at Mullers Lane (southbound) will be constructed under separate approval as part of the Foxground and Berry bypass project, however the right turn bay would be constructed as part of the Berry to Bomaderry upgrade.

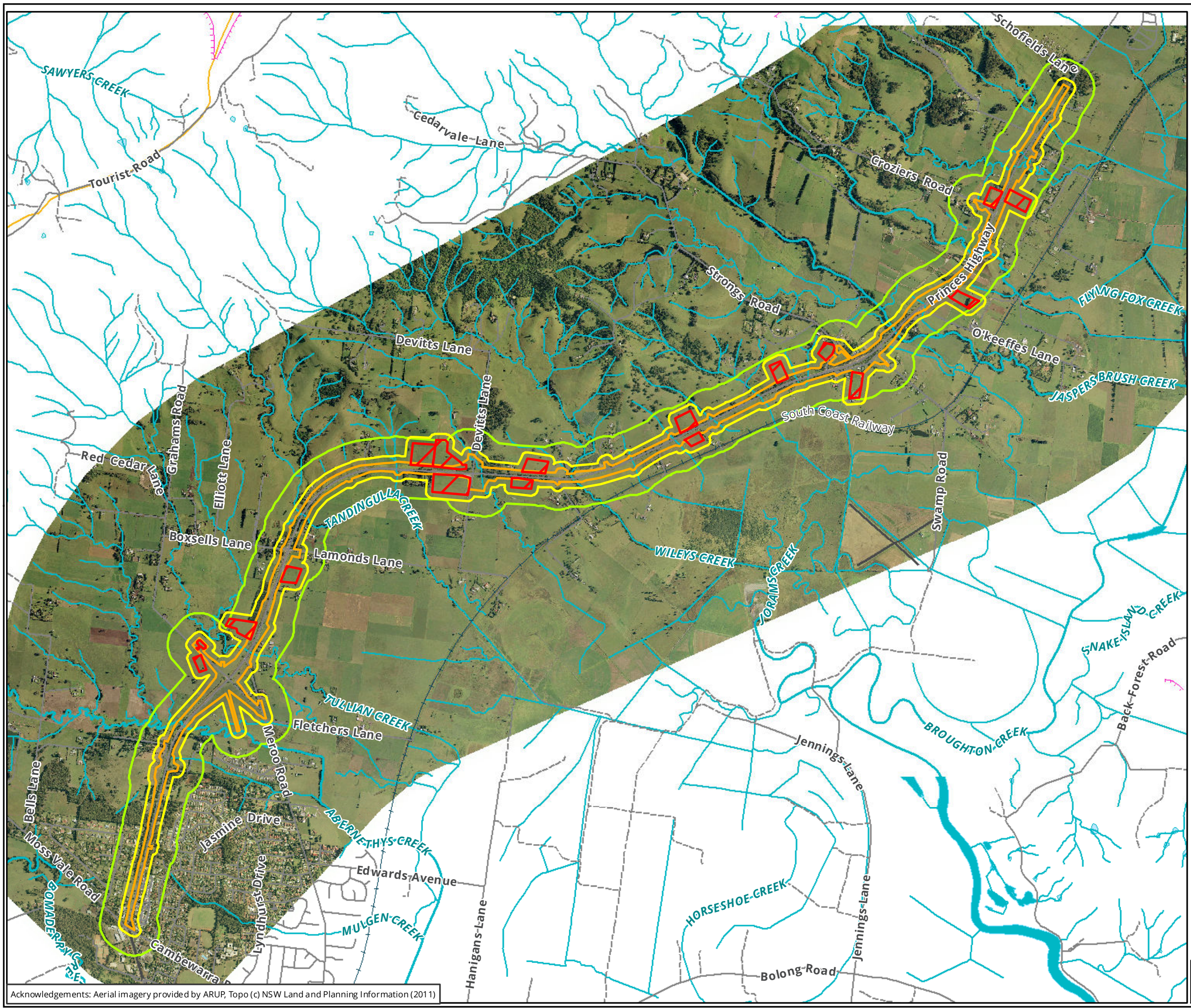
<sup>3</sup> Existing waterway crossings at Flying Fox, Jaspers Brush and Abernethys Creeks are all currently spanned by bridges. These three bridges would be replaced as part of the proposal. The remainder of the existing waterway crossings are culverts. New bridges would be constructed at these locations.



- Physical modifications to about 16 existing property accesses.
- Relocation and formalisation of existing southbound bus stops at Mullers Lane, Jaspers Brush Road, Morschels Lane and Lamonds Lane and existing northbound bus stops at Boxsells Lane, Croziers Road and Strong's Road. Bus stops would be relocated to sites where there is provision for safe vehicular access, set down and pick up.
- Ancillary operational facilities, including permanent detention basins and stormwater treatment facilities.
- Tie-in with the existing highway at the Cambewarra Road / Moss Vale Road roundabout.

Temporary construction ancillary facilities, including construction compounds, stockpile sites, haulage roads and sediment basins would be established and operated for construction and located as shown on **Figure 1**.





- Legend**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 1: Overview of the study area**

0 280 560 840 1,120 1,400  
 Meters  
 Scale: 1:28,000 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
 Location: P:\15800s\15896\mapping\15896\_F1\_Overview\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)



## 2 Methodology

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### 2.1 Previous surveys and assessments

Previous terrestrial ecology survey and assessments were undertaken over the route of the proposal in 2007 and 2009 (Biosis 2009). These assessments included preliminary investigations to assist in selection of a preferred route option for the proposal, and more detailed surveys to assess the preferred route. Survey effort in the earlier ecological surveys was focused in areas identified as being of higher conservation significance. Surveys included habitat-based assessment, trapping, Anabat recording, spotlighting and targeted searches in the study area for the PEI, which included the likely area of earthworks and a buffer of approximately 50 metres on either side to account for potential indirect impacts.

The aim of the Biosis (2009) assessment was to identify areas of conservation significance associated with the proposal. The specific objectives of the terrestrial flora and fauna assessment (Biosis 2009) were to:

- Gather existing information regarding terrestrial flora and fauna within and surrounding the study area, focussing on threatened species, populations and ecological communities.
- Examine the nature, extent and condition of fauna habitats and vegetation associations within the study area, through a combination of desktop and field studies.
- Identify areas supporting vegetation associations that are, or are likely to be, of conservation significance, or support resources that may be utilised by species or populations of conservation significance.
- Assess the potential occurrence of flora and fauna species or populations of conservation significance, in particular, threatened species and populations.
- Identify areas that may be of importance as habitat corridors.
- Assess the potential impacts of the proposed highway upgrade on threatened species and populations (including their habitats) and endangered ecological communities.

### 2.2 Current surveys and assessments

The scope for the current surveys and assessments is based on a gap analysis of the previous investigations. This gap analysis identified work required to progress the ecological surveys and technical working paper to the requirements of clause 228 of the EP&A Regulation and proposal review of environmental factors. In summary the gap analysis identified a requirement to:

- Prepare a terrestrial ecology technical working paper that more specifically addresses the relevant requirements of Clause 228 of the EP&A Regulation.
- Prepare a terrestrial ecology technical working paper that conforms to the specification of the *Environmental Impact Assessment Practice Note – Biodiversity Assessment* (RMS, 2012).
- Assess the proposal against the current design which is different to the previous route of the PEI study area.
- Assess a 200 metre buffer to the road corridor, not considered in the PEI, to provide a biodiversity constraint analysis that would inform the identification of areas suitable for temporary ancillary facilities.

The overall approach to the current surveys and assessments is to build on the earlier investigations. Initially a two phase approach was proposed where:

- Phase 1 updated database searches for a locality of 10 kilometres from the study area (including the ancillary buffer) followed by field survey to ground truth and update vegetation mapping and conduct a habitat based terrestrial flora and fauna assessment. The information gathered in Phase 1 would assess the likelihood of threatened biodiversity occurring within the study area and determine the need for, and location of, more detailed and targeted surveys for threatened biodiversity, following consultation with RMS.
- Phase 2 would include detailed and targeted surveys for threatened biodiversity.

In summary Phase 1 has involved:

- Database searches and literature review.
- Detailed vegetation mapping to either confirm or amend the previous classification by Biosis (2009) consistent with the most recent vegetation communities from Tozer *et al.* (2010) and according most recent Vegetation Types Database (OEH, 2012).
- Broad assessment of vegetation condition according to the BioBanking Assessment Methodology (BBAM) (Department of Environment and Climate Change 2009).
- Conducting habitat assessments for threatened biodiversity that have determined the need for more intensive and seasonal surveys for several threatened flora and fauna species or populations.

Following Phase 1 surveys and assessments, targeted surveys for some threatened biodiversity have been recommended. Targeted surveys (Phase 2) have not progressed due to issues of seasonal survey timing requirements for some species and to carry out a thorough assessment as close to the commencement of construction as practicable. The targeted surveys would be undertaken during the detailed design phase of the proposal and prior to the commencement of construction. For the purposes of this assessment, it has been assumed that threatened biodiversity that would require targeted survey during the detailed design phase of the proposal are present in the study area and had been assessed as such.

The habitat based Phase 1 works are the basis for this technical working paper. The following are the key definitions that adopted in the Phase 1 investigations:

- Subject site (direct) - The area to be directly affected by the proposal (ie the concept design development footprint) and excluding the subject site (indirect).
- Subject site (indirect) - The areas of the proposal which are likely to be affected by indirect impacts incorporating a fifty metre buffer to, but excluding the subject site (direct).
- Study area - a 200 metre buffer to the combined subject site (direct and indirect) to account for an assessment of biodiversity constraints to locating temporary construction ancillary facilities.
- Locality - 10 kilometre radius from the study area to define database search areas.

## 2.3 Database and literature review

### 2.3.1 Databases

In order to provide background for this survey and assessment, information about flora and fauna within the locality and Southern Rivers catchment for native vegetation, was obtained from relevant public databases prior to surveys. Records from the following databases were collated and reviewed:

- BioNet Atlas of NSW Wildlife. © The State of New South Wales, Office of Environment and Heritage (OEH, 2013a).
- PlantNET (RBGDT, 2013) for Rare or Threatened Australian Plants (ROTAP).

- Protected Matters Search Tool (PMST) for matters protected by the EPBC Act (Department of Sustainability, Environment, Water, Population and Communities 2013).
- Vegetation Types Database (OEH, 2012).

Other sources of biodiversity information reviewed included:

- Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands South Coast - Illawarra Vegetation Integration (SCIVI) by Tozer *et al.* (2010).
- Shoalhaven City Council on-line vegetation maps (SCC, 2004).
- Wildlife corridor, threatened biodiversity mapping and *SEPP 14 Coastal Wetlands* accompanying the *South Coast Regional Conservation Plan* (Department of Environment, Climate Change and Water, 2010).
- Threatened biodiversity profiles from the NSW threatened species database (OEH, 2012).
- The Species Profile and Threats Database (DSEWPaC, 2013a).
- Threatened biodiversity final determinations by the NSW Scientific Committee.

### 2.3.2 Literature

The main report reviewed as background to the current investigation was the *Gerringong to Bomaderry, Princes Highway Upgrade Flora and Fauna Assessment* (Biosis, 2009). Key results and assessments of the Biosis (2009) report are summarised below:

- Two threatened ecological communities (TECs), including Illawarra lowlands grassy woodland in the Sydney Basin Bioregion (ILGW) and River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (RFEFCF) were recorded as occurring in the PEI study area. Impact assessments were carried out for each of these TECs and it was determined that the previous proposed concept plan was unlikely to have a significant impact upon either.
- A total of 22 plant species listed on the TSC and/or EPBC Act, or their habitat, had been previously recorded within a 10 kilometre radius of the PEI study area. Of these, six threatened plant species were considered to have a medium to high likelihood of occurrence in the PEI study area based on previous records and habitat. Impact assessments were carried out for each of these species and determined that the formerly assessed route was unlikely to have a significant impact upon any of the subject species of flora.
- No TSC or EPBC Act flora species were recorded in the 2007 to 2009 surveys.
- A total of 95 fauna species listed on the TSC and/or EPBC Act, or their habitat, had been previously recorded within a 10 kilometre radius of the PEI study area. Based on the proximity of records and the presence of identified habitat preferences, known and/or potential habitat was considered present within the PEI study area for 41 threatened and 22 migratory fauna species.
- Eight threatened and four migratory fauna species were recorded within and/or surrounding the PEI study area during the 2007 to 2009 surveys:
  - Impacts to the potential habitat of 26 threatened species were considered negligible and therefore, significance assessments were not conducted for these species.
  - Impact assessments were carried out for the eight recorded species and seven remaining threatened fauna species. These assessments concluded a significant impact was unlikely to result from the formerly assessed route. Impacts to the potential habitat of the 22 migratory species were considered to be negligible.
- Following field surveys Biosis (2009) determined that the proposal was unlikely to result in a significant effect on any species, population or community, and that a Species Impact Statement (SIS) and/or referral to the Commonwealth Minister for the Environment, Heritage and Water was not considered necessary.



The following reports were also reviewed:

- Foxground and Berry Bypass Princes Highway Upgrade. Environmental Assessment Volume 2 – Appendix F Technical Paper: Terrestrial Flora and Fauna. (Biosis, 2012).
- Green and Golden Bell Frog Assessment for the Princes Highway Upgrade – Gerringong (Niche, 2012).
- ‘South Coast Regional Conservation Plan’. (DECCW, 2010).
- Princes Highway Upgrade - Berry to Bomaderry Upgrade. Technical Paper: Aquatic Ecology and Water Quality Management (Cardno Ecology Lab 2013).

## 2.4 Taxonomy and nomenclature

The plant taxonomy (classification) and nomenclature used in this report follows the most recent Flora of New South Wales (Harden 1990; Harden 1992; Harden 1993; Harden 2002). All doubtful species names were verified with the on-line Australian Plant Name Index. In the text of this report plants are referred to by their scientific names only. Plant common names, where available, have been included in threatened species tables and the complete flora list in **Appendix A**.

Names of vertebrates follow the Census of Australian Vertebrates (CAVs) maintained by the Commonwealth *Department of Sustainability, Environment, Water, Population and Communities* (DSEWPaC) (DEWHA 2009a). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the fauna list in **Appendix A**.

## 2.5 Flora surveys

### 2.5.1 Previous surveys

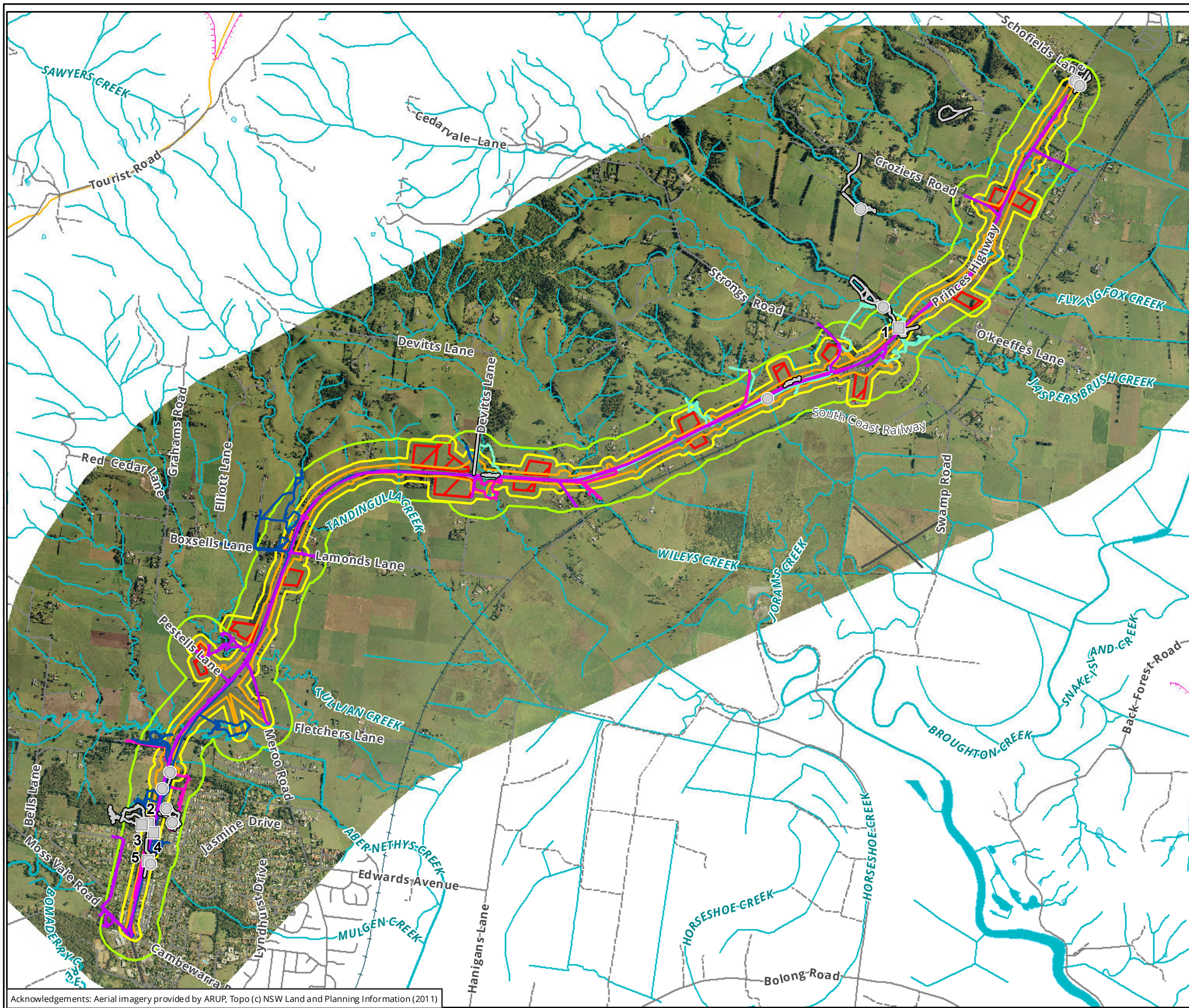
Flora surveys of the PEI study area were carried out over eight days spanning 2007 to 2009. Flora surveys involved targeted searches for threatened plant species using random meander techniques and ground truthing of the plant communities using plot-based surveys. An assessment of vegetation community and habitat condition was conducted at all survey sites. Surveys were conducted in accordance with the draft DECCW publication, *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC, 2004). Survey effort was focused in areas identified as known or potential habitat for threatened plant species and areas identified as TECs. Previous flora survey effort is quantified in Biosis (2009) and is included in the cumulative flora survey effort of **Table 2-1** in **Section 2.5.2**. **Figure 2-1** includes a summary of the previous flora survey effort.

### 2.5.2 Current surveys

Flora surveys of the study area were carried out over four days between 20 and 26 of March 2013 (**Figure 2-1**). The objectives of the current flora surveys are highlighted in **Section 2.2**. The current surveys involved:

- Target searches for threatened flora species known or predicted from the locality.
- Identification of the presence and extent of TECs.
- Ground truthing vegetation mapping to either confirm or amend the previous classification by Biosis (2009) consistent with the most current vegetation communities from Tozer *et al.* (2010) and according to the OEH (2012b) Vegetation Types Database.
- Determining the potential for the study area to provide habitat for threatened flora species and determine the need for, and location of, more intensive and seasonal surveys.
- Assess vegetation condition to identify areas for more detailed survey according to the BBAM should offsets be required.
- Map occurrences of weeds, particularly weeds listed under the *Noxious Weeds Act 1993*.





- Legend**
- 2013 flora survey**
- Random meander 20 March 2013
  - Random meander 21 March 2013
  - Random meander 22 March 2013
  - Random meander 26 March 2013
- 2009 flora survey**
- Habitat condition assessment
  - Quadrat
  - Random meander transect
- Survey area**
- ▭ Subject site (direct impacts)
  - ▭ Subject site (indirect impacts)
  - ▭ Study area (ancillary buffer)
  - ▨ Potential construction ancillary facilities

**Figure 2.1: Flora surveys including 2013 and 2009**

0 280 560 840 1,120 1,400  
Meters

Scale: 1:28,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

Biosis Pty Ltd

Ballarat, Brisbane, Canberra, Melbourne,  
Sydney, Wangaratta & Wollongong

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)

Matter: 15896  
Date: 28 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
Location: P:\15800s\15896\mapping\15896\_F2.1\_Flora\_Survey\_20130813



A summary of cumulative flora survey effort encompassing the surveys commencing in 2007 and up to March 2013 is provided in **Table 2-1**.

**Table 2-1 Cumulative flora survey effort from 2007 to 2013**

Dates of survey	Survey objectives	Survey type	Survey effort (hrs)
20/7/2007, 22/2/2007, 6/11/2008, 11/11/2008, 12/11/2008	Targeted searches for threatened species	Random meanders and parallel line transects	17
20/2/2007, 12/11/2008, 22/5/2009	Describe structure and floristics of each plant community. Identify TECs and search for inconspicuous plant species	Quadrats with five quadrats sampled each measuring 20 x 20 metre or 40 x 10 metre (400 square metres)	6
20/4/2013, 21/4/2013, 22/4/2013, 26/4/2013	Targeted searches for threatened species. Ground truth and amend or confirm existing vegetation mapping. Identify TECs Initial BBAM condition assessment	Detailed vegetation community mapping Random meanders Targeted surveys of specific features or locations	32

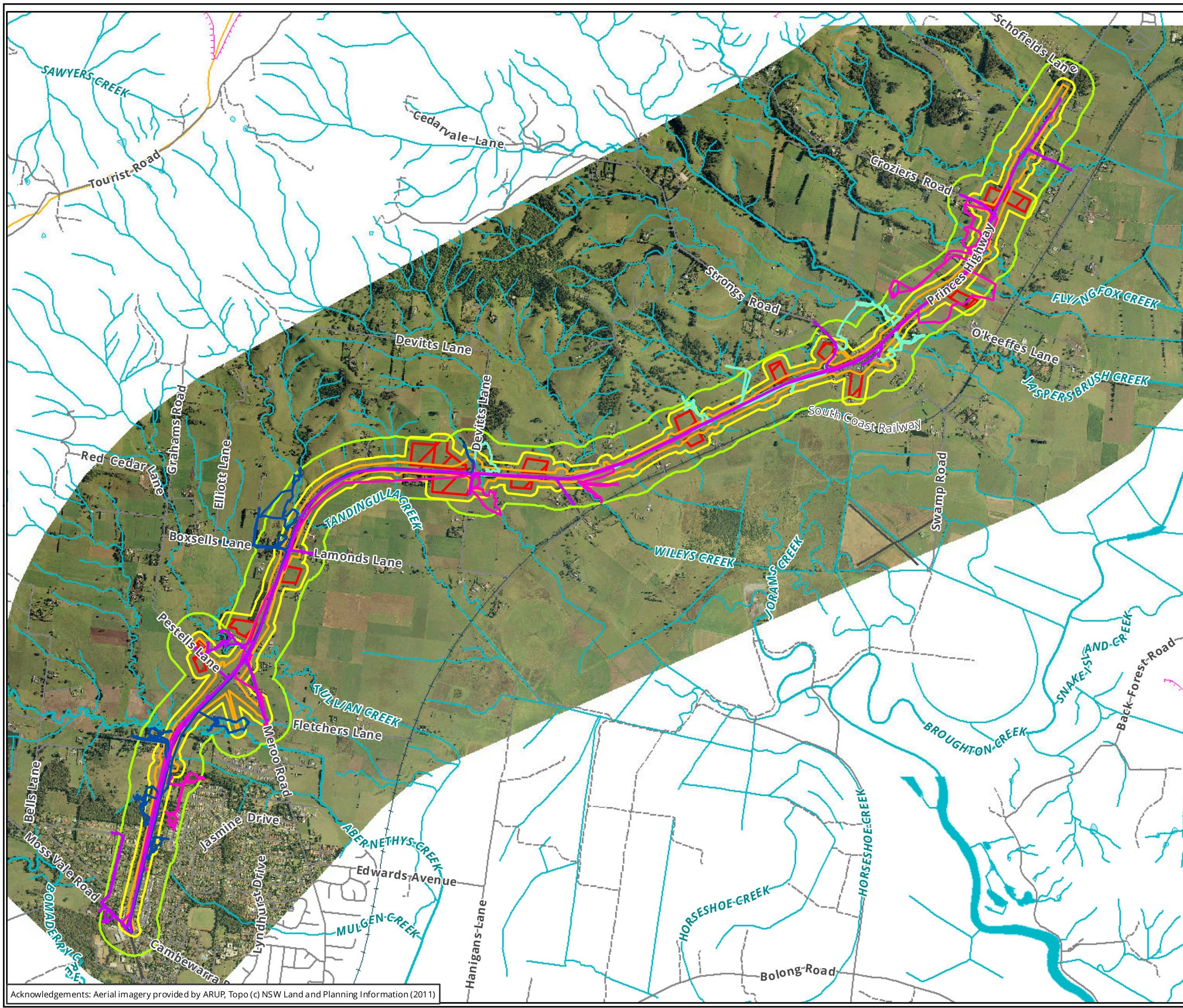
Derived vegetation communities and planted vegetation have been mapped to distinguish these from either native vegetation communities that have a higher conservation value, or to rule out the presence of TECs. This information has informed the proposal design and development, such as the temporary construction ancillary facilities constraints analysis, and highlights areas of low constraint and lower biodiversity impact risk to assist in the detailed design of the proposal. The grassland vegetation corresponding to grazed paddocks and managed or unmanaged pastures has not been mapped in **Figures 3-1 to 3-22** to maintain visual clarity for areas native or derived vegetation with higher biodiversity values. Other vegetation excluded from the mapping includes landscaped gardens and plantings of trees in urban areas and rural properties.

## 2.6 Fauna surveys

### 2.6.1 Previous surveys

Fauna surveys of the PEI study area were carried out over 22 days spanning 2007 to 2009. Fauna surveys involved targeted searches for threatened fauna and their habitats involving a range of techniques including diurnal bird surveys, spotlighting, targeted frog and reptile surveys, harp trapping, Anabat placement, incidental observations for indirect and direct evidence of fauna and fauna habitat condition assessment. Surveys were conducted in accordance with the DEC (2004) survey guidelines and survey effort was focused in areas identified as known or potential habitat for threatened fauna species. Previous fauna survey effort is quantified in Biosis (2009) and is included in the cumulative fauna survey effort of **Table 2-2** in **Section 2.6.2**. **Figure 2-3** shows the previous fauna survey effort.





- Legend**
- 2013 fauna survey**
- Random meander 20 March 2013
  - Random meander 21 March 2013
  - Random meander 22 March 2013
  - Random meander 26 March 2013
- Survey area**
- ▭ Subject site (direct impacts)
  - ▭ Subject site (indirect impacts)
  - ▭ Study area (ancillary buffer)
  - ▭ Potential construction ancillary facilities

**Figure 2.2: Fauna surveys**

0 280 560 840 1,120 1,400  
Meters

Scale: 1:28,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

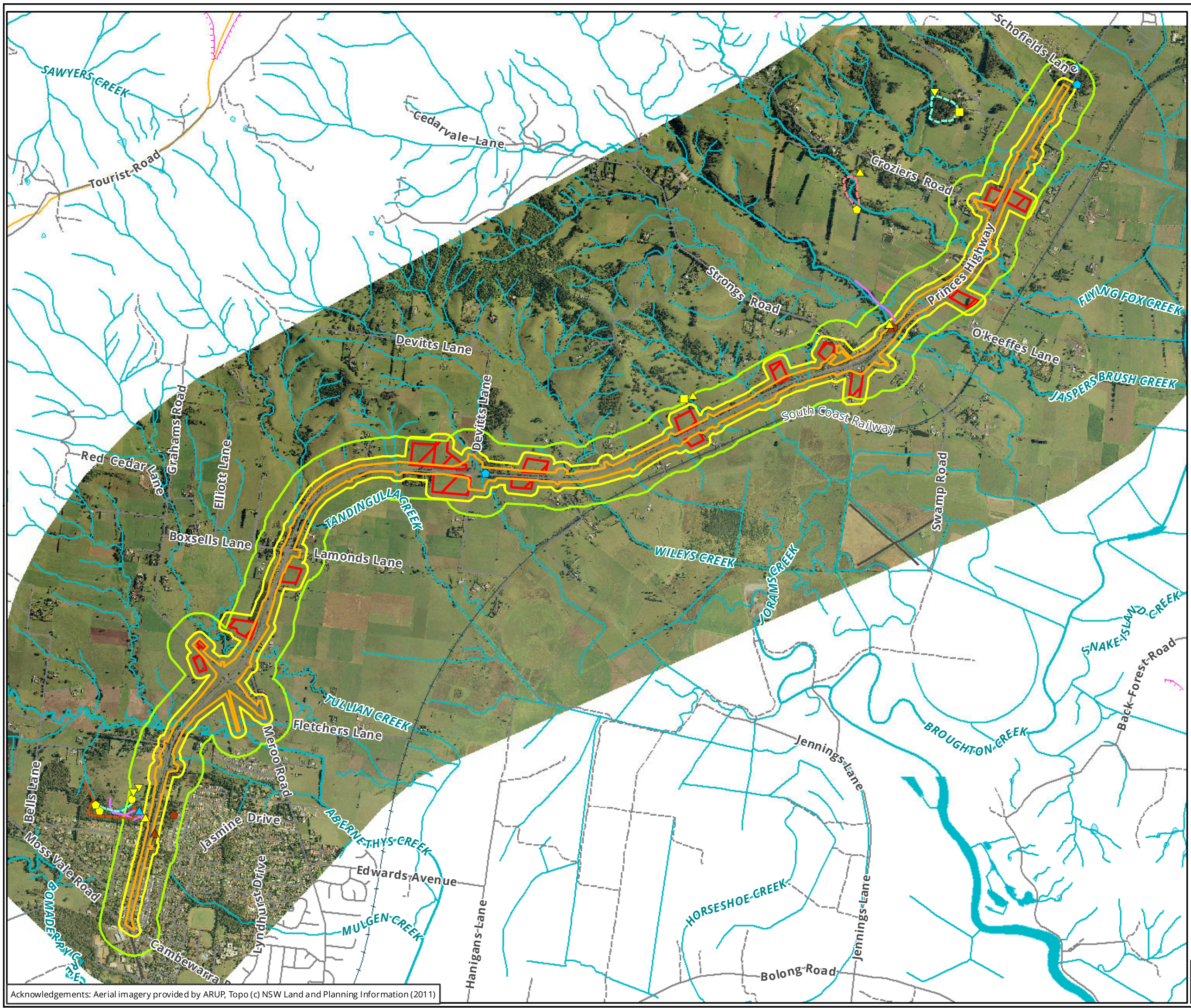
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Sydney, Wangaratta & Wollongong

Matter: 15896  
Date: 28 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
Location: P:\15800s\15896\mapping\15896\_F2.2\_FaunaSurvey\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)





**Legend**

**Previous surveys**

**Summer 2007**

- Anabat
- Anabat/Harp trap
- ▲ Bird survey
- ▼ Frog survey
- ◆ Habitat assessment

**Spring 2008**

- ▲ Bird survey
- ◆ Habitat assessment

**Autumn 2009**

- ▲ Bird survey
- ◆ Habitat assessment

**Previous transects**

**Spring 2008**

- Spotlighting

**Summer 2007**

- - - Bird survey
- - - Spotlighting
- - - Spotlighting/Nocturnal bird survey

**Survey area**

- ▭ Subject site (direct impacts)
- ▭ Subject site (indirect impacts)
- ▭ Study area (ancillary buffer)
- ▭ Potential construction ancillary facilities

**Figure 2.3: Fauna survey effort**

0 280 560 840 1,120 1,400  
Meters

Scale: 1:28,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

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Ballarat, Brisbane, Canberra, Melbourne,  
Sydney, Wangaratta & Wollongong

Matter: 15896  
Date: 28 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
Location: P:\15800s\15896\mapping\15896\_F2.3\_FaunaSurvey\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)



## 2.6.2 Current surveys

Fauna surveys of the study area were carried out over four days between 20 and 26 March 2013 (**Figure 2-2**). The objectives of the current fauna surveys are highlighted in **Section 2.2** and the surveys primarily involved fauna habitat assessment focusing on, but not limited to, areas of better quality or specific fauna species habitats, and included active searching for native fauna in locations of preferential habitat such as native vegetation and drainage lines. The current surveys involved:

- Assessing broad fauna habitat types and identifying significant fauna habitat features such as feed trees, nesting and refuge resources, hollow bearing trees and water bodies.
- Recording hollow bearing trees and stags using a handheld GPS and noting features such as tree species and the number and location of hollows.
- Compiling a fauna species inventory for the study area by direct sightings, observations of other signs and traces (such as tracks and scats) and aural recognition of calls.
- Determining the potential for the study area to provide habitat for threatened fauna species, including the Green and Golden Bell Frog *Litoria aurea* (in accordance with DEWHA 2009b), and determine the need for and location of more intensive and seasonal surveys.
- Given a known population occurs in the locality, a targeted Koala *Phascolarctos cinereus* habitat assessment was undertaken in accordance with the 'Interim Koala Referral Advice for Proponents' (DSEWPac 2012a) and SEPP 44 criteria for Koala habitat (outlined in **Section 3.10**). Searches for evidence of Koala were undertaken during the habitat assessment, including the identification of primary and secondary feed trees throughout the study area. Where appropriate feed trees were located, searches for scats were undertaken around the base, signs of scratches on tree trunks were investigated and tree canopies were surveyed for individuals.

A summary of cumulative fauna survey effort encompassing the surveys commencing in 2007 and up to March 2013 is provided in **Table 2-2**.

**Table 2-2 Cumulative fauna survey effort from 2007 to 2013**

Dates of survey	Survey objectives	Survey type	No. of sites (surveys)	Total transect length (metres)	Total person hours	Total trap / record nights
12 to 21/2/2007	Targeted searches for threatened species and habitat assessments	Diurnal bird survey	7 (10)	611	3.8	n/a
3 to 11/11/2008		Spotlighting (mammals, birds and frogs)	3 (5)	3038	5.0	n/a
18 to 22/5/2009		Frog survey	2 (3)	n/a	3.3	n/a
		Anabat	3 (3)	n/a	n/a	3
		Harp trap	1 (1)	n/a	n/a	1
		Habitat assessment	5 (7)	n/a	n/a	n/a
20/4/2013, 21/4/2013, 22/4/2013, 26/4/2013	Threatened species habitat assessments and hollow bearing tree surveys	Habitat assessment	23 (4)	n/a	40	n/a

## 2.7 Threatened and migratory species likelihood of occurrence criteria

The likelihood of occurrence assessment for threatened flora and fauna and migratory species was based on previous records collated from database searches, data collected during the field survey, the current (known) distribution range of these species, and the presence and condition of suitable habitat in the locality. The criteria to assess the likelihood of threatened flora and fauna or migratory fauna species occurring within the locality is presented in **Table 2-3**.

**Table 2-3 Likelihood of occurrence assessment criteria**

Likelihood of occurrence	Assessment criteria
Low	<p>Species considered to have a low likelihood of occurrence include species not recorded in the field surveys that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>• Have not been recorded previously in the study area or locality and the study area is beyond the known distribution or range.</li> <li>• Are dependent on a narrow range or specific habitats that do not or are not likely to occur in the study area.</li> <li>• Are considered locally extinct.</li> <li>• Are a non-cryptic perennial flora species that were targeted during field surveys.</li> <li>• Are flora species that have a very limited range and highly specific dispersal mechanisms.</li> </ul>
Moderate	<p>Species considered to have a moderate likelihood of occurrence include species not recorded in the field surveys that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>• There are infrequent records for the species in the study area and locality.</li> <li>• Preferential habitats of the species are present in the study area but these are mainly in a poor or modified condition.</li> <li>• May use or occur in habitats within the study area opportunistically during seasonal migration but are unlikely to be present on a permanent basis as a population or as vagrant individuals.</li> <li>• Are cryptic flowering flora species that were not seasonally targeted during surveys.</li> </ul>
High	<p>Species considered to have a high likelihood of occurrence include species recorded during the field surveys or species not recorded that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>• Have a high incidence of previous records in the study area and locality.</li> <li>• Preferentially use habitats that are present in the study area which are abundant and/or in good condition.</li> <li>• Recorded populations are known in the study area or locality.</li> <li>• Are known to regularly use habitats of the site or locality or are highly likely to visit the site during seasonal dispersal or migration.</li> </ul>

## 2.8 Temporary construction ancillary facility sites

Temporary construction ancillary facilities (such as compound sites, stockpiles and sediment basins) would be required for the proposal. Locations for potential construction ancillary facilities have been identified, in consultation with RMS through a preliminary environmental constraints analysis on land within a 200 metre buffer of the proposal corridor (study area) as shown in **Figure 1**. The use of each potential temporary construction ancillary facility has not yet been determined, however a range of potential activities that could be undertaken at each of the potential temporary construction ancillary facility have been proposed. An impact assessment of all identified potential construction ancillary facility sites and potential activities that could be performed on these sites has been undertaken. The preliminary selection criteria that have been considered in the assessment for terrestrial ecology are:

- No substantial vegetation clearing (unless required for project alignment) with sites to have low conservation significance for flora and fauna.
- No removal of TEC's unless area is to be cleared for the highway footprint.

## 2.9 Limitations

The current field surveys were conducted over four days during autumn 2013 and were primarily a habitat based assessment to identify the need for further targeted surveys for threatened biodiversity.

Ecological surveys provide a sampling of flora and fauna at a given time and season. There are a number of reasons why not all species would be detected at a site during survey, such as species dormancy, seasonal conditions, ephemeral status of water bodies and migration and breeding behaviours of some fauna. In many cases these factors do not present a significant limitation to assessing the overall biodiversity values of a site.

In relation to the amount of survey effort in the current investigation and its timing, an adequate sample of the spectrum of flora and fauna species and assessment of the ecological processes that are likely to occur on the study area have been made from desktop assessments, background research and the surveys in autumn 2013. However the full spectrum of flora and fauna species and ecological processes likely to occur on the subject site and in the study area cannot be fully quantified or described in this report.

These limitations have been partly addressed by identifying potential habitats for flora and fauna species and assessing the potential for these species to occur on the subject site and within the study area based on previous records, the type and condition of habitats present, the land use throughout the study area and surrounds (landscape context).

Database searches, and associated conclusions on the likelihood of species to occur within the study area, are reliant upon external data sources and information managed by third parties.

Targeted surveys for threatened species assessed as likely to occur in the study area following the habitat based surveys have been deferred until detailed design/prior to construction. The decision to postpone targeted threatened species surveys to a later date is based on:

- Seasonal survey requirements for some species that cannot be achieved prior to determination of the proposal.
- Population dynamics for some fauna species that may result in either favourable or unfavourable environmental conditions affecting occupation and dispersal in preferable habitats.
- Consideration of the potential impacts in relation to the detailed design and undertaking targeted surveys at that time, prior to the commencement of construction, which would enable a more accurate assessment of potential impacts on these species.

Targeted surveys recommended during the current assessment have been deferred until the detailed design phase of the proposal, and consequently the assessments of significance have been prepared using a precautionary approach. It is assumed that the recommended further targeted surveys would proceed closer to the detailed design phase. This would include adequate lead time to make full and complete surveys at appropriate times of the year for the targeted species and according to any species specific survey guidelines in place at the time of surveys. Additionally the outcomes of the assessments of significance also rely on the premise of avoiding, mitigating and offsetting residual impacts to biodiversity (RTA, 2011). The assessments of significance for the targeted species would be updated following completion of the targeted surveys and any additional mitigation measure identified would be included in the Construction Environmental Management Plan for the proposal.

## 3 Existing environment

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### 3.1 Landscape context

The proposal spans approximately 11.5 kilometres of the Princes Highway between Schofields Lane (south of Berry) and Cambewarra Road, Bomaderry (**Figure 1**) within the Shoalhaven City Council Local Government Area (LGA). The study area covers the existing Princes Highway road reserve, privately owned rural agricultural, rural residential and suburban properties and Shoalhaven City Council reserves. Additionally the proposal occurs in the:

- Illawarra sub region at the southernmost extent of the Sydney basin bioregion in the Interim Biogeographic Regionalisation of Australia (IBRA) system (Thackway and Cresswell, 1995).
- Shoalhaven subregion of the Southern Rivers catchment area. The subregion covers an area of 4660 kilometre<sup>2</sup> spanning 1000 kilometres of the NSW South Coast from Foxground in the north to Durras in the south (SRCMA, 2013).

The proposal is predominantly located on the western margin of the Shoalhaven floodplain and low undulating rises that have been substantially cleared for agriculture. Patches of native vegetation and isolated remnant trees are scattered throughout the majority of this highly modified rural landscape.

The low rises in the study area extend west to the well vegetated and steep slopes of the Cambewarra Range. The proposal crosses a number of creeks including Flying Fox Creek, Jaspers Brush Creek, Wileys Creek, Tandingulla Creek, Tullian Creek, Abernethys Creek and several unnamed drainage lines that descend from the low hills and ranges in the west to the Shoalhaven floodplain in the east.

Conservation reserves that occur either in or just outside the locality include the Cambewarra Range Nature Reserve, the Seven Mile Beach National Park, Comerong Island Nature Reserve, Red Rocks Nature Reserve and the Bomaderry Creek Regional Park. None of these reserves directly adjoin or would be directly impacted by the proposal.

### 3.2 Land use

The study area mainly comprises the existing road reserve, privately owned rural and rural-residential properties and Shoalhaven City Council reserves, collectively supporting houses, cleared paddocks, constructed dams and recreation areas. Small patches of native vegetation and isolated remnant trees are scattered throughout the majority cleared agricultural landscape beyond the Bomaderry urban fringe. Rural land use over the majority of the study area includes dairy farming, beef production, silviculture, vineyards and turf farming which continue to maintain the landscape at a high level of modification.

In addition to the Princes Highway road reserve and minor roads other major linear infrastructure in the locality in places are high voltage transmission lines and the South Coast rail line.


### 3.3 Vegetation communities and habitat

#### 3.3.1 Vegetation communities

Seven native vegetation communities occur in the study area, including two TECs listed solely under the TSC Act and two derived native plant communities. All seven vegetation communities occur in the subject site and would potentially be directly and indirectly impacted. Two additional vegetation communities, Grassland and Planted, that are not considered to be native or derived vegetation communities are also present in the subject site and study area. **Tables 3-1 to 3-9** describe the vegetation communities of the study area.

**Table 3-1 Poor to good condition Currumbene Batemans lowland forest**


<b>Extent within subject site (direct) (approx)</b>	1.44 hectares of mapped Currumbene Batemans lowland forest in <b>Figures 3-1 to 3-22</b> .
<b>Description</b>	<p>Canopy: variable from almost pure stands of <i>Corymbia maculata</i>, such as at that adjoining the Princes Highway near Devitts Lane, to patches that include <i>Corymbia gummifera</i> and <i>Syncarpia glomulifera</i> ssp. <i>glomulifera</i> with occasional <i>Eucalyptus sclerophylla</i>, as occurs in the large area of the community near the southern end of the alignment.</p> <p>Mid canopy: some areas of the community such as the stand near to the southern end of the alignment include a mid -canopy of regenerating canopy species, including <i>Allocasuarina littoralis</i>, <i>Glochidion ferdinandi</i> var. <i>ferdinandi</i> and scattered <i>Pittosporum undulatum</i>.</p> <p>Understorey: largely absent in most stands of the community but with some patches including sparse <i>Bursaria spinosa</i>, <i>Pittosporum revolutum</i> and <i>Leucopogon juniperinus</i>.</p> <p>Groundcover: good condition remnant stands support a high percentage cover of native grasses and herbs. Dominant species include <i>Brunoniella australis</i>, <i>Commelina cyanea</i>, <i>Echinopogon caespitosus</i> var. <i>caespitosus</i>, <i>Entolasia marginata</i>, <i>Lepidosperma laterale</i>, <i>Microlaena stipoides</i> var. <i>stipoides</i> and <i>Pratia purpurascens</i> with introduced species such as <i>Bidens pilosa</i>, <i>Paspalum dilatatum</i>, <i>Pennisetum clandestinum</i>, <i>Sida rhombifolia</i> and <i>Sonchus oleraceus</i>. In lower condition stands of the community, such as those subject to grazing, the groundcover stratum is dominated by introduced pasture species and environmental weeds including <i>Bromus catharticus</i>, <i>Paspalum dilatatum</i>, <i>Pennisetum clandestinum</i>, <i>Rumex crispus</i> and <i>Trifolium repens</i>.</p>
<b>Condition</b>	Poor to Good. Areas in Good condition include those at the north-east corner of Princes Highway and Devitts Lane ( <b>Figure 3-10</b> ) and the patch to the south on the western side of Princes Highway ( <b>Figure 3-2</b> ). These areas are intact and have a largely native midstorey, understorey and groundcover. Other stands of the community range from Poor to Moderate condition dependant on levels of disturbance such as grazing and weed invasion. Areas in Moderate condition have intact canopy with mid and under storey absent but a mix of native and introduced groundcovers and less intense grazing. Areas in Poor condition are characterised by declining trees in the canopy, thickets of woody weeds such <i>Lantana camara</i> and <i>Ligustrum lucidum</i> or with no mid or understorey and groundcovers dominated by introduced grasses and herbs with severe compaction of soils.
<b>Threatened species of plant?</b>	<p>None recorded. The Moderate to Good condition stands of this community provide potential habitat for the following threatened species of ground orchid:</p> <ul style="list-style-type: none"> <li>• Pterostylis gibbosa.</li> <li>• Cryptostylis hunteriana.</li> <li>• Genoplesium baueri.</li> </ul>
<b>Threatened community?</b>	No.
<b>Southern Rivers CMA Biometric vegetation type</b>	Red Bloodwood - Blackbutt - Spotted Gum shrubby open forest on coastal foothills, southern Sydney Basin.

<b>Estimated per cent cleared of Biometric vegetation type in the Southern Rivers CMA</b>	45
	

**Table 3-2 Moderate to good condition Shoalhaven sandstone forest**

<b>Extent within subject site (direct) (approx)</b>	0.24 hectare of mapped Shoalhaven sandstone forest in <b>Figures 3-1 to 3-22</b> .
<b>Description</b>	<p>Canopy: although canopy of this community is floristically similar to Currumbene Batemans lowland forest the dominant species differ and the two patches of the community are likely to be transitional forms to Currumbene Batemans lowland forest. Canopy of the Shoalhaven sandstone forest is dominated by <i>Eucalyptus sclerophylla</i>, <i>Corymbia gummifera</i> and <i>Allocasuarina littoralis</i> with <i>Corymbia maculata</i> and <i>Syncarpia glomulifera</i> ssp. <i>glomulifera</i> occasional.</p> <p>Mid canopy: regenerating canopy species and <i>Pittosporum undulatum</i> form an open mid canopy in places.</p> <p>Understorey: present and well developed in places such as the stand west of Moss Vale Road and Princes Highway and in the reserve between Princes Highway and Sheraton Crescent. Common native shrubs include <i>Banksia spinulosa</i> var. <i>spinulosa</i>, <i>Daviesia ulicifolia</i>, <i>Kunzea ambigua</i>, <i>Lambertia formosa</i>, <i>Pittosporum revolutum</i> and <i>Platylobium formosum</i> ssp. <i>formosum</i>. Elsewhere such as where the community is present on private properties and the road reserve to the south of the study area the understorey is either absent or very sparse due to ongoing maintenance.</p> <p>Groundcover: good condition remnant stands support high percentage cover of native grasses and herbs with dominant species including <i>Anisopogon avenaceus</i>, <i>Dianella caerulea</i> var. <i>caerulea</i>, <i>Imperata cylindrica</i>, <i>Microlaena stipoides</i> var. <i>stipoides</i>, <i>Mirbelia rubiifolia</i>, <i>Paspalidium distans</i>, <i>Pratia purpurascens</i>, <i>Stylidium graminifolium</i> and <i>Themeda australis</i>. Introduced species are present mainly around the edges to cleared and managed landscapes or in locations of previous disturbance, such as where earthworks have occurred. Common introduced grasses, herbs and vines include <i>Briza maxima</i>, <i>Conyza</i> sp., <i>Hypochaeris radicata</i>, <i>Lonicera japonica</i>, <i>Stenotaphrum secundatum</i> and <i>Thunbergia alata</i> with occasional woody weeds such as <i>Lantana camara</i> and <i>Pavonia hastata</i> present in some areas of the community.</p>
<b>Condition</b>	Moderate to Good. The two main stands of this community are in a Moderate ( <b>Figure 3-2</b> ) to Good ( <b>Figure 3-1</b> ) condition with remnant or regrowth canopy and native shrubs and groundcovers present.
<b>Threatened species of plant?</b>	<p>None recorded. The Moderate to Good condition stands of this community provide potential habitat for the following threatened species of ground orchid:</p> <ul style="list-style-type: none"> <li>• <i>Pterostylis gibbosa</i>.</li> <li>• <i>Cryptostylis hunteriana</i>.</li> <li>• <i>Genoplesium baueri</i>.</li> </ul>
<b>Threatened community?</b>	No.
<b>Southern Rivers CMA Biometric vegetation type</b>	Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin



<b>Estimated per cent cleared of Biometric vegetation type for Southern Rivers CMA</b>	20
	

**Table 3-3 Poor to moderate condition Illawarra gully wet forest**

<b>Extent within subject site (direct) (approx)</b>	0.98 hectare of mapped Illawarra gully wet forest in <b>Figures 3-1 to 3-22</b> .
<b>Description</b>	<p>Canopy: <i>Eucalyptus saligna</i> X <i>botryoides</i> and <i>Eucalyptus pilularis</i> dominate with occasional <i>Corymbia maculata</i> and <i>Syncarpia glomulifera</i> ssp. <i>glomulifera</i> and uncommon occurrences of <i>Eucalyptus paniculata</i> ssp. <i>paniculata</i> and <i>Eucalyptus teretecornis</i>.</p> <p>Mid canopy: regenerating canopy species, <i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>, <i>Acacia binervata</i>, <i>Acacia maidenii</i> and <i>Pittosporum undulatum</i> form an open mid canopy in places.</p> <p>Understorey: poorly developed, absent or dominated by woody weeds across the several small patches of the community. Occasional native shrubs include <i>Breynia oblongifolia</i>, <i>Notelaea longifolia</i>, and <i>Pittosporum revolutum</i>. Woody weeds include <i>Lantana camara</i> and <i>Ligustrum sinense</i>.</p> <p>Groundcover: generally poor condition but with minor patches of native species present or dispersed throughout introduced grasses and herbs. Common to occasional native groundcover species include <i>Dichondra repens</i>, <i>Glycine tabacina</i>, <i>Microlaena stipoides</i> var. <i>stipoides</i>, <i>Oplismenus aemulus</i>, <i>Pteridium esculentum</i> and <i>Tylophora barbata</i>. Common introduced plant species include <i>Paspalum dilatatum</i>, <i>Pennisetum clandestinum</i> and <i>Trifolium repens</i>.</p>
<b>Condition</b>	Poor to Good. The most intact and resilient stand is a small patch of the community adjoining the large area of Currambene Batemans lowland forest in the south of the study area ( <b>Figure 3-2</b> ). The stand of the community nearby and further to the north ( <b>Figure 3-3</b> ) is in Moderate condition whilst the remaining small isolated stands are considered to be in Poor condition and are subject to grazing by livestock.
<b>Threatened species of plant?</b>	None recorded. Based on the condition of the vegetation and size of the individual stands, habitat potential for threatened plant species in this community is considered to be low.
<b>Threatened community?</b>	No.
<b>Southern Rivers CMA Biometric vegetation type</b>	Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin.
<b>Estimated per cent cleared of Biometric vegetation type in the Southern Rivers CMA</b>	50




**Table 3-4 Poor to moderate condition Riverbank forest**

<b>Extent within subject site (direct) (approx)</b>	0.53 hectare of mapped Riverbank forest in <b>Figures 3-1 to 3-22</b> .
<b>Description</b>	<p>Canopy: dominated in all areas by <i>Casuarina cunninghamiana</i> ssp. <i>cunninghamiana</i> with occasional or uncommon occurrences of Eucalyptus species including <i>Eucalyptus botryoides</i> and <i>Eucalyptus tereticornis</i>.</p> <p>Mid canopy: woody weeds, such as <i>Salix babylonica</i>, <i>Cinnamomum camphora</i>, and <i>Erythrina x sykesii</i>, form dense stands in places. Elsewhere the mid canopy is sparse, and, where present, includes the dominant woody weeds and regenerating <i>Casuarina cunninghamiana</i> ssp. <i>cunninghamiana</i>, <i>Acacia binervata</i> and <i>Acacia maidenii</i>. The native vine <i>Pandorea pandorana</i> forms shrouds over the mid canopy on open edges.</p> <p>Understorey: thickets of <i>Lantana camara</i> are common in the more open areas of the community such as the edge of the road reserve. The understorey is mainly absent in areas that are being grazed but is characterised by woody weeds interspersed with small native trees and shrubs where riparian zones have been fenced off. Other common woody weeds are <i>Ligustrum</i> spp. and <i>Salix fragilis</i> var. <i>fragilis</i>. Native species in the understorey include <i>Breynia oblongifolia</i>, <i>Ficus coronata</i>, <i>Hymenanchera dentata</i>, <i>Pittosporum multiflorum</i>, <i>Pittosporum undulatum</i> and <i>Streblus brunonianus</i>.</p> <p>Groundcover: generally in Poor condition with introduced grasses, herbs, vines and semi aquatic weeds dominating, but with minor patches of native species present or dispersed throughout. Common introduced species are <i>Ageratina riparia</i>, <i>Araujia sericifera</i>, <i>Bidens pilosa</i>, <i>Cyperus eragrostis</i>, <i>Paspalum dilatatum</i>, <i>Rumex crispus</i>, <i>Sida rhombifolia</i>, <i>Solanum nigrum</i> and <i>Tradescantia fluminensis</i>. Native species of the groundcover include <i>Commelina cyanea</i>, <i>Dichondra repens</i>, <i>Lomandra longifolia</i>, <i>Microlaena stipoides</i> var. <i>stipoides</i>, <i>Oplismenus aemulus</i>, <i>Persicaria strigosa</i>, <i>Pteridium esculentum</i> and <i>Urtica incisa</i>.</p>
<b>Condition</b>	Poor to Moderate. The majority of the community inspected and mapped in the current surveys is in Poor condition with areas of Moderate condition vegetation present on both sides of the Princes Highway on Jaspers Brush Creek.
<b>Threatened species of plant?</b>	None recorded. Based on the condition of the vegetation and size of the individual stands, habitat potential for threatened plant species in this community is considered to be low.
<b>Threatened community?</b>	Yes. Assessed as River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (RFEFCF).
<b>Southern Rivers CMA Biometric vegetation type</b>	River Oak open forest of major streams, Sydney Basin and South East Corner.
<b>Estimated per cent cleared of Biometric vegetation type in the Southern Rivers CMA</b>	40







**Table 3-5 Poor condition South Coast Grassy Woodland**

<p><b>Extent within subject site (direct) (approx)</b></p>	<p>0.30 hectare of mapped South Coast grassy woodland in <b>Figure 3-1 to 3-22</b>.</p>
<p><b>Description</b></p>	<p>Canopy: one stand of the community is characterised by regrowth <i>Eucalyptus tereticornis</i> and <i>Angophora floribunda</i> whilst the second stand in the study area, outside the subject site, is dominated by <i>Melaleuca styphelioides</i>.  Mid canopy: absent.  Understorey: absent.  Groundcover: in Poor condition with introduced grasses, and herbs dominating. Introduced plant species include <i>Bidens pilosa</i>, <i>Chloris gayana</i>, <i>Conyza</i> sp., <i>Euphorbia peplus</i>, <i>Paspalum dilatatum</i>, <i>Pennisetum clandestinum</i> and <i>Plantago lanceolata</i> with native species including <i>Centella asiatica</i>, <i>Commelina cyanea</i> and <i>Cynodon dactylon</i>.</p>
<p><b>Condition</b></p>	<p>Poor. The area of the community inspected and mapped in the current surveys is in Poor condition.</p>
<p><b>Threatened species of plant?</b></p>	<p>None recorded. Based on the condition of the vegetation and size of the individual stands, habitat potential for threatened plant species in this community is considered to be low.</p>
<p><b>Threatened community?</b></p>	<p>Yes. Assessed as Illawarra lowlands grassy woodland in the Sydney Basin Bioregion (ILGW).</p>
<p><b>Southern Rivers CMA Biometric vegetation type</b></p>	<p>Forest Red Gum - Thin-leaved Stringybark grassy woodland on coastal lowlands, southern Sydney Basin.</p>
<p><b>Estimated per cent cleared of Biometric vegetation type in the Southern Rivers CMA</b></p>	<p>85</p>
	

**Table 3-6 Moderate condition Reedland**


<b>Extent within subject site (direct) (approx)</b>	0.12 hectares of mapped Reedland in <b>Figures 3-1 to 3-22</b> .
<b>Description</b>	<p>Emergent: uncommon occurrences of individual shrubs or trees or small isolated patches of mixed native and introduced tree species including <i>Melaleuca linariifolia</i>, <i>Melaleuca styphelioides</i>, <i>Salix babylonica</i> and <i>Solanum mauritianum</i>.</p> <p>Overstorey: mainly comprising native reeds and rushes including <i>Bolboschoenus caldwellii</i>, <i>Phragmites australis</i>, <i>Typha domingensis</i>, <i>Typha orientalis</i> and <i>Schoenoplectus validus</i>.</p> <p>Groundcover: varying from Poor to Moderate condition including native sedges, herbs and floating attached species and introduced grasses and herbs. Common native species include <i>Carex longebrachiata</i>, <i>Centella asiatica</i>, <i>Cyperus brevifolius</i>, <i>Cyperus polystachyos</i>, <i>Hydrocotyle laxiflora</i>, <i>Ludwigia peploides</i> ssp. <i>montevidensis</i>, <i>Philydrum lanuginosum</i> and <i>Ranunculus inundatus</i>. Common introduced species include <i>Aster subulatus</i>, <i>Axonopus fissifolius</i>, <i>Cyperus eragrostis</i>, <i>Pennisetum clandestinum</i> and <i>Phalaris aquatica</i>.</p>
<b>Condition</b>	Poor. The area of the community inspected and mapped in the current surveys is in Poor condition.
<b>Threatened species of plant?</b>	None recorded. Based on the habitat type and previous threatened species record of the locality, potential for threatened plant species to occur in this community is considered to be low.
<b>Threatened community?</b>	Yes. High conservation value wetlands have been assessed by Cardno Ecology Lab (2013) as part of the Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
<b>Southern Rivers CMA Biometric vegetation type</b>	Reedland is a derived vegetation community with no corresponding Southern Rivers CMA Biometric vegetation type.
	

**Table 3-7 Poor condition Acacia scrub**


<b>Extent within subject site (direct) (approx)</b>	1.50 hectares of mapped Acacia scrub in <b>Figures 3-1 to 3-22</b> .
<b>Description</b>	<p>Canopy: mainly a mix of locally occurring Acacia species such as <i>Acacia decurrens</i>, <i>Acacia irrorata</i> ssp. <i>irrorata</i>, <i>Acacia maidenii</i>, <i>Acacia mearnsii</i> and <i>Acacia parramattensis</i> with occasional regrowth native tree species such as <i>Angophora floribunda</i>, <i>Eucalyptus botryoides</i>, <i>Eucalyptus tereticornis</i> and <i>Pittosporum undulatum</i>.</p> <p>Understorey: varies from absent in immature stands to well developed in more mature stands. Where present, the understorey is either characterised entirely by regenerating <i>Acacia</i> spp. or a mix of other native shrubs and introduced species such as <i>Hakea dactyloides</i>, <i>Cotoneaster</i> sp. and <i>Lantana camara</i> (in dry areas) and <i>Hymenanthera dentata</i> and <i>Ligustrum sinense</i> (in drainage and damp areas).</p> <p>Groundcover: in Poor condition and, as most areas of this derived community, is characterised by a suite of annual and perennial weeds commonly occurring throughout the disturbed areas of the road reserve with occasional occurrences of disturbance tolerant native species.</p>
<b>Condition</b>	Poor. The area of this derived community inspected and mapped in the current surveys is in Poor condition.
<b>Threatened species of plant?</b>	None recorded. Based on the habitat type and previous threatened species record of the locality, potential for threatened plant species to occur in this community is considered to be low.
<b>Threatened community?</b>	No.
<b>Southern Rivers CMA Biometric vegetation type</b>	Acacia scrub is a derived vegetation community with no corresponding Southern Rivers CMA Biometric vegetation type.
	



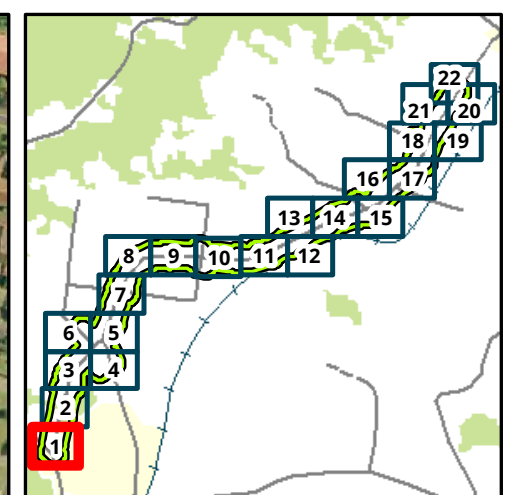
**Table 3-8 Poor condition Grassland**

<b>Extent within subject site (direct) (approx)</b>	86.87 hectares of estimated Grassland (not mapped)
<b>Description</b>	<p>Emergent: scattered and uncommon occurrences of native and introduced trees present as isolated individual trees or in small stands. Species include <i>Acacia</i> spp. <i>Casuarina cunninghamiana</i> ssp. <i>cunninghamiana</i>, <i>Corymbia maculata</i>, <i>Eucalyptus pilularis</i>, <i>Ficus macrophylla</i>, <i>Ficus obliqua</i>, <i>Syncarpia glomulifera</i> ssp. <i>glomulifera</i>, <i>Salix babylonica</i>, <i>Cinnamomum camphora</i> and <i>Erythrina x sykesii</i>.</p> <p>Groundcover: in Poor condition with introduced grasses and herbs dominating. Dominant or common species include <i>Axonopus fissifolius</i>, <i>Chloris gayana</i>, <i>Cirsium vulgare</i>, <i>Hypochaeris radicata</i>, <i>Paspalum urvillei</i>, <i>Pennisetum clandestinum</i>, <i>Phalaris aquatica</i>, <i>Rumex crispus</i>, <i>Senecio madagascariensis</i>, <i>Trifolium repens</i> and <i>Verbena bonariensis</i>. Native grasses and herbs present in minor patches or mixed through the exotic cover include <i>Cynodon dactylon</i>, <i>Commelina cyanea</i>, <i>Glycine</i> spp., <i>Dichondra repens</i>, <i>Microlaena stipoides</i> var. <i>stipoides</i> and <i>Themeda australis</i>.</p>
<b>Condition</b>	Poor. Grassland of the study area varies from closed to open dependant on the intensity of grazing or other rural uses such as slashing for silage and turf farming.
<b>Threatened species of plant?</b>	None recorded. Based on the condition of the vegetation and ongoing agricultural uses and management practices, habitat potential for threatened plant species in this community is considered to be low.
<b>Threatened community?</b>	No. This is an entirely altered vegetation community.
<b>Southern Rivers CMA Biometric vegetation type</b>	Grassland of the study area is an entirely altered vegetation community with no corresponding Southern Rivers CMA Biometric vegetation type.
	 <p>The photograph shows a wide, green grassy field in the foreground. In the middle ground, there are several trees, including a prominent, large, rounded tree on the left. The background features rolling hills under a clear blue sky with some light clouds. The overall scene depicts a rural landscape with grassland and scattered trees.</p>

**Table 3-9 Planted vegetation.**

<b>Extent within subject site (direct) (approx)</b>	4.80 hectares of mapped Planted vegetation in <b>Figures 3-1 to 3-22.</b>
<b>Description</b>	<p>Canopy: there is a wide range of locally occurring native tree species present in stands of planted vegetation including <i>Casuarina glauca</i>, <i>Corymbia maculata</i>, <i>Eucalyptus botryoides</i>, <i>Eucalyptus pilularis</i>, <i>Eucalyptus robusta</i>, <i>Eucalyptus saligna</i>, <i>Melaleuca quinquenervia</i> and <i>Syncarpia glomulifera</i> ssp. <i>Glomulifera</i>.</p> <p>Mid canopy: in places smaller native tree species such as <i>Acacia maidenii</i>, <i>Acacia mearnsii</i>, <i>Allocasuarina littoralis</i>, <i>Melaleuca linariifolia</i> and <i>Melaleuca styphelioides</i> form a planted mid canopy.</p> <p>Understorey: occasional native shrubs such as <i>Acacia</i> spp. and woody weeds such as <i>Lantana camara</i>, <i>Solanum mauritianum</i> and <i>Rubus fruticosus</i> agg. sp. are present in places.</p> <p>Groundcover: in Poor condition with introduced grasses and herbs dominating and disturbance tolerant native species also present.</p>
<b>Condition</b>	Poor. The area of the community inspected and mapped in the current surveys is in Poor condition.
<b>Threatened species of plant?</b>	None recorded. Based on the condition of the vegetation previous land use and management practices, habitat potential for threatened plant species in this community is considered to be low.
<b>Threatened community?</b>	No. This is an entirely constructed type of vegetation.
<b>Southern Rivers CMA Biometric vegetation type</b>	Planted areas have no corresponding Southern Rivers CMA Biometric vegetation type.
	





- Legend**
- Native vegetation (Biosis 2013)**
    - Shoalhaven sandstone forest
  - Constructed (Biosis 2013)**
    - Planted
  - Native vegetation (SCIVI 2010)**
    - Currambene-Batemans Lowlands
    - Forest
    - Illawarra Gully Wet Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

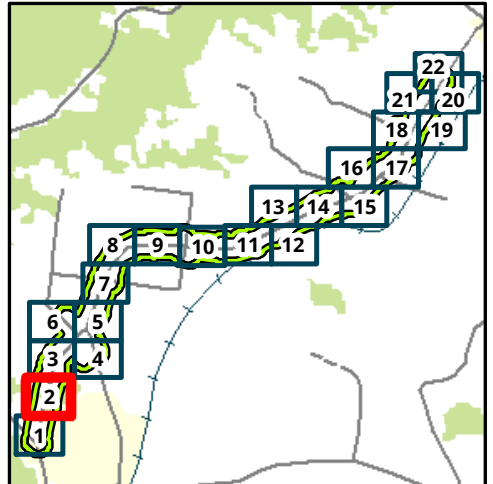
**Figure 3.1: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

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Coordinate System: GDA 1994 MGA Zone 56

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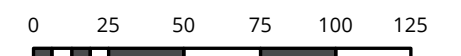
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Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
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- Legend**
- Hollow bearing tree
  - Native vegetation (Biosis 2013)**
    - Currumbene Batemans lowland forest
    - Illawarra gully wet forest
    - Shoalhaven sandstone forest
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
    - Reedland
  - Constructed (Biosis 2013)**
    - Planted
  - Native vegetation (SCIVI 2010)**
    - Currumbene-Batemans Lowlands
    - Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.2: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



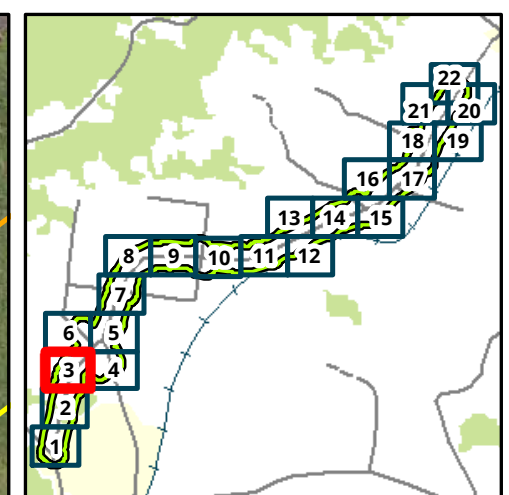
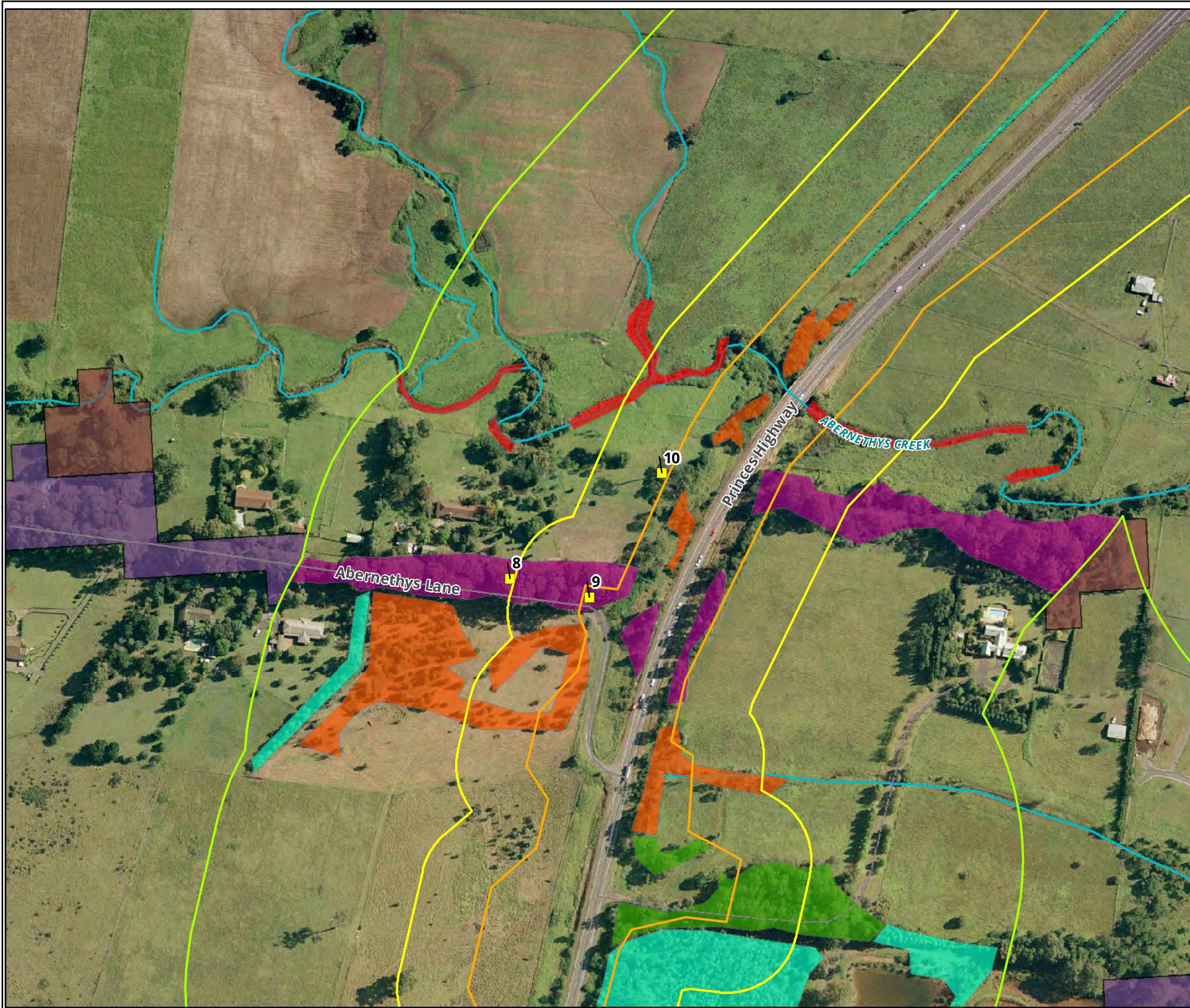
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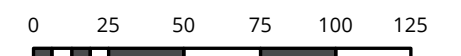
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- Legend**
- Hollow bearing tree
  - Stag
- Native vegetation (Biosis 2013)**
- Currumbene Batemans lowland forest
  - Illawarra gully wet forest
- Derived vegetation (Biosis 2013)**
- Acacia scrub
  - Reedland
- Constructed (Biosis 2013)**
- Planted
- Native vegetation (SCIVI 2010)**
- Currumbene-Batemans Lowlands Forest
  - Illawarra Gully Wet Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.3: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



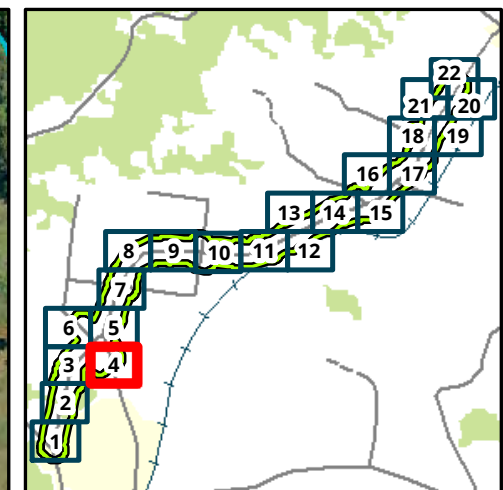
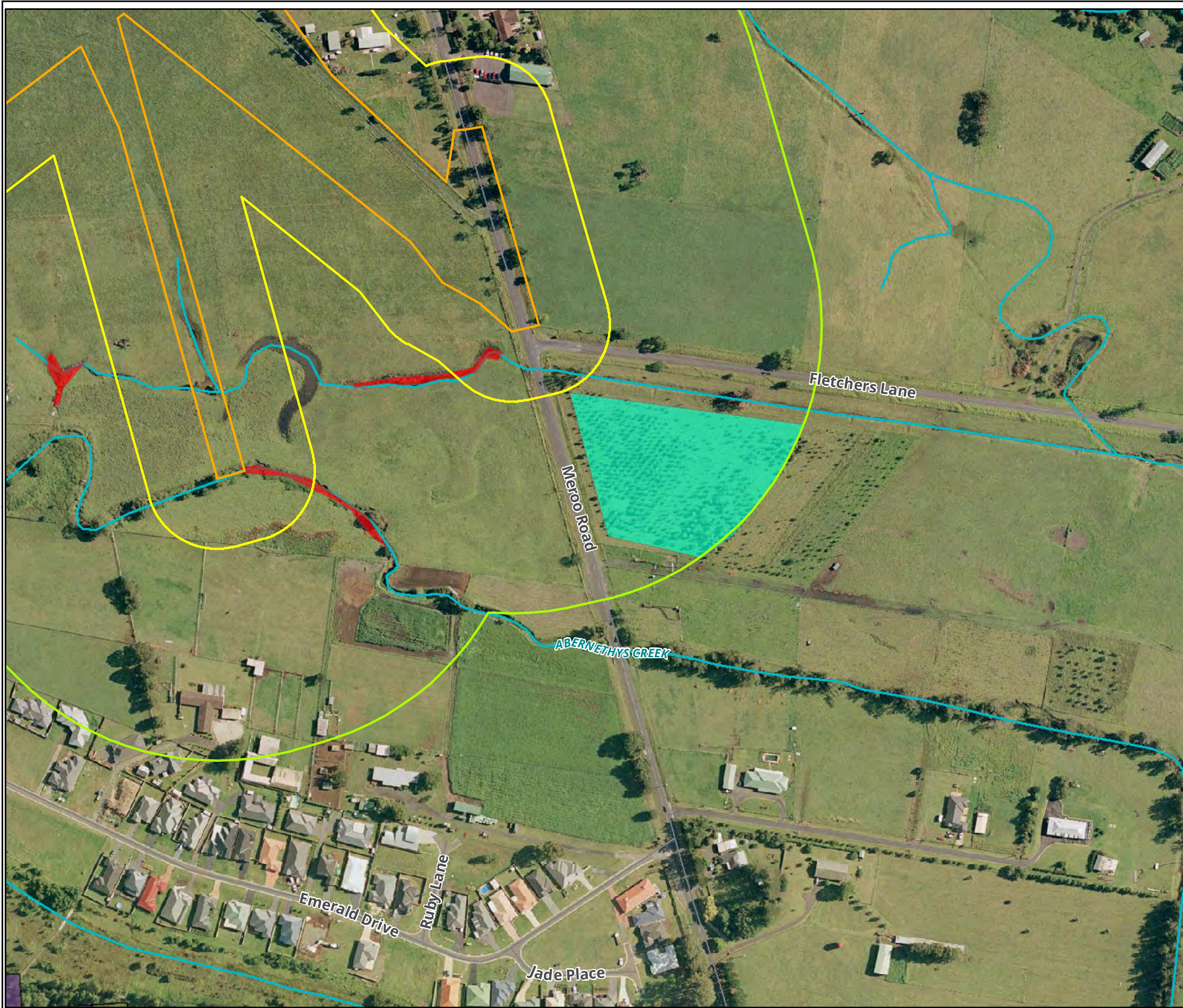
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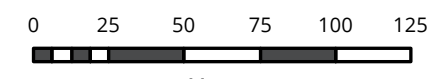
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 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Derived vegetation (Biosis 2013)**
    - Reedland
  - Constructed (Biosis 2013)**
    - Planted
  - Native vegetation (SCIVI 2010)**
    - Currambene-Batemans Lowlands
    - Forest
    - Floodplain Swamp Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.4: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



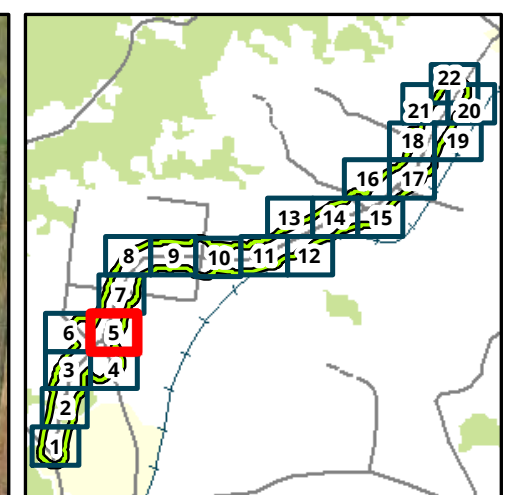
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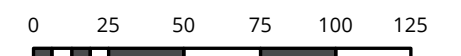
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 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing trees
  - Native vegetation (Biosis 2013)**
    - Currumbene Batemans lowland forest
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
  - Constructed (Biosis 2013)**
    - Planted
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.5: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



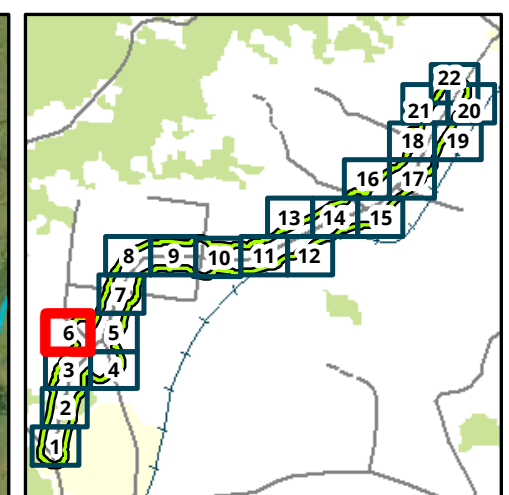
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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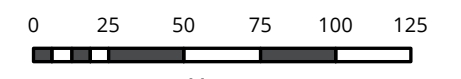
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location n:P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Stag
- Derived vegetation (Biosis 2013)**
- Reedland
- Constructed (Biosis 2013)**
- Planted
- Native vegetation (SCIVI 2010)**
- Illawarra Gully Wet Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.6: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



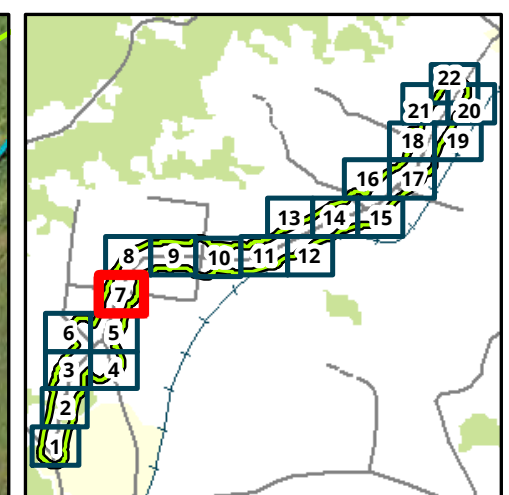
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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Matter: 15896  
 Date: 12 August 2013  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Hollow bearing trees
- Native vegetation (Biosis 2013)**
- Currumbene Batemans lowland forest
- Derived vegetation (Biosis 2013)**
- Reedland
- Constructed (Biosis 2013)**
- Planted
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.7: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

0 25 50 75 100 125  
Metres

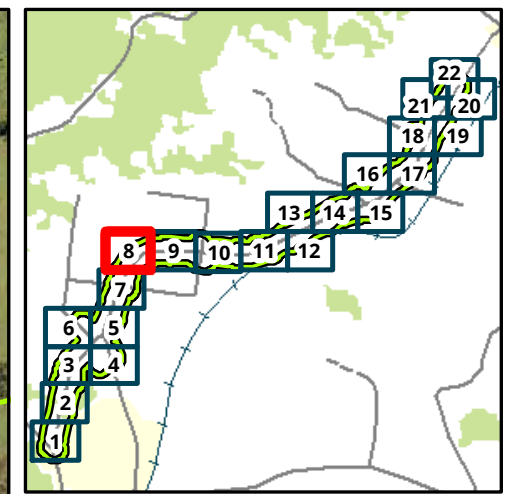
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

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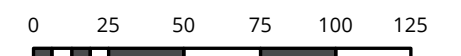
Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing trees
  - Constructed (Biosis 2013)**
  - Planted
  - Native vegetation (SCIVI 2010)**
  - Currumbene-Batemans Lowlands
  - Forest
  - Illawarra Gully Wet Forest
  - Warm Temperate Layered Forest
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.8: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



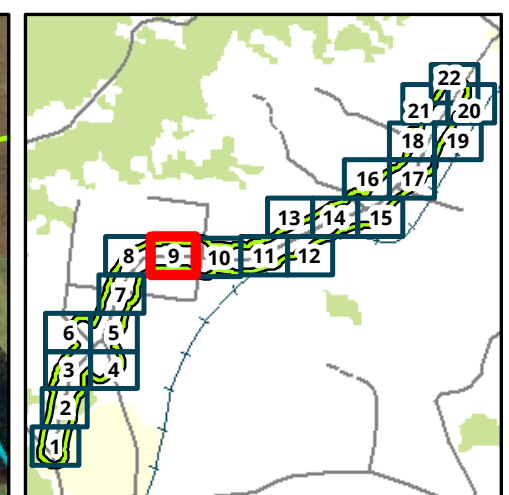
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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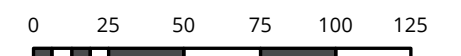
Matter: 15896  
 Date: 12 August 2013  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Stag
  - Native vegetation (Biosis 2013)**
    - Currambene Batemans lowland forest
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.9: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



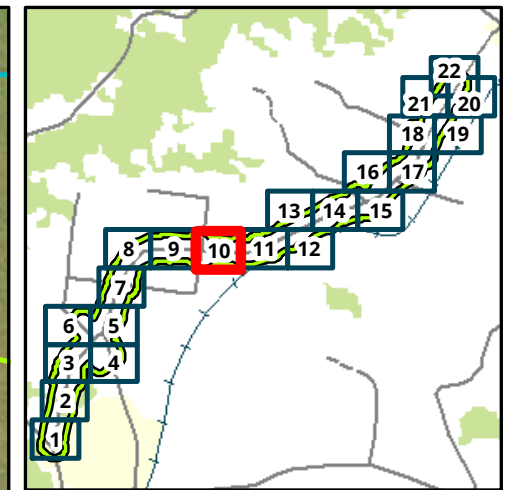
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Stag
- Native vegetation (Biosis 2013)**
- Currumbene Batemans lowland forest
- Derived vegetation (Biosis 2013)**
- Acacia scrub
- Constructed (Biosis 2013)**
- Planted
- Native vegetation (SCIVI 2010)**
- Currumbene-Batemans Lowlands
  - Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.10: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

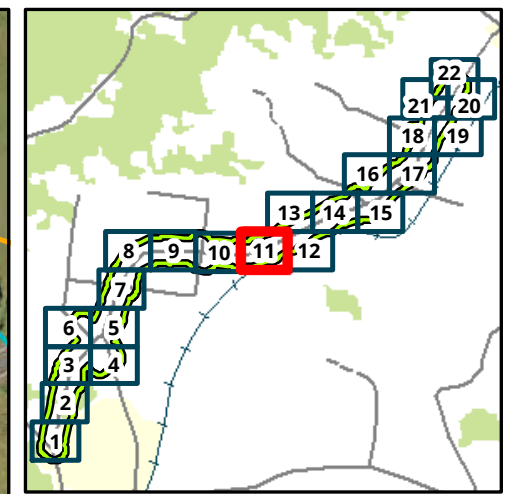
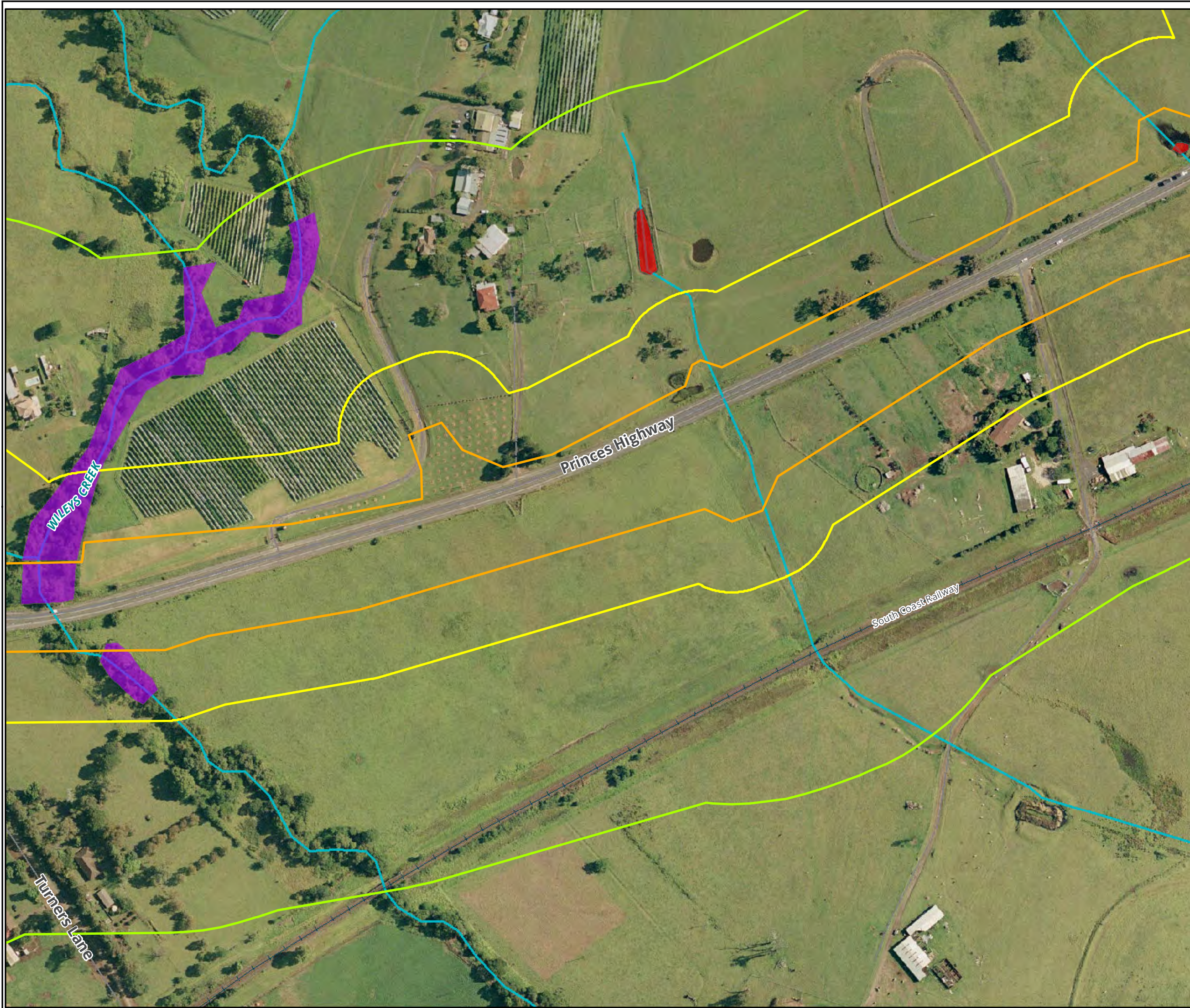
0 25 50 75 100 125  
Metres  
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



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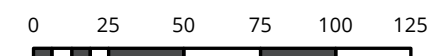
Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Native vegetation (Biosis 2013)**
    - Riverbank forest (River-flat eucalypt forest on coastal floodplains)
  - Derived vegetation (Biosis 2013)**
    - Reedland
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.11: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



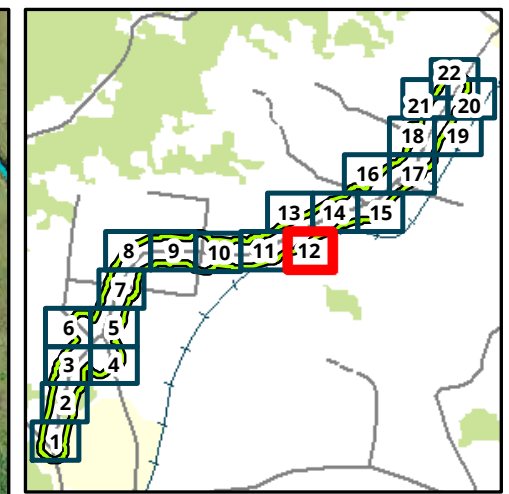
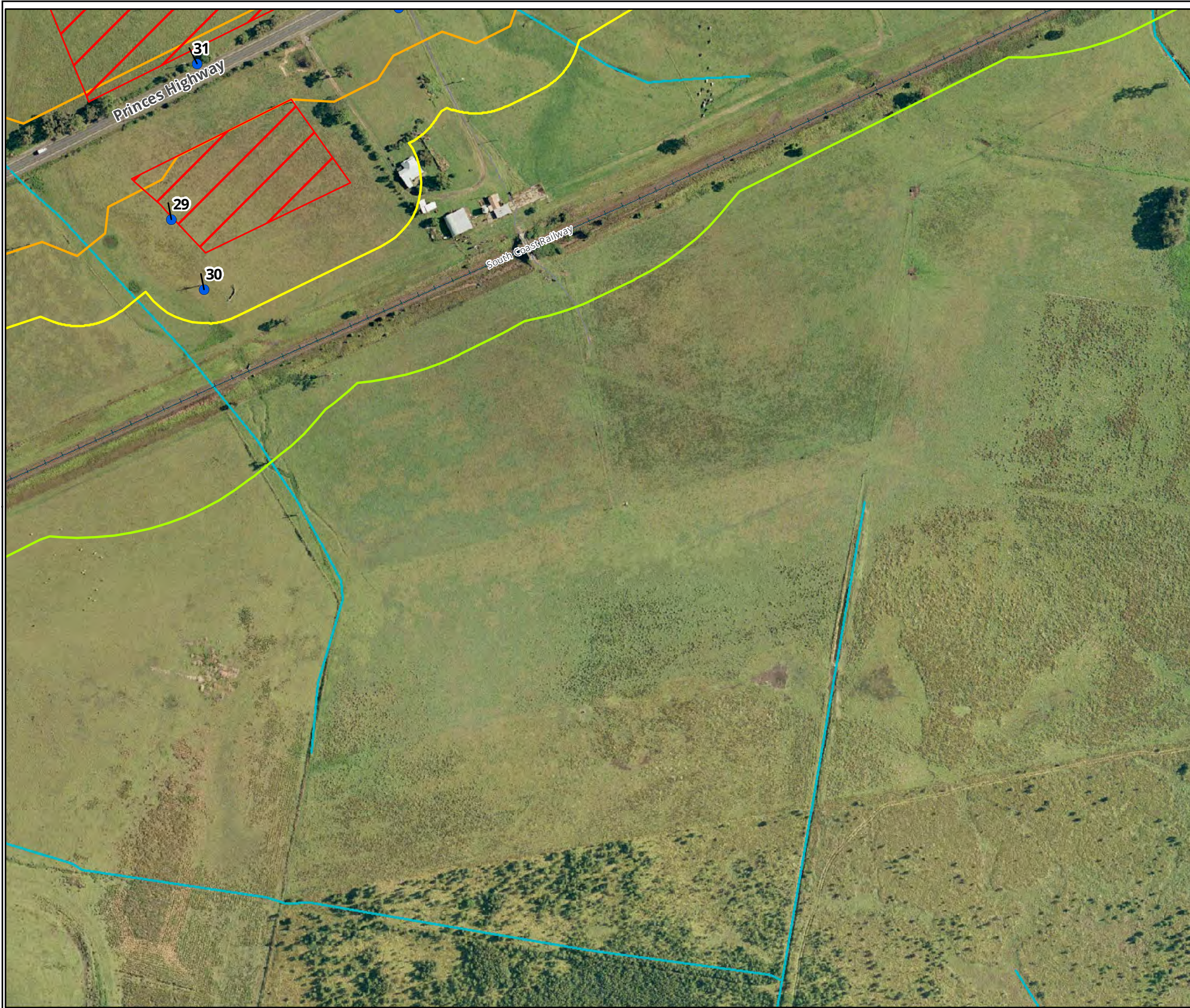
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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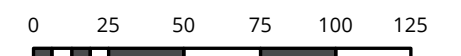
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Stag
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.12: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



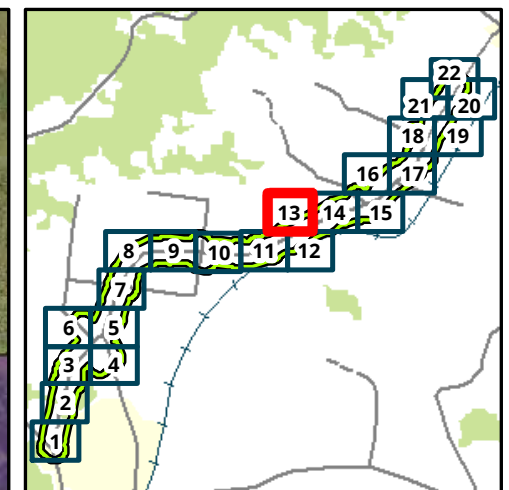
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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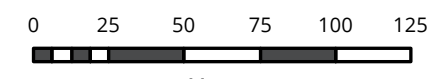
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Stag
  - Native vegetation (Biosis 2013)**
    - Illawarra gully wet forest
    - South Coast grassy woodland
    - (Illawarra lowlands grassy woodland)
  - Derived vegetation (Biosis 2013)**
    - Reedland
  - Native vegetation (SCIVI 2010)**
    - Currambene-Batemans Lowlands
    - Forest
    - Floodplain Swamp Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.13: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



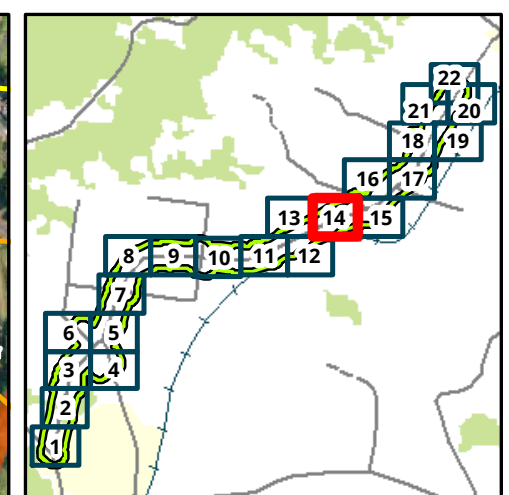
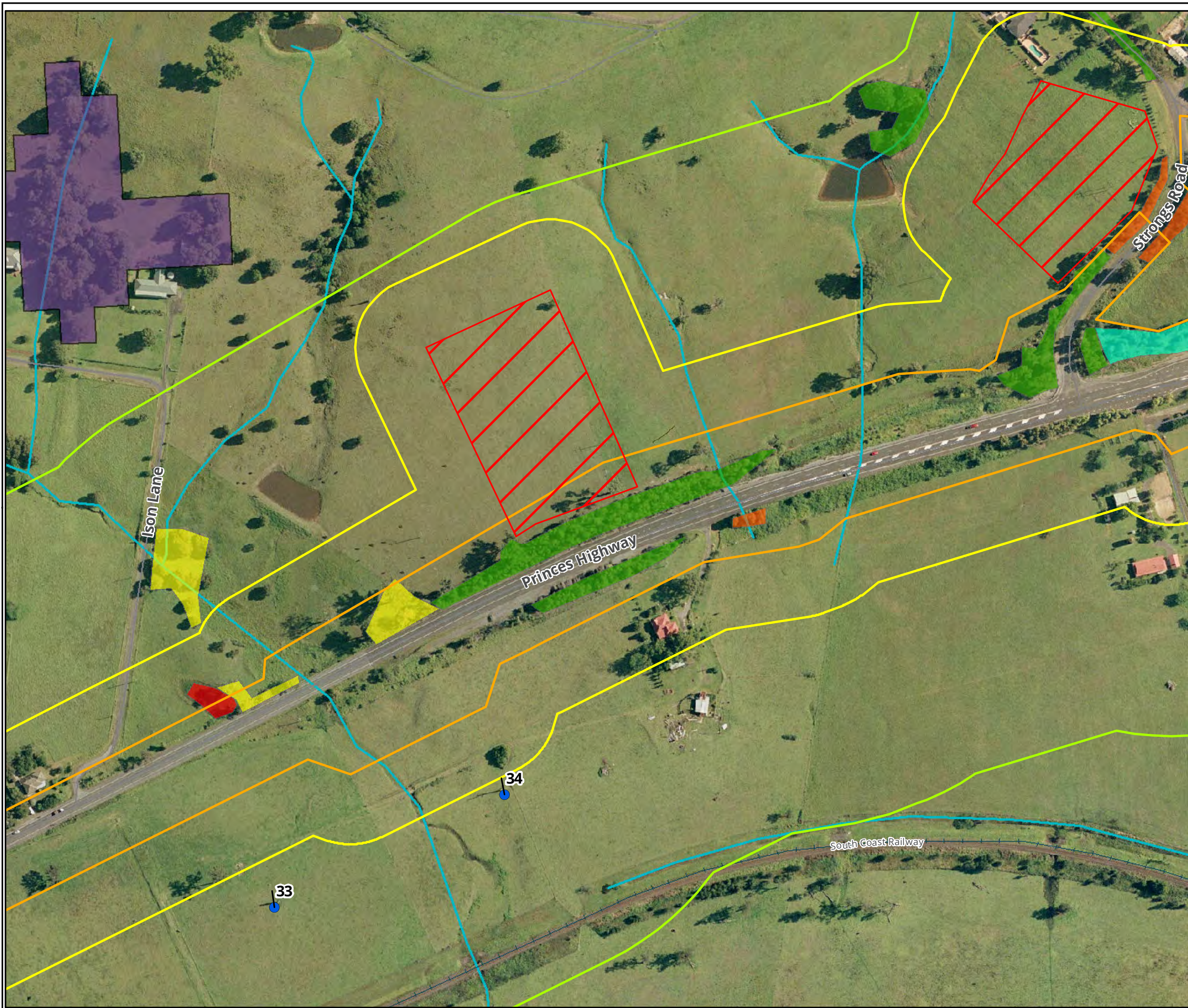
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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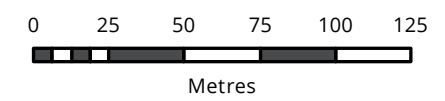
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Stag
  - Native vegetation (Biosis 2013)**
    - Illawarra gully wet forest
    - South Coast grassy woodland
    - (Illawarra lowlands grassy woodland)
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
    - Reedland
  - Constructed (Biosis 2013)**
    - Planted
  - Native vegetation (SCIVI 2010)**
    - Currambene-Batemans Lowlands
    - Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.14: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



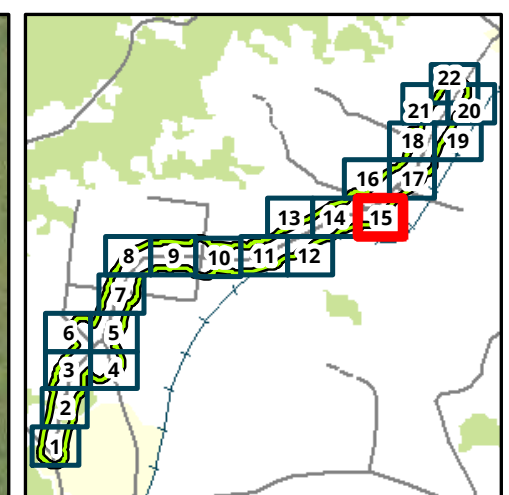
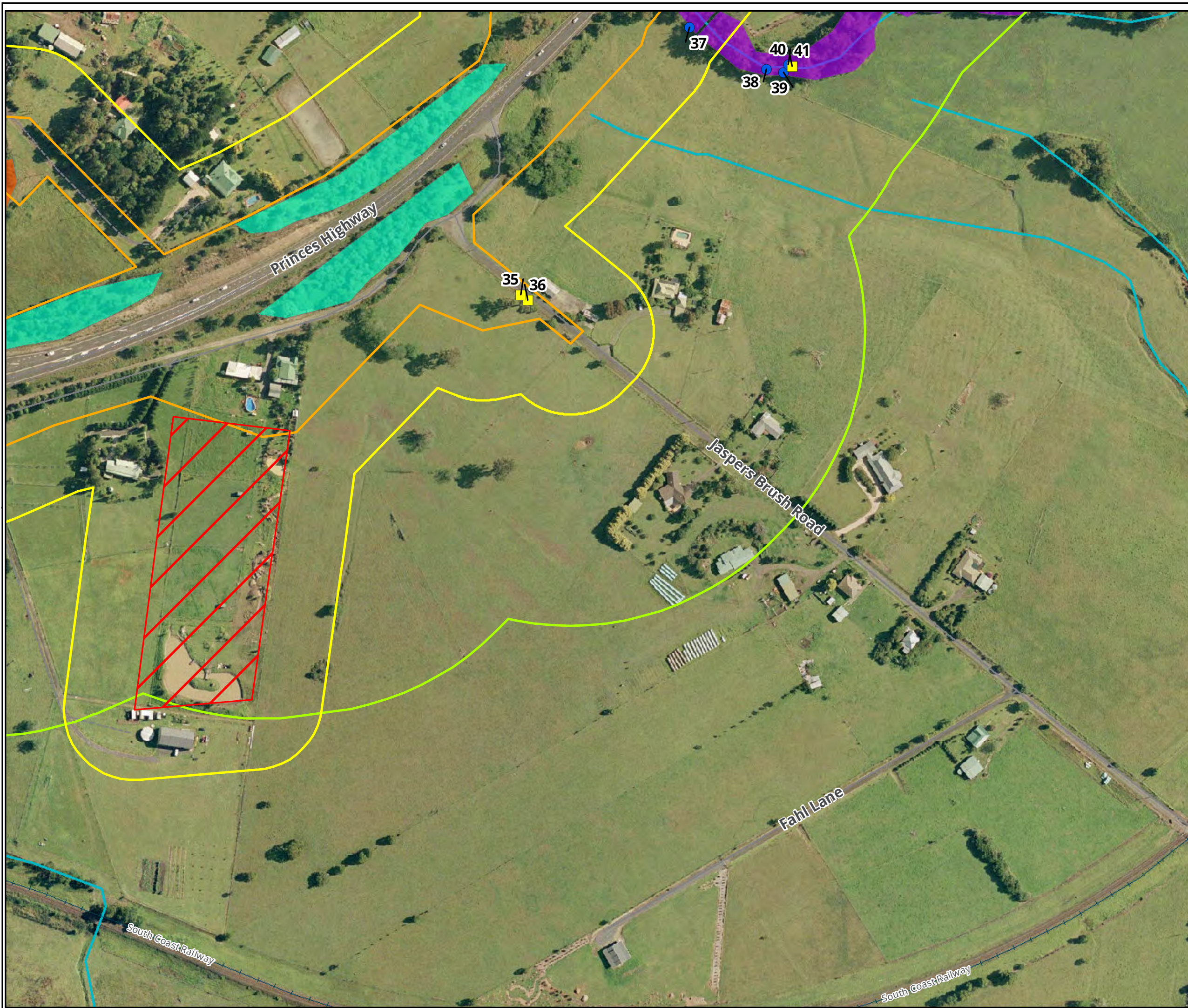
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



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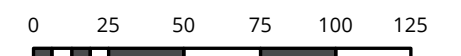
Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Stag
- Native vegetation (Biosis 2013)**
- Riverbank forest (River-flat eucalypt forest on coastal floodplains)
- Derived vegetation (Biosis 2013)**
- Acacia scrub
- Constructed (Biosis 2013)**
- Planted
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.15: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



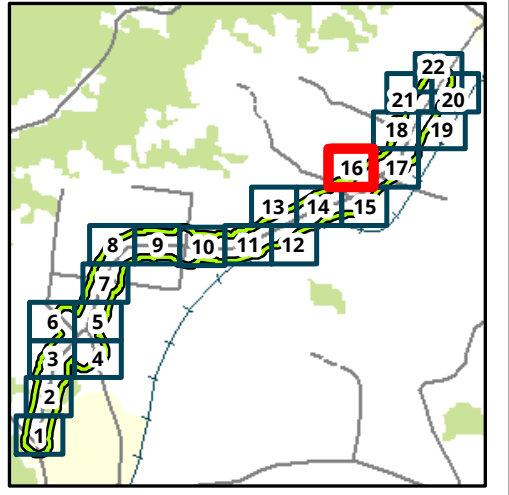
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Stag
- Native vegetation (Biosis 2013)**
- Illawarra gully wet forest
  - Riverbank forest (River-flat eucalypt forest on coastal floodplains)
- Derived vegetation (Biosis 2013)**
- Reedland
- Constructed (Biosis 2013)**
- Planted
- Native vegetation (SCIVI 2010)**
- Currumbene-Batemans Lowlands Forest
  - Illawarra Gully Wet Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.16: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

0 25 50 75 100 125  
Metres

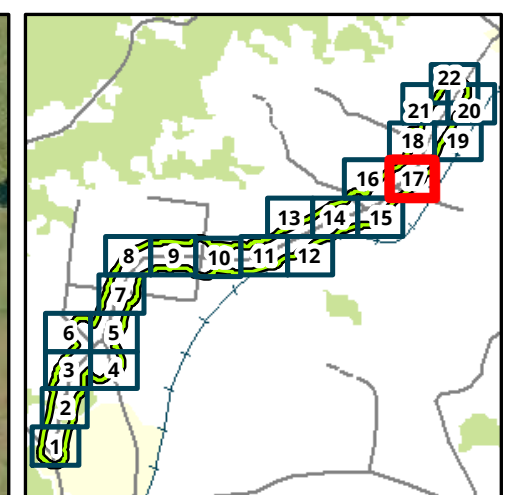
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

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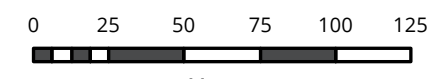
Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Native vegetation (Biosis 2013)**
    - Riverbank forest (River-flat eucalypt forest on coastal floodplains)
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
  - Constructed (Biosis 2013)**
    - Planted
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.17: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56

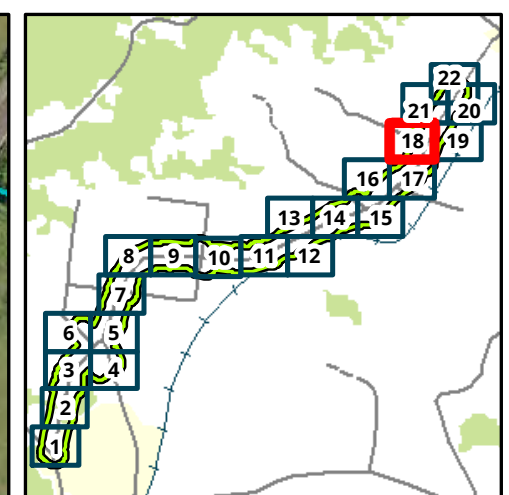
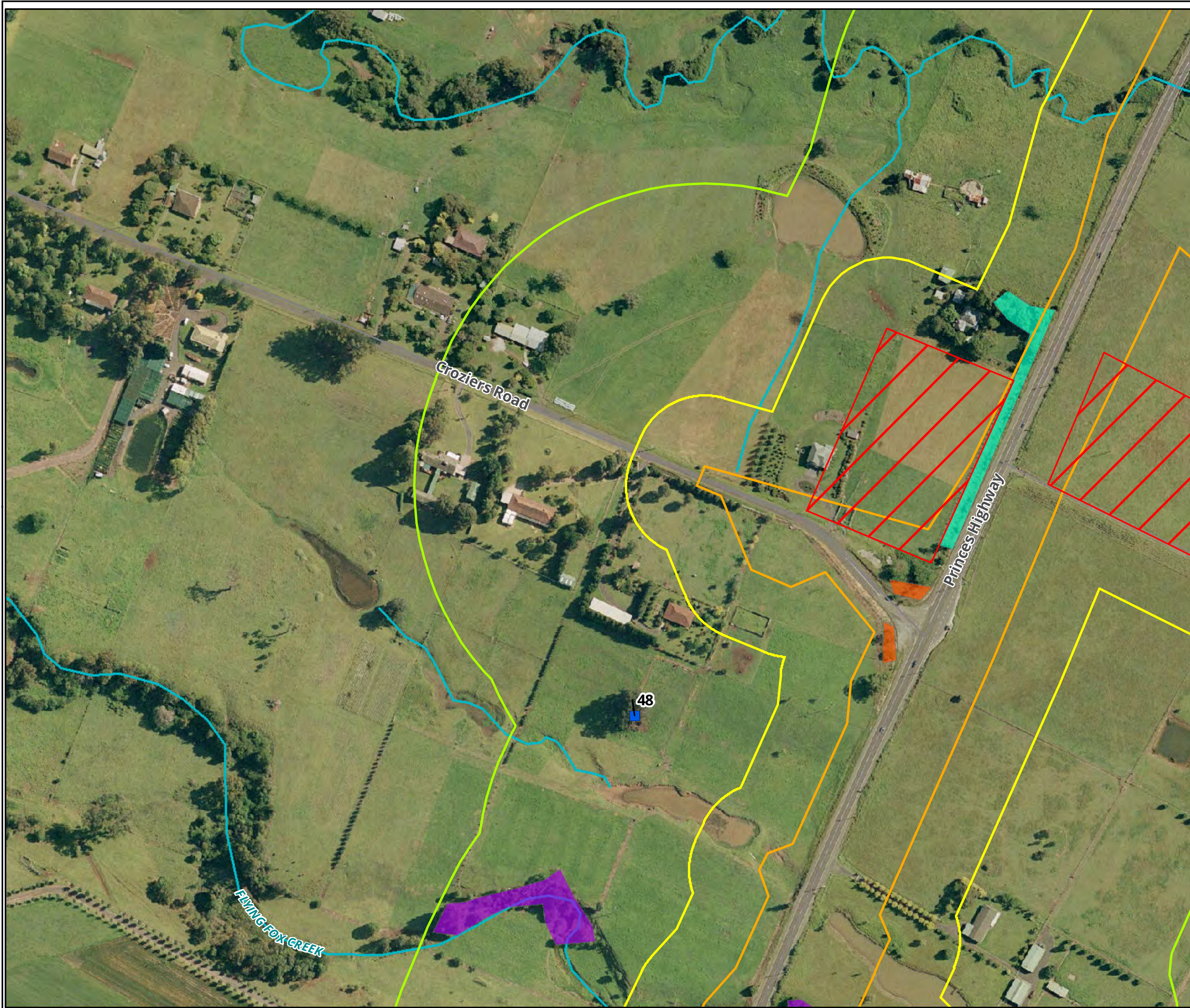


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Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813

45 46 47





- Legend**
- Hollow bearing trees
  - Native vegetation (Biosis 2013)**
    - Riverbank forest (River-flat eucalypt forest on coastal floodplains)
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
  - Constructed (Biosis 2013)**
    - Planted
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

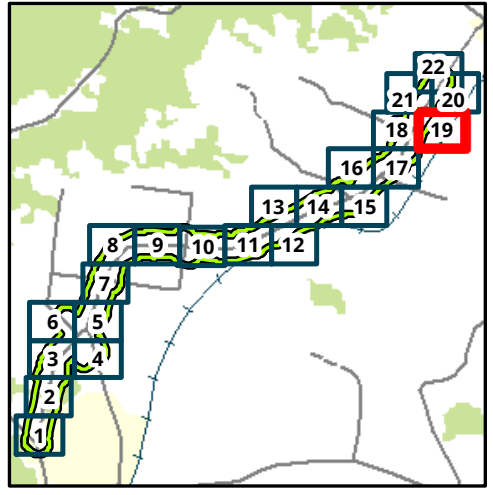
**Figure 3.18: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

0 25 50 75 100 125  
Metres  
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



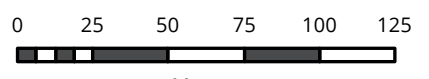
Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Derived vegetation (Biosis 2013)**
  - Reedland
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.19: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



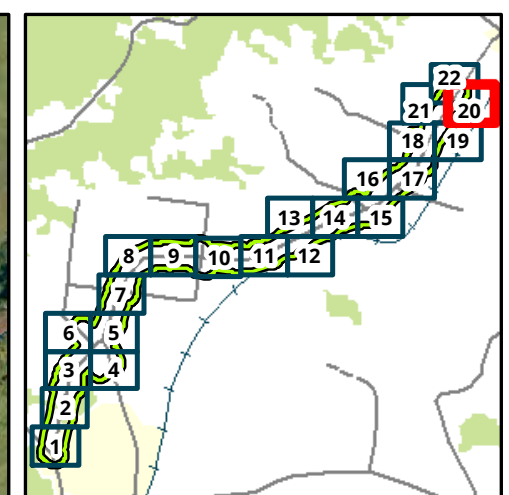
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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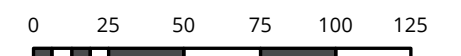
Matter: 15896  
 Date: 12 August 2013  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Native vegetation (Biosis 2013)**
  - Illawarra gully wet forest
  - Derived vegetation (Biosis 2013)**
  - Acacia scrub
  - Native vegetation (SCIVI 2010)**
  - Currumbene-Batemans Lowlands Forest
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.20: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



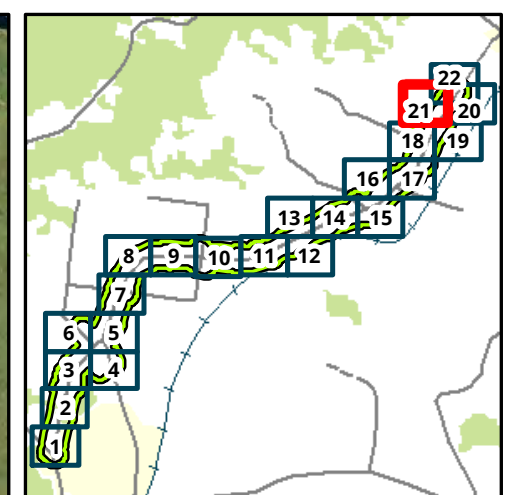
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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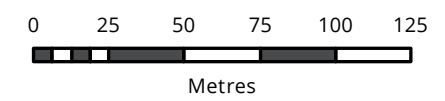
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Native vegetation (Biosis 2013)**
- Illawarra gully wet forest
- Derived vegetation (Biosis 2013)**
- Acacia scrub
  - Reedland
- Native vegetation (SCIVI 2010)**
- Coastal Warm Temperate Rainforest
  - Currambene-Batemans Lowlands
  - Forest
  - Illawarra Gully Wet Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.21: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



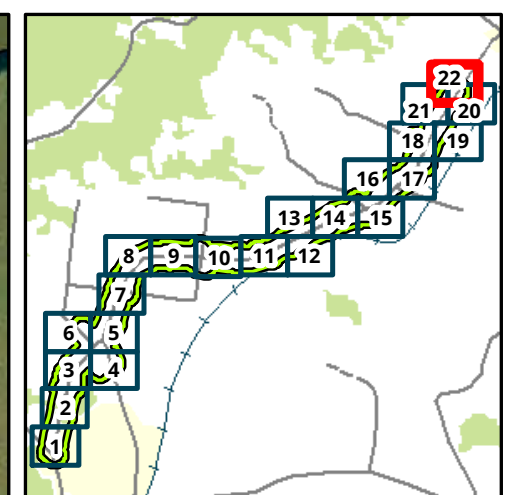
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



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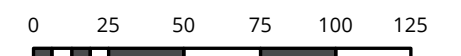
Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Native vegetation (Biosis 2013)**
  - Illawarra gully wet forest
  - Native vegetation (SCIVI 2010)**
  - Currumbene-Batemans Lowlands
  - Forest
  - Floodplain Swamp Forest
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.22: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813




### 3.3.2 Fauna habitat

Six fauna habitat types were identified within the study area. Most habitat types **Tables 3-10 to 3-15** outline each fauna habitat type, and describe the features, condition and fauna either recorded or likely to utilise the identified habitat types.

**Table 3-10 Open forest**

<b>Habitat type</b>	Open forest
<b>Vegetation community</b>	This habitat type is found within all areas of mapped Currumbene Batemans lowland forest – moderate and high quality, as described in <b>Table 3-1</b> , Shoalhaven sandstone forest as described in <b>Table 3-2</b> , and Illawarra gully wet forest as described in <b>Table 3-3</b> . Vegetation community mapping can be observed in <b>Figures 3-1 to 3-22</b> .
<b>Habitat features</b>	<p>Open forest habitat largely consists of mature trees, including hollows. The understory and shrub layer is largely absent due to historic and ongoing grazing and clearing works. Scattered patches of weed species, such as <i>Rubus fruticosus</i> and <i>Lantana camara</i>, and native <i>Pteridium esculentum</i> still remain, providing foraging and sheltering habitat for small birds. The groundcover largely consists of native and exotic grasses, with some small deposits of fallen timber, coarse woody debris, and leaf litter, which provide limited foraging and sheltering habitat for ground dwelling fauna such as reptiles and small mammals.</p> <p>Shoalhaven sandstone forest also contains stands of <i>Allocasuarina littoralis</i> which is a key feed tree for the Glossy Black Cockatoo <i>Calyptorhynchus lathami</i>.</p> <p>Whilst connectivity to off-site habitats is limited for most stands, this habitat does provide potential breeding and nesting/roosting habitat for birds, microchiropteran bats within the hollow-bearing trees and stags. The tree canopy also provides foraging resources, such as nectar, pollen and insects, for birds, some species of microchiropteran bats, and arboreal glider species.</p>
<b>Condition</b>	These forest environments have become largely disturbed and are highly fragmented in the local landscape, being surrounded by farmland and/or residential development. They do however support a moderate level of fauna habitat features that are important in the maintenance of native fauna diversity and the lifecycle of the local fauna populations, despite having undergone, in some places, a high level of disturbance in the past.
<b>General fauna</b>	<p>Fauna species observed utilising this habitat type in the current and previous surveys include, but are not limited to, Yellow-tailed Black-Cockatoo <i>Calyptorhynchus funereus</i>, Black-faced Cuckoo-shrike <i>Coracina novaehollandiae</i>, Eastern Whipbird <i>Psophodes olivaceu</i>, Wonga Pigeon <i>Leucosarcia melanoleuca</i>, Eastern Horseshoe-bat <i>Rhinolophus megaphyllus</i> and Grey-headed Flying-fox <i>Pteropus poliocephalus</i>.</p> <p>Other fauna groups likely to utilise this habitat type for foraging, roosting, sheltering, nesting, breeding and/or dispersal include forest owls, and arboreal and ground dwelling mammals.</p>



<p><b>Threatened species of animal?</b></p>	<p>Threatened species previously recorded within this habitat type include, Grey-headed Flying-fox <i>Pteropus poliocephalus</i>, Rufous Fantail <i>Pteropus poliocephalus</i>, Eastern Freetail Bat <i>Mormopterus norfolkensis</i> and Southern Myotis <i>Myotis macropus</i>. Based on the habitat features and previous threatened species records of the locality this habitat also has the potential for threatened species fauna to occur including the Gang Gang Cockatoo <i>Callocephalon fimbriatum</i>, Glossy Black Cockatoo <i>Calyptorhynchus lathami</i>, and forest owls including the Powerful Owl <i>Ninox strenua</i>, Sooty Owl <i>Tyto tenebricosa</i>, Barking Owl <i>Ninox connivens</i> and the Masked Owl <i>Tyto novaehollandiae</i>.</p>
	



**Table 3-11 Riparian corridors**

<b>Habitat type</b>	Riparian corridors
<b>Vegetation community</b>	Riverbank forest (equating to RFEFCF) described in <b>Table 3-4</b> . Vegetation community mapping can be observed in <b>Figures 3-1 to 3-22</b> .
<b>Habitat features</b>	<p>Riparian corridors within the Study Area contain both disturbed remnant vegetation and regrowth. Ongoing disturbances, such as grazing and erosion, and a high degree of weed infestation have had a major impact on habitat condition within these areas. Riparian corridors are characterised by a tall native canopy of <i>Casuarina cunninghamiana</i> but the natural understory and ground layers are no longer intact and in most areas the midstorey and ground layers are either absent or dominated by weed species. The present weed infested understory does provide foraging, nesting and sheltering habitat for small birds however.</p> <p>Regardless of the degraded nature of these areas, many sites contain mature <i>Casuarina cunninghamiana</i> with hollows. These trees provide potential roost sites for fauna, including common arboreal mammals, and microchiropteran bats. Riparian Corridors also provide connectivity in the landscape by providing potential dispersal routes and foraging habitat for species of ground dwelling and arboreal mammals, microchiropteran bats and forest owls.</p>
<b>Condition</b>	Poor to Moderate. This habitat type is generally in Poor condition throughout the study area, with areas of Moderate condition vegetation present on both sides of the Princes Highway at Jaspers Brush Creek. Besides the presence of the tall native canopy, these cleared and weed infested areas have little capacity for the regeneration of natural vegetation without considerable resources allocated to weed control and revegetation. They do however support a moderate level of fauna habitat features that are important in the maintenance of native fauna diversity and the lifecycle of local fauna populations, despite having experienced an ongoing regime of disturbance.
<b>General fauna</b>	<p>Fauna species observed utilising this habitat type in the current and previous surveys include, but are not limited to, the Grey Teal <i>Anas gracilis</i>, Pacific Black Duck <i>Anas superciliosa</i>, Magpie-lark <i>Grallina cyanoleuca</i>, Galah <i>Cacatua roseicapilla</i>, Crested Pigeon <i>Ocyphaps lophotes</i>, Superb Fairy-wren <i>Malurus cyaneus</i>, Red-browed Finch <i>Neochmia temporalis</i>, Eastern Yellow Robin <i>Eopsaltria australis</i>, Common Wombat <i>Vombatus ursinus</i>, Eastern Water Dragon <i>Physignathus lesueurii</i> and the Striped Skink <i>Ctenotus robustus</i>.</p> <p>A stand of Black Oak <i>Allocasuarina littoralis</i> is also present along Jaspers Brush Creek, providing a potential feeding resource for the Glossy Black Cockatoo <i>Calyptorhynchus lathami</i>.</p> <p>Other fauna groups likely to utilise this habitat type for foraging, roosting, sheltering, nesting, breeding and/or dispersal include forest owls, microchiropteran bats and arboreal mammals.</p>
<b>Threatened species of animal?</b>	None previously recorded. Based on the habitat type and previous threatened species records of the locality, this habitat also has the potential to provide potential foraging habitat for threatened fauna to occur including the Glossy black cockatoo <i>Calyptorhynchus lathami</i> , forest owls including the Powerful owl <i>Ninox strenua</i> , Sooty owl <i>Tyto tenebricosa</i> , Barking owl <i>Ninox connivens</i> and the Masked owl <i>Tyto novaehollandiae</i> and microchiropteran bat species. It is also likely to provide connectivity between stands of higher quality fauna habitat.







**Table 3-12 Woodland**

<b>Habitat type</b>	Woodland
<b>Vegetation community</b>	South Coast grassy woodland as described in <b>Table 3-5</b> and Currumbene Batemans lowland forest – low quality as described in <b>Table 3-1</b> . Vegetation community mapping can be observed in <b>Figures 3-1 to 3-22</b> .
<b>Habitat features</b>	<p>The habitat type is largely represented by scattered remnant trees, regrowth and roadside vegetation, growing in linear patches on roadside cuttings, and/or in isolated patches within open paddocks. The mid canopy and understory is absent, and the ground cover is generally highly degraded and made up of introduced and some native grass species.</p> <p>Fauna species within these linear patches of regrowth are likely to be limited to common species that are tolerant of highly disturbed environments. Plant species within these patches of vegetation are likely to provide feeding resources for common fauna, including small birds.</p> <p>Scattered remnant trees within cleared grazing lands include mature hollow-bearing trees and stags with fissures. These trees provide potential roost sites for fauna, particularly microchiropteran bats.</p>
<b>Condition</b>	Poor. The area of the community inspected and mapped in the current surveys is in Poor condition due to the isolation of small patches and the absence of native vegetation structure. This habitat type does however still provide foraging and nesting habitat for small birds, and roosting resources for microchiropteran bats.
<b>General fauna</b>	<p>Fauna species observed utilising this habitat type in the current and previous surveys includes, but is not limited to, Rainbow Lorikeet <i>Trichoglossus haematodus</i>, Eastern rosella <i>Platycercus eximius</i> and Eastern Spinebill <i>Acanthorhynchus tenuirostris</i>.</p> <p>Other species of small birds are likely to utilise this habitat type for foraging, breeding, nesting and sheltering. Some species of microchiropteran bats may also utilise the hollow-bearing trees and stags for roosting sites in close proximity to foraging resources such as water bodies and open forests.</p>
<b>Threatened species of animal?</b>	None recorded. Based on the habitat type and previous threatened species records of the locality potential for threatened fauna species other than roosting microchiropteran bats, to occur in this habitat is considered to be low.







**Table 3-13 Aquatic and semi aquatic**

<b>Habitat type</b>	Aquatic and semi aquatic
<b>Vegetation community</b>	Reedland as described in <b>Table 3-6</b> . Vegetation community mapping can be observed in <b>Figures 3-1 to 3-22</b> .
<b>Habitat features</b>	<p>The creeklines, drainage lines and large water bodies (farm dams) within the study area contain a number of microhabitats suitable for foraging, sheltering and breeding resources for fauna. All large water bodies containing fringing and emergent vegetation and Reedland provide feeding, nesting and sheltering habitats for aquatic birds, frogs and reptiles, as well as resources for microchiropteran bats.</p> <p>The riparian corridors created along the various creeklines provide suitable foraging habitat for microchiropteran bats and dispersal habitat for other fauna. The creeks within the study area support fringing vegetation, consisting of mostly exotic species, and are made up of varied stream structures including pools and run. A number of the creeklines and drainage lines contain <i>Typha domingensis</i>, providing potential breeding, foraging and sheltering habitat for frogs. Creeks and water bodies also provide a water resource for all fauna species.</p> <p>Aquatic environments within the study area largely lack many critical fauna habitat components, such as significant areas of sheltering rocks or basking platforms, suitable floating aquatic vegetation and large stands of emergent vegetation. Despite this these areas are likely to support and provide resources for a number of fauna species.</p>
<b>Condition</b>	Moderate. The aquatic environments within the study area are considered to be of moderate fauna habitat value for terrestrial species.
<b>General fauna</b>	<p>Fauna species observed utilising this habitat type in the current and previous surveys include but are not limited to the Greater Broad-nosed Bat <i>Platyrrhinus vittatus</i>, Southern Myotis <i>Myotis macropus</i>, Yellow-bellied Sheath-tail-bat <i>Saccolaimus flaviventris</i>, Purple Swamp Hen <i>Porphyrio porphyrio</i>, Eurasian Coot <i>Fulica atra</i>, Australian Wood Duck <i>Chenonetta jubata</i>, Intermediate Egret <i>Ardea intermedia</i>, Eastern Dwarf Tree Frog <i>Litoria fallax</i>, Striped Marsh Frog <i>Limnodynastes peronii</i>, Peron's Tree Frog <i>Litoria peronii</i> and Red-bellied Black Snake <i>Pseudechis porphyriacus</i>.</p> <p>Ground-dwelling mammals may also use this habitat as dispersal and foraging corridors.</p>
<b>Threatened species of animal?</b>	<p>Threatened species that have been recorded utilising the aquatic habitat within the study area include the Greater Broad-nosed Bat <i>Platyrrhinus vittatus</i>, Southern Myotis <i>Myotis macropus</i>, Eastern Bentwing-bat <i>Miniopterus schreibersii oceanensis</i>, Eastern Freetail Bat <i>Mormopterus norfolkensis</i>, Large-eared Pied Bat <i>Chalinolobus dwyeri</i>, and the Yellow-bellied Sheath-tail-bat <i>Saccolaimus flaviventris</i>.</p> <p>Potential foraging and breeding habitat for the Green and Golden Bell Frog <i>Litoria aurea</i> has also been identified within some water bodies and drainage lines within the study area.</p>







**Table 3-14 Scrubland/Planted**

<b>Habitat type</b>	Scrubland/Planted
<b>Vegetation community</b>	Acacia Scrub as described in <b>Table 3-7</b> and Planted vegetation as described in <b>Table 3-9</b> . Vegetation community mapping can be observed in <b>Figures 3-1 to 3-22</b> .
<b>Habitat features</b>	<p>Acacia scrub and Planted vegetation occur in patches within the study area and provide nesting and foraging habitat for some species of birds.</p> <p>The Acacia scrub canopy is dominated by native <i>Acacia</i> spp. and provides nesting and foraging habitat for birds. The understory is absent in some patches; however, where present, the understory is either characterised entirely by regenerating <i>Acacia</i> spp. or a mix of other native shrubs and introduced species such as <i>Hakea dactyloides</i>, <i>Cotoneaster</i> sp. and <i>Lantana camara</i> (in dry area) and <i>Hymenanthera dentata</i> and <i>Ligustrum sinense</i> (in drainage and damp areas). Ground cover is poor, with generally a mixture of annual and perennial weeds. Due to recent disturbance leaf litter deposits and fallen timber are absent from this habitat therefore limiting its ability to provide good quality reptile habitat.</p> <p>Planted stands are largely made up of a native vegetation structure including native canopy and mid-story species. Some stands contain plantings of Black oak <i>Allocasuarina littoralis</i>, a known feed tree for the Glossy black cockatoo <i>Calyptorhynchus lathami</i>. Some of the more mature planted stands contain high levels of vegetative debris providing potential foraging and sheltering habitat for reptiles, and small ground-dwelling mammals.</p>
<b>Condition</b>	Moderate. This scrubland is considered to be of moderate fauna habitat value.
<b>General fauna</b>	<p>Fauna species observed utilising this habitat type in the current and previous surveys include, but are not limited, to Yellow-rumped thornbill <i>Acanthiza chrysorrhoa</i>, Willy wagtail <i>Rhipidura leucophrys</i> and Striated thornbill <i>Acanthiza lineata</i>.</p> <p>Areas of Acacia scrub/Planted vegetation provide important habitat for insectivorous birds, and microchiropteran bat species, as well as a stepping stone for native birds between larger and more significant habitat features. This habitat type is considered to be of moderate habitat value.</p>
<b>Threatened species of animal?</b>	None recorded for this habitat within the study area. Threatened species of microchiropteran bats, ground dwelling mammals, small insectivorous birds, Gang Gang Cockatoos <i>Callocephalon fimbriatum</i> and Glossy Black Cockatoos <i>Calyptorhynchus lathami</i> may all potentially use these stands as foraging and dispersal habitat on occasion. Small insectivorous birds may find nesting and breeding resources within this habitat type also.







**Table 3-15 Exotic Closed Grassland**

<b>Habitat type</b>	Closed grassland
<b>Vegetation community</b>	Grassland as described in <b>Table 3-8</b> (Grassland is not mapped, see <b>Section 2.5.2</b> ).
<b>Habitat features</b>	<p>Exotic closed grassland is widely dispersed within the study area. These areas contain a limited number of habitat resources for native fauna species.</p> <p>The vast majority of the canopy and shrub layer has previously been removed and the ground layer is impacted by a number of rural land uses including grazing of domestic stock, slashing for silage and turf farming. Isolated paddock trees may provide potential foraging and dispersal habitat within the landscape for some native bird species. If hollows and/or fissures are present, these habitat trees may provide roosting habitat for microchiropteran bats and birds. There are few areas of accumulated woody debris and leaf litter which may provide some potential sheltering habitat for reptiles.</p> <p>These grassland habitats were observed to provide foraging habitat for raptor species, with open areas providing prey such as exotic rodent species, rabbits and hares, and native reptiles.</p>
<b>Condition</b>	Poor. Overall, very little breeding, foraging or sheltering habitat is present within the grassland habitat of the study area. Given that the majority of native vegetation has been removed, the grassland habitat is considered to be of poor fauna habitat value.
<b>General fauna</b>	<p>Fauna species observed utilising this habitat type in the current and previous surveys include, but are not limited to, the Galah <i>Eolophus roseicapilla</i>, Black-shouldered Kite <i>Elanus axillaris</i>, Nankeen kestrel <i>Falco cenchroides</i>, Swamp harrier <i>Circus approximans</i> and Cattle egret <i>Bubulcus ibis</i>.</p> <p>The Closed grasslands may also provide potential foraging habitat for reptiles, ground-dwelling mammals and nocturnal forest owls.</p>
<b>Threatened species of animal?</b>	A migratory species, the Cattle egret <i>Bubulcus ibis</i> , has previously been observed within this habitat type. Based on the habitat type and previous threatened species records of the locality, potential for threatened fauna species include roosting and foraging microchiropteran bats in isolated stags and hollow-bearing trees, and foraging threatened raptor and forest owl species.





## 3.4 Threatened ecological communities

### 3.4.1 River-flat eucalypt forest on coastal floodplains

RFEFCF is an endangered ecological community listed under the TSC Act. RFEFCF is associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. RFEFCF generally occurs below 50 metre elevation, but may occur on localised river flats up to 250 metres above sea level in the NSW north coast, Sydney Basin and South East Corner bioregions. The structure of the community can vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. Typically these forests and woodlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water. Natural floristic composition of RFEFCF is primarily determined by the frequency and duration of waterlogging and the texture, nutrient and moisture content of the soil. Composition also varies with latitude (NSW Scientific Committee, 2004).

RFEFCF generally occupies central parts of floodplains and raised levees; habitats where flooding is periodic and soils are rich in silt, without deep humic horizons and show little or no influence of saline ground water. Remaining stands or patches of the community are severely fragmented by past clearing and are further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, overgrazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs and activation of acid sulfate soils (NSW Scientific Committee, 2004).

Although Tozer *et al.* (2010) and OEH (2013) do not align Riverbank forest with RFEFCF, the current survey and assessment have determined Riverbank forest in the study area corresponds to RFEFCF. Determination of the presence of this TEC has applied the following decision making criteria:

- The clauses of the final determination for RFEFCF, including the characteristic species list, position in the landscape and the low condition the community can persist in.
- Identification of RFEFCF in the PEI of the study area (Biosis, 2009).
- Identification and assessment of vegetation with similar characteristics in the Foxground and Berry bypass environmental assessment as RFEFCF.



The PEI for the study area notes the presence of RFEFCF at Jaspers Brush Creek (Biosis, 2009) and this is confirmed in the current surveys (**Figures 3-15 and 3-16**). In addition the current survey and assessment has mapped RFEFCF on both sides of the Princes Highway at Wileys Creek (**Figure 3-11**) and Flying Fox Creek (**Figures 3-17 and 3-18**).

### 3.4.2 Illawarra Lowlands Grassy Woodland

ILGW is an endangered ecological community listed under the TSC Act. ILGW occurs on relatively gently sloping to undulating lands less than about 200 metre elevation on Berry Siltstone, Budgong Sandstone and Quaternary alluvium. Most remnants are small and fragmented and their long term viability is threatened. Some remnants consist of regrowth after clearing or other disturbances. At any one time, seeds of some species may only be present in the soil seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site and by its recent disturbance history (NSW Scientific Committee, 1999). Determination of the presence of this TEC has applied the following decision making criteria:

- The clauses of the final determination for ILGW including the characteristic species list, position in the landscape and the condition the community can persist as following previous and continuing disturbance.
- Identification of ILGW in the PEI in the study area (Biosis, 2009).

ILGW of the study area occurs as several scattered patches on the northern side of the Princes Highway to the west of Strongs Road (**Figures 3-13 and 3-14**). All stands of the community are considered to be in a low condition based on floristic composition and ongoing impacts including weed invasion and livestock grazing.

The PEI for the study area notes and maps the presence of ILGW at Jaspers Brush south of Strongs Road (Biosis, 2009). The current survey and assessment amends and updates the identification and mapping of ILGW by Biosis (2009) to exclude one area previously mapped as the community and to include another area not previously mapped as the community (**Figure 3-14**). This amendment has been made on the basis of the floristic composition of the area as at the time of the current surveys, position in the landscape and the floristic composition and structure of nearby stands of other different plant communities.

### 3.4.3 Freshwater Wetlands on Coastal Floodplains

FWCF is an endangered ecological community listed under the TSC Act. Sections of higher conservation Reedland identified in **Section 3.3.1** have been identified by Cardno Ecology Lab (2013) as matching this community.

For further information on FWCF see **Section 3.2.2** and **Figures 3.3 and 3.8** of Cardno Ecology Lab (2013).

## 3.5 Threatened species and endangered populations

### 3.5.1 Threatened flora species

No TSC Act or EPBC Act listed threatened flora species were observed in the current or previous surveys. Searches of the Atlas of NSW Wildlife (OEH, 2013) for the locality have identified previous records for 16 TSC Act listed flora species (**Figure 4**). Potential habitat (exclusive of records) has been identified for an additional 10 EPBC Act listed flora species from the PMST (DSEWPac, 2013) for the locality. Twenty flora species have a dual listing under the TSC and EPBC Acts, two species are solely listed under the EPBC Act and four species are solely listed under the TSC Act.

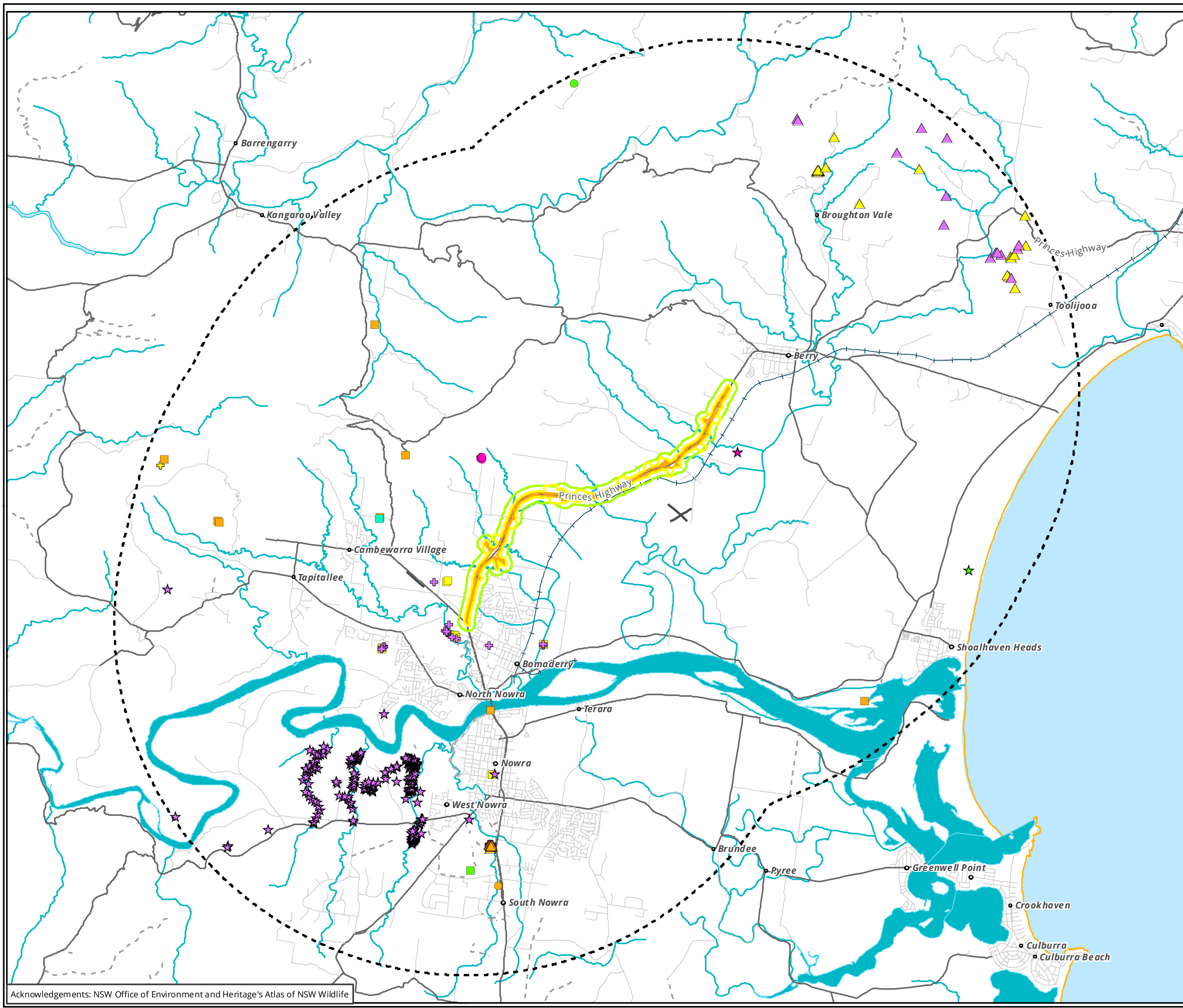


**Appendix B (Table A2-1)** provides an assessment of the likelihood of occurrence in the study area of the 26 threatened flora species previously recorded in the locality. This assessment considers the criteria set out in **Table 2.3**. Based on the current and previous surveys between 2009 and 2013 for some species, habitats present in the study area and other considerations, including current disturbance regimes and the number and distribution of previous records, these assessments have determined that:

- There is a low likelihood for 22 of these species to be present in the study area.
- There is medium likelihood for four of these species to be present in the study area as above ground or as soil stored vegetative structures.
- No threatened flora species are considered to have a high likelihood of occurrence in the study area.

The four flora species assessed as having a medium likelihood of occurrence are *Pterostylis gibbosa*, *Cryptostylis hunteriana*, *Genoplesium baueri* and *Thesium australe*. These species have been considered further in **Chapter 5** of this report.





**Legend**

**Threatened flora**

- Acacia pubescens
- Boronia deanei
- ★ Chamaesyce psammogeton
- ⊕ Cryptostylis hunteriana
- ▲ Daphnandra johnsonii
- Eucalyptus langleyi
- Genoplesium baueri
- ★ Lastreopsis hispida
- ⊕ Pterostylis gibbosa
- ▲ Pterostylis vernalis
- Solanum celatum
- Syzygium paniculatum
- ★ Triplarina nowraensis
- ⊕ Zieria baeuerlenii
- ▲ Zieria granulata
- Zieria tuberculata

**Survey area**

- Subject site (direct impacts)
- Subject site (indirect impacts)
- Study area (ancillary buffer)
- ⋯ 10km search area

**Figure 4: Threatened flora records (OEH 2013)**

0 1 2 3 4 5  
Kilometers

Scale: 1:1 00,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

**biosis**  
Biosis Pty Ltd

Ballarat, Brisbane, Canberra, Melbourne,  
Sydney, Wangaratta & Wollongong

Matter: 15896  
Date: 13 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
Location: P:\15800s\15896\mapping\15896\_F4\_ThrFlora\_20130813



### 3.5.2 Endangered flora populations

No TSC Act or EPBC Act listed endangered flora populations were observed in the current or previous surveys. Searches of the Atlas of NSW Wildlife (OEH, 2013) have identified the potential for the TSC Act and EPBC Act listed *Eucalyptus langleyi*, including the endangered population 'Eucalyptus langleyi population north of the Shoalhaven River in the Shoalhaven LGA' to occur within the study area. This species, and therefore the threatened population, was not recorded in the current surveys and is considered to have a low likelihood of occurrence in the study area based on limited availability of suitable habitat.

### 3.5.3 Threatened fauna species

Although no threatened species were recorded during the current 2013 field surveys, the following eight threatened fauna species were recorded during the previous field surveys (Biosis 2009):

- Glossy Black-Cockatoo *Calyptorhynchus lathami* listed as Vulnerable under the TSC Act.
- Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris* listed as Vulnerable under the TSC Act.
- Eastern Freetail Bat *Mormopterus norfolkensis* listed as Vulnerable under the TSC Act.
- Grey-headed Flying-fox *Pteropus poliocephalus* listed as Vulnerable under the TSC and EPBC Acts.
- Eastern Bentwing Bat *Miniopterus schreibersii oceanensis* listed as Vulnerable under the TSC Act.
- Large-eared Pied Bat *Chalinolobus dwyeri* Vulnerable under the TSC and EPBC Acts.
- Southern Myotis *Myotis macropus* listed as Vulnerable under the TSC Act.
- Greater broad-nosed bat *Scoteanax rueppellii* listed as Vulnerable under the TSC Act.

Searches of the Atlas of NSW Wildlife (OEH, 2013) for the locality have identified previous records of threatened fauna (**Figure 5**) or potential habitat from the PMST (DSEWPaC, 2013) (exclusive of records<sup>4</sup>) for a total of 70 threatened fauna species. Of these 70 threatened fauna species, 21 species have a dual listing under the TSC and EPBC Acts, two species are solely listed under the EPBC Act and 47 species are solely listed under the TSC Act.

Marine and pelagic species have been excluded from assessment and mapping except those that may forage on land. The excluded marine and pelagic species are not considered relevant to the habitats of the study area or the construction and operation of the proposal.

**Appendix B (Table A2-2)** ranks the likelihood of the 70 threatened fauna species identified in the locality occurring within the study area. This assessment considers the criteria set out in **Table 2.3**. Based on the field surveys, including targeted searches between 2007 and 2009 for some species; general surveys in 2013; habitats present in the study area; current disturbance regimes; and the number and distribution of previous records, these assessments have determined that:

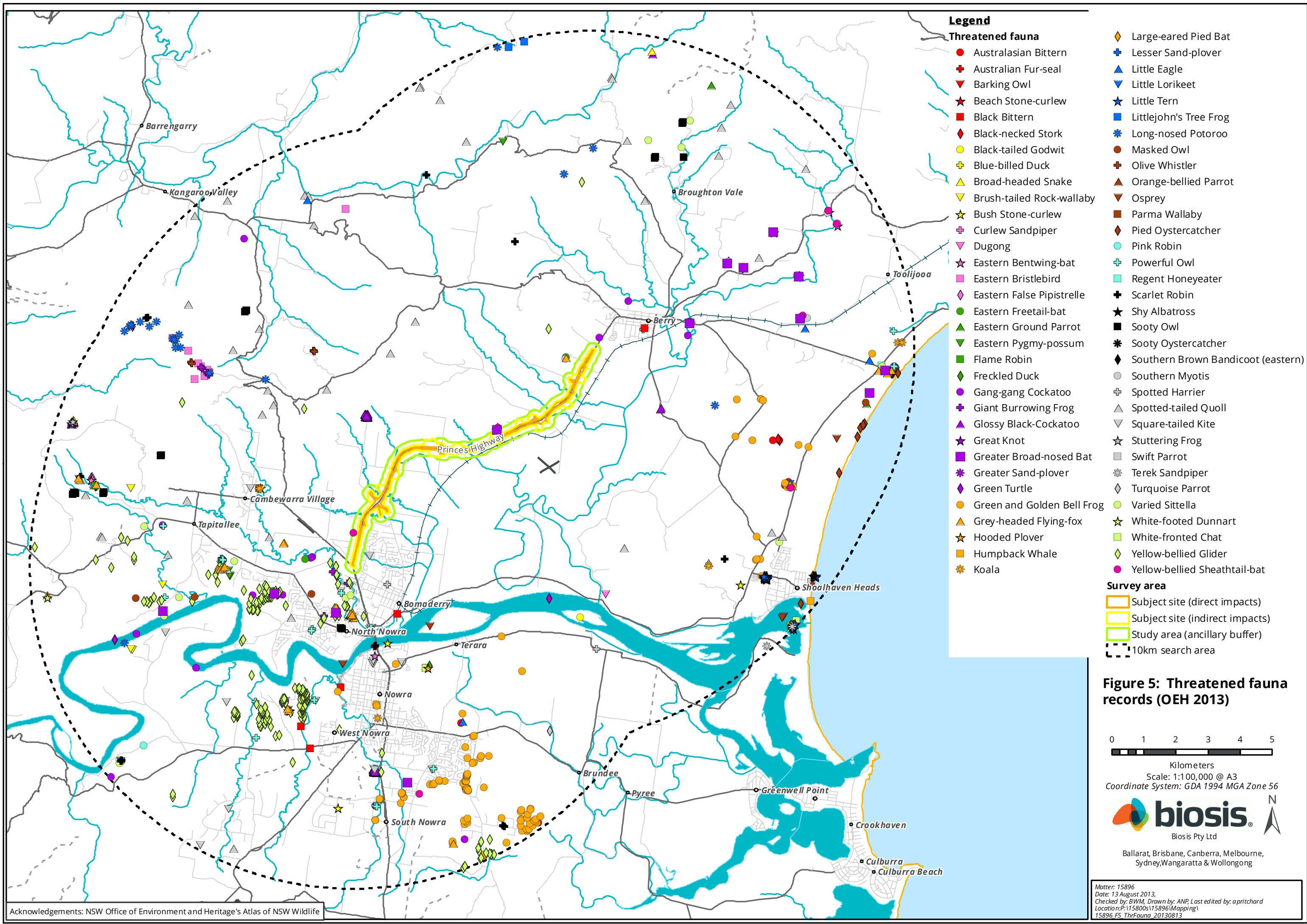
- There is a low likelihood for 40 of these species to be present in the study area.
- There is a medium likelihood for 14 of these species to be present in the study area.
- There is a high likelihood for 16 of these species to be present in the study area, including eight species previously recorded.

The 30 fauna species assessed as having a medium or high likelihood of occurrence are listed in **Appendix B (Table A2-2)** and have been considered further in **Chapter 5** of this report. Assessments of significance have been completed for 18 threatened fauna species (**Section 5.3** and **Appendices D and E**).

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<sup>4</sup> PMST includes predictions of species that are based (exclusive of records) on species habitat *known* to occur within the area.





**Legend**

- Threatened fauna**
- Australasian Bittern
  - ✚ Australian Fur-seal
  - ▼ Barking Owl
  - ★ Beach Stone-curlew
  - Black Bittern
  - ◆ Black-necked Stork
  - Black-tailed Godwit
  - ✚ Blue-billed Duck
  - ▲ Broad-headed Snake
  - ▼ Brush-tailed Rock-wallaby
  - ★ Bush Stone-curlew
  - ✚ Curlew Sandpiper
  - ▼ Dugong
  - ★ Eastern Bentwing-bat
  - Eastern Bristlebird
  - ◆ Eastern False Pipistrelle
  - Eastern Freetail-bat
  - ▲ Eastern Ground Parrot
  - ▼ Eastern Pygmy-possum
  - Flame Robin
  - ◆ Freckled Duck
  - Gang-gang Cockatoo
  - ✚ Giant Burrowing Frog
  - ▲ Glossy Black-Cockatoo
  - ★ Great Knot
  - Greater Broad-nosed Bat
  - ✚ Greater Sand-plover
  - ◆ Green Turtle
  - Green and Golden Bell Frog
  - ▲ Grey-headed Flying-fox
  - ★ Hooded Plover
  - Humpback Whale
  - ✚ Koala
  - ◆ Large-eared Pied Bat
  - ✚ Lesser Sand-plover
  - ▲ Little Eagle
  - ▼ Little Lorikeet
  - ★ Little Tern
  - Littlejohn's Tree Frog
  - ✚ Long-nosed Potoroo
  - Masked Owl
  - ✚ Olive Whistler
  - ▲ Orange-bellied Parrot
  - ▼ Osprey
  - Parma Wallaby
  - ◆ Pied Oystercatcher
  - Pink Robin
  - ✚ Powerful Owl
  - Regent Honeyeater
  - ✚ Scarlet Robin
  - ★ Shy Albatross
  - Sooty Owl
  - ✚ Sooty Oystercatcher
  - ◆ Southern Brown Bandicoot (eastern)
  - Southern Myotis
  - ✚ Spotted Harrier
  - ▲ Spotted-tailed Quoll
  - ▼ Square-tailed Kite
  - ★ Stuttering Frog
  - Swift Parrot
  - ✚ Terek Sandpiper
  - ◆ Turquoise Parrot
  - Varied Sittella
  - ★ White-footed Dunnart
  - White-fronted Chat
  - ◆ Yellow-bellied Glider
  - Yellow-bellied Sheathtail-bat

- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - - - 10km search area

**Figure 5: Threatened fauna records (OEH 2013)**

0 1 2 3 4 5  
Kilometers  
Scale: 1:1 00,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



Ballarat, Brisbane, Canberra, Melbourne, Sydney, Wangaratta & Wollongong

Matter: 15896  
Date: 13 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
Location: P:\15800s\15896\Mapping\15896\_F5\_ThrFauna\_20130813

Acknowledgements: NSW Office of Environment and Heritage's Atlas of NSW Wildlife



As a result of the current habitat based assessments, the presence of suitable habitat (particularly important habitat) and greater potential for impacts to occur, it is recommended that targeted surveys be undertaken for the following species:

- Green and Golden Bell Frog (GGBF) *Litoria aurea*.
- Microchiropteran bats, including the Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*, Eastern Freetail-bat *Mormopterus norfolkensis*, Southern Myotis *Myotis macropus*, Yellow-bellied Sheath-tail-bat *Saccolaimus flaviventris* and Greater Broad-nosed Bat *Scoteanax rueppellii*.
- Forest Owls, including the Barking Owl *Ninox connivens*, Powerful Owl *Ninox strenua*, Sooty Owl *Tyto tenebricosa* and Masked Owl *Tyto novaehollandiae*.

All targeted surveys have been recommended in areas containing significant habitat features for the above listed species (such as breeding habitat, roost sites, limiting foraging habitat or key dispersal routes) where there is potential for these significant fauna features to be impacted. Detailed locations descriptions and mapping co-ordinates for all recommended survey locations have been provided to RMS in a separate document; however recommended survey methodology and total survey effort for each species is outlined below.

It is recommended that these targeted surveys be undertaken during the detailed design and prior to the construction of the proposal.

#### *Green and Golden Bell Frog field surveys*

Targeted surveys for the species within the study area are recommended due to the proximity to the Coomonderry Swamp key population and the presence of potential dispersal and sub-optimal breeding habitat for the species within the study area.

Eight water bodies have been recommended for further survey in order to determine if the GGBF occurs in the study area. The recommended targeted surveys have been designed according to the survey requirements outlined in DECC (2009), DEWHA (2009), DEWHA (2010) and NPWS (2003a). Field surveys would be undertaken following the seasonal and climatic recommendations in the guidelines:

- Seasonal: September to March.
- Weather Conditions: Warm temperatures, no wind and following one week of heavy rainfall (less than 50 millimetres in seven days).
- Timing: Between dusk and dawn (nocturnal hours).

The following methodology would be implemented during the targeted surveys:

- A reference site at South Nowra would be established and/or discussions would be undertaken with the Australian Research Centre for Urban Ecology regarding the GGBF population modeling research being undertaken for RMS in South Nowra, prior to the commencement of targeted surveys for the GGBF within the study area.
- Optimally a reference site at South Nowra would be surveyed to determine whether the GGBF is active prior to the commencement of each targeted survey. During this check an initial five minute passive listening period would be undertaken to determine if the species is calling unsolicited. If not detected, a five minute period of call playback would be undertaken in an attempt to elicit the advertisement call of the male GGBF, followed by a period of active spotlighting. Visual observations of any adults and/or tadpoles, if present would be noted at this time. This process is undertaken for at least one person hour. If a reference site cannot be established, then verbal confirmation of active GGBF within the South Nowra population would be established prior to the commencement of each survey (if feasible). The purpose of checking reference sites is to determine whether the species is active ie males are present broadcasting their breeding calls at the time of survey and increasing the chances of detecting whether individuals are present within the study area. This is a requirement of both state and federal



survey guidelines.

- Providing the GGBF is identified to be calling within the reference site or at the Crookhaven River Floodplain population on the day, a total of eight water bodies located within the study area would then be surveyed on four separate nights between September 2013 to March 2014 (optimally in January and February 2014)
- Targeted surveys within the selected water bodies of the study area would include an initial five minute period of passive listening to detect the call of male GGBF. This would be followed by a period of call playback (broadcast of frog calls) in an attempt to elicit a response from any frogs that might be present. Following call playback each water body would then be carefully searched for frogs and tadpoles using hand-held spotlights and binoculars. Area searches and transects of vegetation and drainage lines surrounding those water bodies considered to be suitable habitat, would also be searched. Active searching of refuge sites (eg under logs, rocks or tin) would also be undertaken on site
- Tadpole surveys would be conducted by either using a dip net in open water bodies during nocturnal surveys or by using light traps (bait traps) in those habitats where dip netting is not feasible such as those containing dense fringing vegetation. Tadpoles and other fauna captured (such as Eastern Mosquito fish *Gambusia holbrooki*) will be identified to species or genus level in the field (note that GGBF tadpoles can be easily distinguished from other *Litoria* species).
- Survey times for individual water bodies is dependent on size, with those water bodies less than 0.3 hectare requiring four hour survey on four separate survey nights, and those water bodies less than 0.3 hectare requiring one hour of survey on four separate survey nights. All eight water bodies identified within the study area are less than 0.3 hectare each.

If the species is identified within the study area or within the locality prior to completion of all surveys, subsequent surveys would be used to identify the extent of the population, occupancy at other water bodies and to assess potential impacts. If the species were located in the subject site or study area it would be managed in accordance with a GGBF Management Plan. The plan would detail short- and long-term management measures to minimise and mitigate impacts to GGBF including impacts to dispersal, foraging or breeding habitats.

### *Microchiropteran bats*

Following the recording of six microchiropteran bat species within the PEI study area (Biosis 2009) and the identification of potential foraging and roosting habitat within the subject site and surrounding study area during the current surveys, targeted surveys for microchiropteran bats (microbats) are recommended, focussing on potential roosting habitat identified within the subject site. Species targeted include Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*, Eastern Freetail-bat *Mormopterus norfolkensis*, Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Southern Myotis *Myotis macropus*, Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*, Large-eared Pied Bat *Chalinolobus dwyeri* and Greater Broad-nosed Bat *Scoteanax rueppellii*.

Targeted surveys are recommended at fourteen locations along the alignment within the study area. The data collected at these sites would be used to determine if threatened microbats occur within the study area, and identify the locations of roost sites within the study area (if present). The following survey recommendations have been developed in line with those recommended in the *Draft Threatened Species Survey and Assessment Guidelines* (DEC 2004). Field surveys would be undertaken following the seasonal and climatic recommendations in the guidelines:

- Seasonal: October to March.
- Weather Conditions: Avoid cold temperatures, strong winds, heavy rain and full moons.
- Timing: From dusk and dawn (minimum of four hours).



The following methodology would be implemented during the targeted surveys:

- Searches of the 14 potential microbat roost sites such as culverts, bridges and hollow-bearing trees likely to be disturbed by the proposal that are easily accessible would be undertaken using an endoscope and torch. Where identification of the species cannot be confirmed (for example, if individuals are detected but not observed, an active echolocation survey combined with spotlighting would be conducted (see below).
- Those sites where access is limited or where not all cracks and crevices can be inspected due to height, creeklines, traffic etc. an active echolocation survey combined with spotlighting would be undertaken. Surveys should be conducted over two hours, one hour prior to dusk, and one hour following dusk to detect microbats leaving their roost sites if present. Handheld ultrasonic echolocation detection devices (Anabats or Songmeters) would be used during this two hour period to confirm the species of microbats if detected.
- Any microbats found should be managed in accordance with a Microbat Management Plan. The plan would detail short- and long-term management measures to minimise and mitigate impacts to microbats and identified roost sites. If no microbats are located during pre-construction surveys, it would be assumed that they are no longer roosting within the study area and no Microbat Management Plan would be required.

### *Forest owls*

Potential foraging, roosting and sub-optimal nesting habitat for four forest owls, including the Barking Owl *Ninox connivens*, Powerful Owl *Ninox strenua*, Sooty Owl *Tyto tenebricosa* and Masked Owl *Tyto novaehollandiae*, were recorded along the alignment. Targeted surveys are recommended at three locations within the subject site, focusing on potential roosting habitat within the subject site.

The data collected at these sites would be used to determine if listed Forest Owls occur within the study area and if so what species occur, and, where possible, to determine the locations of roost and nesting sites within the subject site (if present).

The following survey recommendations have been developed in line with those recommended in the *Draft Threatened Species Survey and Assessment Guidelines* (DEC 2004). Field surveys would be undertaken following the seasonal and climatic recommendations in the guidelines:

- Seasonal: December to June.
- Weather Conditions: Avoid cold temperatures, strong winds, and heavy rain and full moons.
- Timing: From dusk and dawn (nocturnal hours).
- Effort: up to four nights with a 50 per cent probability of locating an owl species or up to nine nights with a 90per cent probability of locating an owl species.

The following methodology would be implemented during the targeted surveys:

- Targeted surveys would involve the use of call playback and spotlighting techniques. Call playback involves the broadcasting of each species call using a 10 watt amplifier.
- At each call playback location an initial period of 10 minutes listening would be undertaken. This would be followed by a 10 minute spotlighting search of the locality to detect the presence of any forest owls or incidental species in the immediate vicinity. The call of all three target species would then be broadcast intermittently for 5 minutes, followed by another 10 minute listening period. Another 10 minutes of spotlighting would follow to check for birds that may have been attracted by the calls but are not vocalising.
- Following the recommended survey effort for the species being targeted, this process would need to be repeated over eight nights at all three survey locations.
- Owl pellets, if sighted, would be collected at each survey site and sent to a specialist for identification.



### 3.5.4 Threatened fauna populations

No endangered fauna populations listed under Part 2 of Schedule 1 of the TSC Act are expected to occur within the study area or the locality.

## 3.6 Migratory species

Although no migratory species were recorded during the current 2013 field surveys, the following four migratory species were recorded during the previous field surveys (Biosis 2009):

- White-bellied Sea-eagle *Haliaeetus leucogaster*.
- Cattle Egret *Ardea ibis*.
- Black-faced Monarch *Monarcha melanopsis*.
- Rufous Fantail *Rhipidura rufifrons*.

Searches of the Atlas of NSW Wildlife (OEH, 2013) and PMST (DSEWPac, 2013) for the locality have identified previous records or potential habitats for an additional 40 migratory fauna species. **Figure 6** displays the location of the most recent records for all 40 of the migratory species recorded within the locality. Marine and pelagic species have been excluded (except those that may forage on land). **Appendix C Table A3-1** provides the inventory of migratory species subject to the current assessment.

Australia is a signatory to international agreements aimed at protecting migratory species. These include the *Japan Australia Migratory Bird Agreements* (JAMBA), the *China Australia Migratory Bird Agreement* (CAMBA), the *Republic of Korea Australia Migratory Bird Agreement* (RoKAMBA), and the *Bonn Convention on the Conservation of Migratory Species of Wild Animals*. Migratory species are considered to be Matters of National Environmental Significance (MNES) and as such are protected under the EPBC Act.

While migratory species of birds may potentially use the locality (see **Appendix B**), the study area would not be classed as an 'important habitat' as defined under the *Matters of National Environment Significance Impact Guidelines 1.1* (DEWHA 2009) in that the site does not contain:

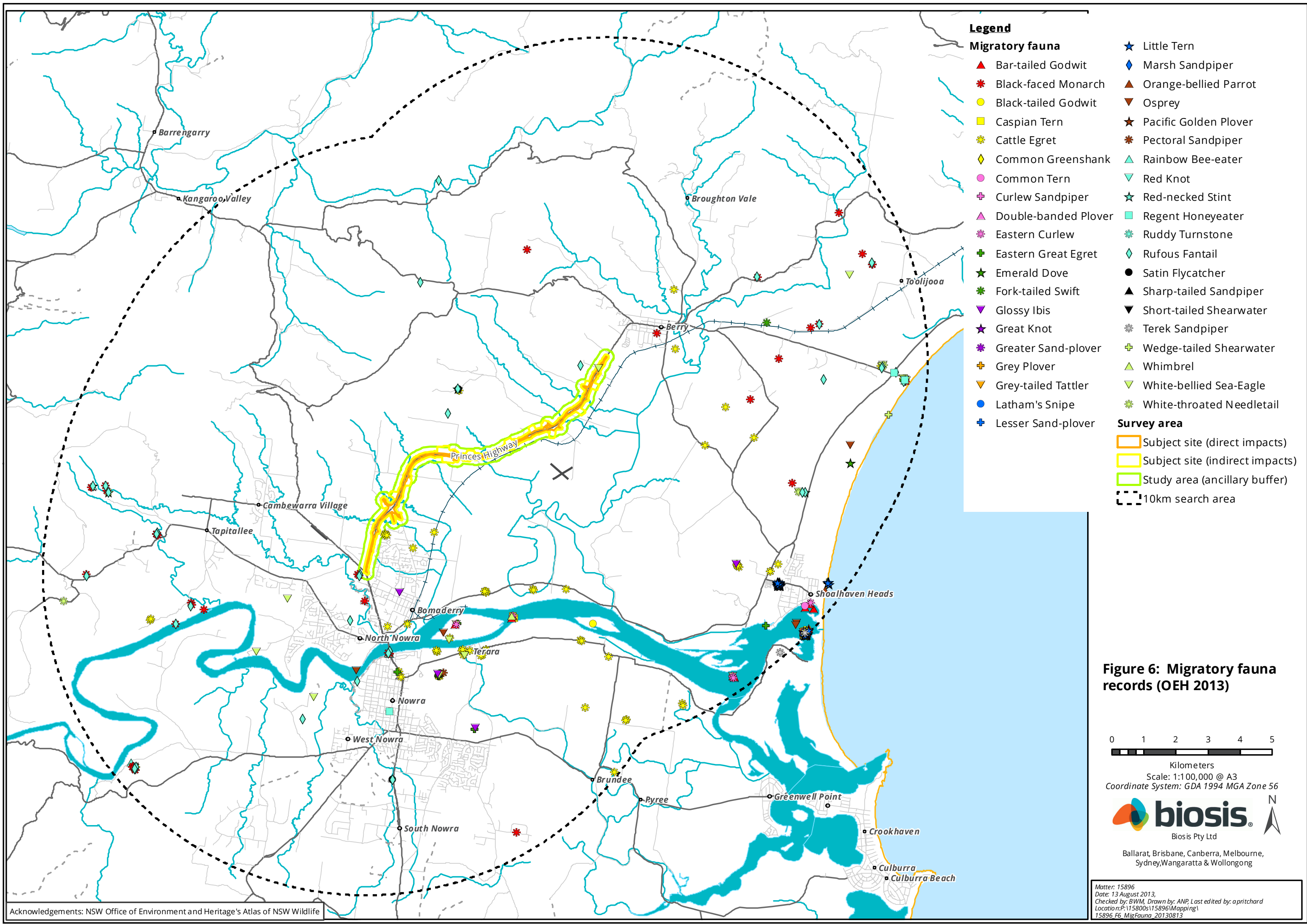
- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecological significant proportion of the population of the species.
- Habitat that is of critical importance to the species at particular life stages.
- Habitat utilised by migratory species which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

In addition to the above, the proposal is unlikely to result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species (DEWHA 2009).

The study area is not considered to support an ecologically significant proportion of the population of any migratory species assessed in **Appendix B**. Therefore the proposal is unlikely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species (DEWHA 2009).

In view of the above, no assessments of significance have been completed for migratory species previously recorded or likely to occur within the study area.





- Legend**
- Migratory fauna**
- ▲ Bar-tailed Godwit
  - ✱ Black-faced Monarch
  - Black-tailed Godwit
  - Caspian Tern
  - ✱ Cattle Egret
  - ◇ Common Greenshank
  - Common Tern
  - ✱ Curlew Sandpiper
  - ▲ Double-banded Plover
  - ✱ Eastern Curlew
  - ✱ Eastern Great Egret
  - ★ Emerald Dove
  - ✱ Fork-tailed Swift
  - ▼ Glossy Ibis
  - ★ Great Knot
  - ✱ Greater Sand-plover
  - ✱ Grey Plover
  - ▼ Grey-tailed Tattler
  - Latham's Snipe
  - ✱ Lesser Sand-plover
  - ★ Little Tern
  - ◇ Marsh Sandpiper
  - ▲ Orange-bellied Parrot
  - ▼ Osprey
  - ★ Pacific Golden Plover
  - ✱ Pectoral Sandpiper
  - ▲ Rainbow Bee-eater
  - ▼ Red Knot
  - ★ Red-necked Stint
  - Regent Honeyeater
  - ✱ Ruddy Turnstone
  - ◇ Rufous Fantail
  - Satin Flycatcher
  - ▲ Sharp-tailed Sandpiper
  - ▼ Short-tailed Shearwater
  - ✱ Terek Sandpiper
  - ✱ Wedge-tailed Shearwater
  - ▲ Whimbrel
  - ▼ White-bellied Sea-Eagle
  - ✱ White-throated Needletail
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - 10km search area

**Figure 6: Migratory fauna records (OEH 2013)**

0 1 2 3 4 5  
Kilometers

Scale: 1:1 00,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



Ballarat, Brisbane, Canberra, Melbourne,  
Sydney, Wangaratta & Wollongong

Matter: 15896  
Date: 13 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
Location: P:\15800s\15896\Mapping\15896\_F6\_MigFauna\_20130813



### 3.7 Critical habitat

No areas of critical habitat for flora or fauna have been declared within the study area under either the EPBC or TSC Act (OEH 2013; DSEWPaC 2013b).

In response to a public nomination, the Director-General of NSW National Parks and Wildlife Service (NPWS) prepared a proposal to list critical habitat for the TSC and EPBC Act endangered flora species *Zieria baeuerlenii* (NPWS 2002). The critical habitat proposal was placed on public exhibition in May 2002, and 54 hectares of the bushland was formally identified by the NSW Minister of the Environment as critical habitat for the species in 2003. The boundary of the identified critical habitat is the local top of the watershed, to provide protection from pollutants and water borne pathogens such as *Phytophthora cinnamomi*, except in the north eastern portion of the area where the top of the watershed occurs beyond existing development. The identified critical habitat has not been declared by the NSW Minister of the Environment, primarily due to the creation of the Bomaderry Creek Regional Park which protects most of the population (DECC 2010).

The northern extent of the area identified as proposed critical habitat for *Zieria baeuerlenii* (NPWS 2002; DECC 2010) falls just inside the boundary of the study area near the intersection of the Princes Highway and Moss Vale Road at the southern end of the proposal. The area of proposed critical habitat for *Zieria baeuerlenii* would not be directly or indirectly impacted by the proposal.

### 3.8 Fauna movement corridors

Wildlife corridors can be best defined as “retained and/or restored systems of (linear) habitat which, at a minimum, enhance connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation” (Wilson and Lindenmayer, 1995). Alternatively, they can be defined as “linear habitats that differ from a more extensive surrounding matrix; frequently they link one or more patches of habitat in the landscape, but they may also occur as isolated lines of habitat” (Bennett, 1990).

Vegetation cover in a corridor may not always be continuous. Corridors may include smaller remnants, wetlands, roadside vegetation, groups of trees, and even individual trees. Corridors may be broken, or fragmented, by currently degraded or cleared areas but still contribute to landscape connectivity. Discontinuous corridors can provide important stepping-stone links (Scotts *et al.*, 2000). The functioning of a corridor can be best described in terms of its connectivity, of which there are two components:

- Structural connectivity. This is the mapable spatial continuity of the corridor. This can include the distance over which the corridor extends, the width, the number of gaps and the presence of habitat nodes.
- Functional connectivity. This is a measure of the ability of a species to move between two habitats. The functional connectivity of a corridor depends not only on its spatial continuity, but also on factors such as behaviour of the species, the scale of the species' movements, and its response to the width and quality of habitat in the corridor (Bennett 1990).

Corridor structural connectivity over the study area from the vegetated slopes and foothills of the Cambewarra Range east to the coastal wetlands and woodlands of Coomonderry Swamp and Seven Mile Beach National Park is severely depleted and mainly characterised by grasslands. Complexity of this vegetation type and associated habitat is low. Other vegetation is limited to discontinuous and very narrow strips of tree cover with understorey in places. There are also minor patches and isolated occurrences of trees over the lower Shoalhaven floodplain. The low level of structural connectivity results in a low level of functional connectivity which is likely to support a narrow range of fauna species and does not provide for favourable conditions for dispersal of native flora including propagules and pollen.



### 3.8.1 Regional corridors

The *South Coast Regional Conservation Plan* (DECCW, 2010) amalgamates several corridor plans to provide an analysis that considers the configuration of vegetation (patch size, condition and connectedness) and identified areas that are important for decreasing or at least maintaining the current level of habitat fragmentation on the South Coast. The mapping by DECCW (2010) ranks lands potentially valuable for improving natural landscape function into two classes, these being 'environmental corridors' and 'priority areas for restoration and enhancement'. In summary environmental corridors include the following three subgroups:

- Corridors that are currently incorporated in statutory and other local plans. These narrow corridors are known to be used by threatened fauna, and they must be maintained if the local populations are to be sustained.
- Verified regional corridors that are additional areas identified by the DECCW (2010) analysis for the NSW south coast as the highest priority for maintaining or improving habitat connectivity.
- Riparian corridors including second-order and above streams as corridors.

Priority areas for restoration and enhancement are broad zones in the region where connection between core vegetation is ecologically sensible in the long term but the means by which this is achieved is most strongly influenced by local circumstances such as tenure and critical land uses, the level of interest in a local community and the presence of keystone species and their habitats. The identified corridors provide a focus for future protection and landscape restoration, but are not currently operating as viable fauna movement corridors (**Figure 7-1**).

Riparian corridors falling into the environmental corridors class traverse the study area at Wileys Creek and Jaspers Brush Creek (**Figures 7-1 and 7-2**). Additionally some patches of tree cover within two kilometres of the study area mapped by DECCW (2010) are in **Figure 7-2**.

### 3.8.2 Local corridors

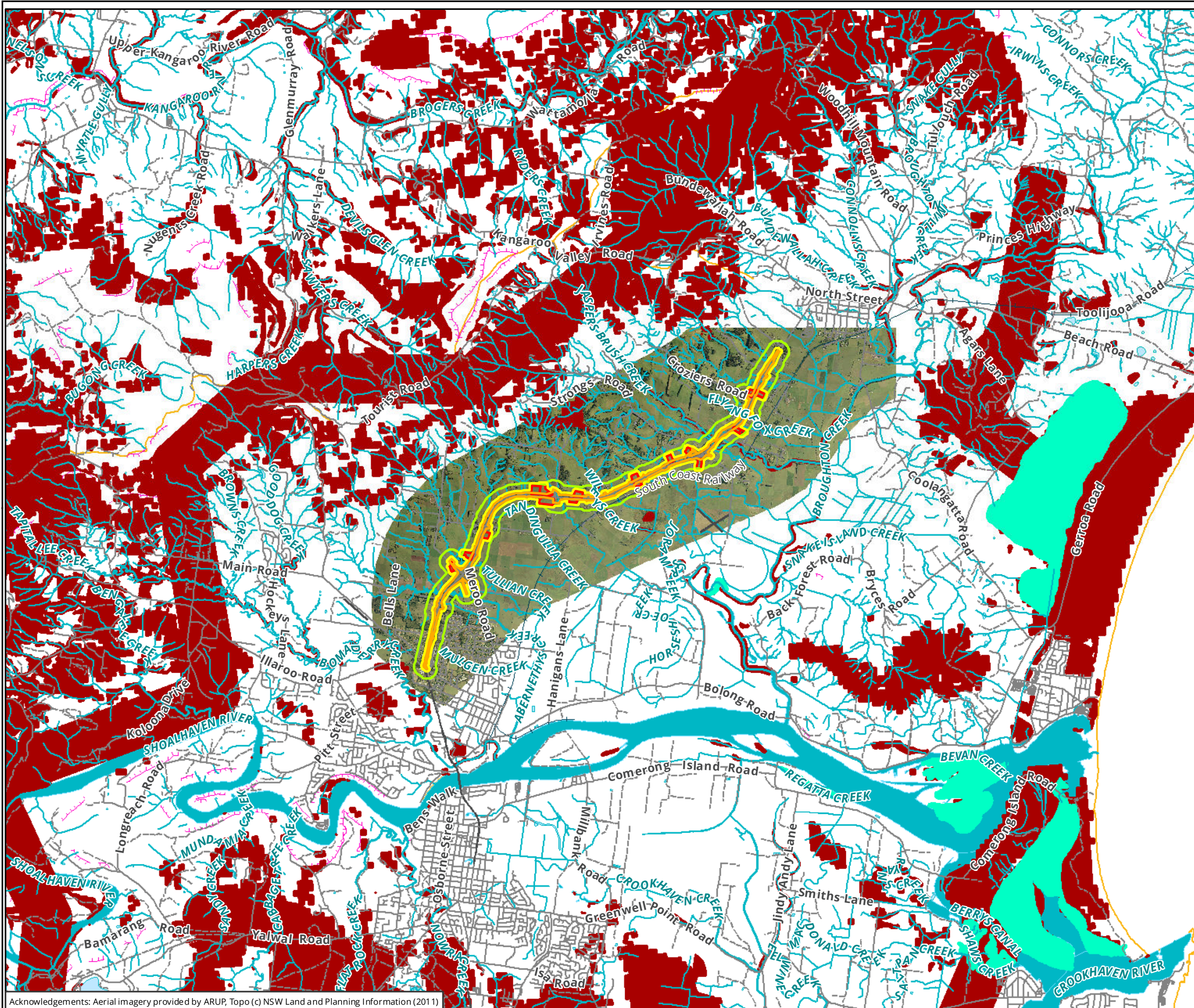
The majority of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation and have not been mapped or described as a native plant community. Wildlife corridors in the study area are limited.

Creeks provide dispersal habitat for aquatic fauna and vegetation along creeks and some road reserves within the study area would also provide some value as stepping stones, aiding in the movement of some species. These smaller corridors are important in linking the larger corridors, and also provide the added values of protecting riverbanks, improving water quality and flows, controlling soil erosion and increasing land productivity through shelterbelts, windbreaks and screens (Shoalhaven City Council 2005).

Animals can use road reserves as habitat in which to live as well as movement corridors facilitating local movements, dispersal and migration (Bennett 1990). Within highly modified landscapes, remnant patches and strips of vegetation within road reserves are often the only remaining vegetation links. A number of studies have indicated the importance of such roadside vegetation (Breckwoldt 1990).

Within the study area native roadside vegetation is limited to small discontinuous segments of native and exotic tree cover and groundcover within a matrix of introduced grasses and weeds. Isolated, small patches of vegetation in the study area provide limited value for native wildlife.





- Wildlife corridors SCRPC (DECCW)
- SEPP 14 wetlands SCRPC (DECCW)
- 
- 
- 
- Potential construction ancillary facilities

**Figure 7.1: Wildlife corridors and SEPP 14 wetlands - South Coast Regional Conservation Plan (SCRPC) (DECCW 2010)**

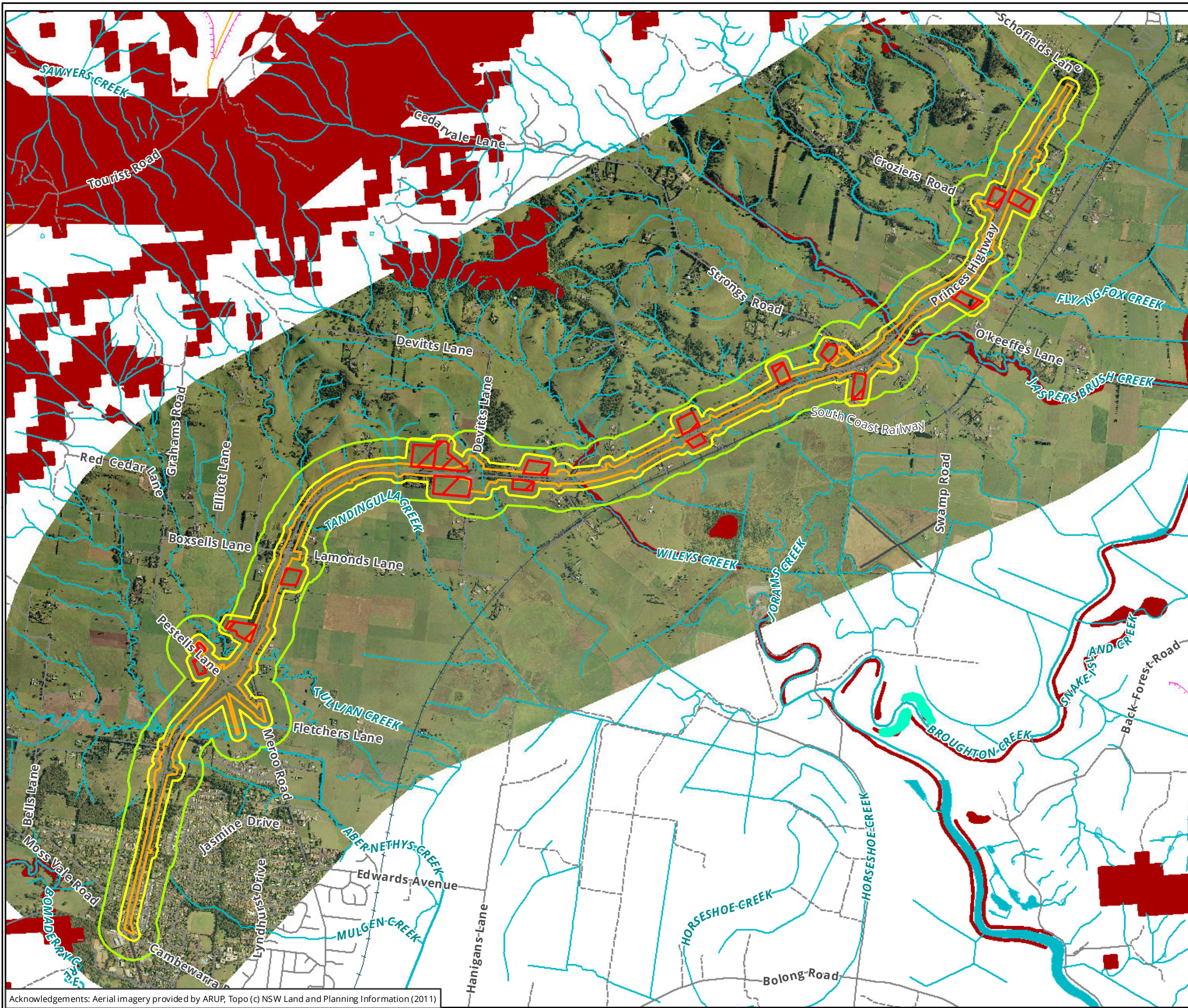
0 0.75 1.5 2.25 3 3.75  
 Kilometers  
 Scale: 1:75,000 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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 Date: 28 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
 Location: P:\15800s\15896\mapping\15896\_F7.1\_Corridors\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)





- Legend**
- Wildlife corridors SCRCP (DECCW 2010)
  - SEPP 14 wetlands SCRCP (DECCW 2010)
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 7.2: Wildlife corridors and SEPP 14 wetlands - South Coast Regional Conservation Plan (SCRCP) (DECCW 2010)**

0 280 560 840 1,120 1,400  
Meters  
Scale: 1:28,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

Biosis Pty Ltd  
Ballarat, Brisbane, Canberra, Melbourne, Sydney, Wangaratta & Wollongong

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)

Matter: 15896  
Date: 28 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
Location: P:\15800s\15896\mapping\15896\_F7.2\_Corridors\_20130813



### 3.9 Groundwater dependant ecosystems

Groundwater dependant ecosystems (GDEs) have been discussed in detail in the *Princes Highway upgrade - Berry to Bomaderry upgrade. Technical Paper: Aquatic Ecology and Water Quality Management* (Cardno Ecology Lab 2013). In summary Cardno Ecology Lab (2013) discuss the shallow alluvial groundwater systems upstream in the Broughton Creek floodplain and in the area immediately north of Berry, where Broughton Mill Creek, Bundewallah Creek and Connollys Creek converge and note that shallow alluvial groundwater systems are often in direct connection with surface water bodies, such as coastal waterways. Cardno Ecology Lab (2013) have assessed the groundwater system in the study area is likely to support surface base flows, hyporheic ecosystems and terrestrial vegetation such as riparian forests. It is acknowledged that these systems are a component of aquatic and terrestrial habitats in riparian areas and that RFEFCF of the study area has a high probability of being a GDE along with the Reedland community described in this report. Cardno Ecology Lab (2013) concludes however that the relationship between groundwater and persistence of riparian habitat in the study area is not fully understood.

### 3.10 SEPP 44 – Koala habitat protection

The *State Environmental Planning Policy 44 – Koala Habitat Protection* (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas *Phascolarctos cinereus*, ensuring a permanent free-living population over their present range and attempting to reverse the current trend of Koala population decline. Under this policy the distinction is made between 'potential' and 'core' Koala habitat.

"Potential Koala habitat" is defined as areas of native vegetation where the tree species listed in Schedule 2 of the policy constitute at least 15 per cent of the total number of trees in the upper or lower strata of the tree component and where the area of native vegetation is equal to or greater than one hectare. "Core Koala Habitat" is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

### 3.11 SEPP 14 – Coastal wetlands

*State Environmental Planning Policy 14 Coastal Wetlands* (SEPP 14) aims to protect and preserve coastal wetlands. Over 1300 coastal wetlands have been mapped under SEPP 14, representing seven per cent of all coastal wetlands in NSW. Under SEPP 14, a person must not clear land, construct a levee, drain land or fill land which is covered by SEPP 14 except with the consent of the local council and the concurrence (agreement) of the NSW Minister for Planning. The nearest SEPP 14 wetland is approximately 2.5 kilometres to the south east of the study area, along Broughton Creek (**Figures 7-1 and 7-2**). SEPP14 wetlands are also mapped at Coomonderry Swamp six kilometres to the east and at Shoalhaven Heads and Comerong Island Nature Reserve over nine kilometres to the southeast (**Figure 7-1**).



## 4 Potential impacts

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This chapter assesses the types of impacts that may result as a consequence of the construction and operation of the proposal. The assessment focuses on the most likely or representative scenarios based on the current proposal concept design, desktop analysis and cumulative terrestrial flora and fauna field surveys. The representative scenarios include foreseeable work methods and management measures during construction, ongoing operational controls and consideration of additional safeguards such as the biodiversity constraint criteria for locating temporary construction ancillary facilities and RMS policy and procedures such as the 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011). The reality that further refinement of the proposal would occur in phases over a time period spanning the environmental assessment and detailed design phases of the proposal has also been considered. In this instance where there may be some uncertainty regarding the location and magnitude of impacts it is assumed that due diligence would be applied, including further targeted surveys for threatened biodiversity, and adoption of the avoid, minimise, mitigate or offset approach.

Potential impacts resulting from road construction and operation phases of the proposal on terrestrial ecological values of the study area that are addressed in this section include the following:

- Loss of vegetation and flora and fauna habitat.
- Habitat fragmentation, and edge and barrier effects.
- Injury and mortality.
- Weeds.
- Pests and pathogens.
- Impact on relevant key threatening processes (TSC Act and EPBC Act).
- Cumulative impacts.
- Koala habitat.
- Coastal wetlands.

Potential impacts of these key considerations during the construction and operation phases of the proposal are discussed in the following sections.

### 4.1 Loss of vegetation and flora habitat

#### 4.1.1 Construction impacts

The majority of native vegetation and flora habitat to be cleared as a result of the proposal is in a poor condition or completely altered and is considered to have low conservation significance. Vegetation clearing for the proposal would result in the loss of habitat for native flora primarily due to direct impacts on native plant communities during construction. While stands of native plant communities provide a range of conditions suitable for the recruitment, growth and longevity of individual plants including influencing microclimate, soil conditions, plant association, exchange and dispersal of genetic the proposal is unlikely to significantly impact on important flora habitats in the study area.

**Table 4-1** shows the area of each native and derived vegetation community and other vegetation types recorded in the subject site and study area that would be impacted by the proposal. Additionally **Table 4-1** highlights the areas of vegetation that are likely to be avoided through consideration of the terrestrial biodiversity constraint criteria for locating temporary construction ancillary facilities.



**Table 4-1 Area of each vegetation community and type impacted or avoided by the proposal**

Vegetation community	Concept design development footprint		Temporary construction ancillary facilities		Total subject site (direct and indirect) hectares	% cleared in Southern Rivers CMA*	% impacted for locality	Study area/ ancillary facilities area avoided <sup>†</sup> hectares
	Subject site (direct) hectares	Subject site (indirect) hectares	Subject site (direct) hectares	Subject site (indirect) hectares				
Currambene Batemans lowland forest	1.44	2.36	0	0	3.80	45	0.09	5.80
Shoalhaven sandstone forest	0.24	1.56	0	0	1.80	20	0.06	3.26
Illawarra gully wet forest	0.98	0.74	0	0	1.72	50	0.13	3.30
Riverbank forest (RFEFCF)*	0.53	0.74	0	0	1.27	95	2.61	2.23
South Coast grassy woodland (ILGW)*	0.30	0.01	0	0	0.31	85	0.13	0.19
Reedland #	0.12	0.19	0	0	0.31	Not calculated	Not calculated	0.75
Acacia scrub #	1.50	0.49	0	0	1.99	Not calculated	Not calculated	0.82
Planted #^	4.80	3.89	0	0	8.69	Not calculated	Not calculated	3.82

\* Percentage cleared in the Southern Rivers CMA, as per the corresponding Vegetation Type from the NSW Vegetation Types Database

<sup>†</sup> Estimated areas of native plant communities, derived plant communities and other vegetation that will remain in the study area and are unlikely to be directly or indirectly impacted by the proposal.

\* TECs

# Not mapped at a Locality scale by current or published studies

^ Not considered to be a native or derived native vegetation community



In the combined subject site (direct and indirect) native vegetation communities are considered to support better quality flora habitats compared with the derived plant communities and constructed or altered vegetation types. **Table 4-1** shows that up to 3.48 hectares of native vegetation would be directly impacted during the construction phase of the proposal.

The derived vegetation communities and planted vegetation type provide a lesser quality of flora habitat. Direct impacts to these and the flora habitat they support are estimated at 6.41 hectares. The Grassland vegetation type supports the least value native flora habitat and would be subject to the highest areas of likely direct impact by the proposal estimated at 86.87 hectares for the concept design development footprint and an additional 22.27 hectares for the temporary construction ancillary facilities.

The study area of the current investigation assesses a 200 metre buffer to the combined subject site (direct and indirect) to highlight biodiversity constraints and guided the selection of potential locations for temporary construction ancillary facilities. As a result of application of these criteria **Table 4-1** shows that:

- There would be no additional direct or indirect impacts to native vegetation.
- Impacts to 14.77 hectares of native vegetation, including 2.42 hectares, of TEC would be avoided during construction.

#### *Impacts to threatened ecological communities*

The TSC Act listed TEC RFEFCF is present at Jaspers Brush Creek (**Figures 3-15 and 3-16**), Wileys Creek (**Figure 3-11**) and Flying Fox Creek (**Figures 3-17 and 3-18**). The majority of the community inspected and mapped in the current surveys is in Poor condition with areas of Moderate condition vegetation present on both sides of the Princes Highway on Jaspers Brush Creek. In summary 0.53 hectares of the community would be directly impacted by the proposal equating to 1.1 per cent of the community mapped in the locality by Tozer *et al* (2010). The remaining RFEFCF present in the study area excluding the areas in the subject site (direct and indirect), estimated at 2.23 hectares is unlikely to be directly impacted through the application of the temporary construction ancillary facilities impact avoidance criteria.

ILGW is a TEC listed under the TSC Act occurring as several scattered patches on the northern side of the Princes Highway to the west of Strongs Road (**Figures 3-13 and 3-14**). All stands of the community are considered to be in a low condition based on floristic composition and ongoing impacts including weed invasion and livestock grazing. In summary 0.3 hectares of the community would be directly impacted by the proposal equating to 0.1 per cent of the community mapped in the locality by Tozer *et al* (2010). The remaining ILGW present in the study area excluding the areas in the subject site (direct and indirect), estimated at 0.19 hectares, is unlikely to be directly impacted through the application of the ancillary facilities impact avoidance criteria.

Assessment of the potential impact of the proposal on TSC Act listed threatened ecological communities inclusive of direct impacts during construction is in **Chapter 5**.



### *Impacts to threatened flora species habitat*

Four threatened flora species are assessed as having a medium likelihood of occurrence in the study area based on the presence of previous records in the locality and types and condition of suitable habitats, primarily the presence of native plant communities. Three of these species *Pterostylis gibbosa*, *Cryptostylis hunteriana* and *Thesium australe* have dual listing under the TSC and EPBC Acts with one species *Genoplesium baueri* only listed under the TSC Act. Impacts to these species habitats based on the direct impacts of the proposal such as vegetation clearing include:

- Combined direct impacts of 1.74 hectares to Currumbene Batemans lowland forest and South Coast grassy woodland representing poor to good potential habitat for *Pterostylis gibbosa*.
- Combined direct impacts of 1.68 hectares to Currumbene Batemans lowland forest and Shoalhaven sandstone forest representing poor to good potential habitat for *Cryptostylis hunteriana*.
- Direct impacts of 0.24 hectares to Shoalhaven sandstone forest representing moderate to good potential habitat for *Genoplesium baueri*.
- Combined direct impacts of 2.95 hectares to Currumbene Batemans lowland forest, Shoalhaven sandstone forest, Illawarra gully wet forest and South Coast grassy woodland representing poor to good potential habitat for *Thesium australe*.

Assessment of the potential impact of the proposal on TSC and EPBC Act listed threatened flora species including during construction is discussed in **Chapter 5**.

#### 4.1.2 Operation impacts

Potential impacts during operation of the proposal would mainly be indirect impacts such as those associated with edge effects. The majority of vegetation that would be subject to ongoing impacts during the operation phase is the Grassland vegetation type. This vegetation supports the lowest quality native flora habitat and the area that would be subject to indirect impacts is estimated at 129 hectares.

Approximately 4.57 hectares of the derived vegetation communities and planted vegetation type flora habitat would be indirectly impacted. Additionally up to 5.41 hectares of native vegetation supporting better quality flora habitats would be affected during operation of the proposal as a result of indirect impacts such as alteration of microclimate, soil conditions, weed invasion and over spraying of herbicide during maintenance.

### *Impacts to threatened ecological communities*

RFEFCF occurs at Jaspers Brush Creek (**Figures 3-15 and 3-16**), Wileys Creek (**Figure 3-11**) and Flying Fox Creek (**Figures 3-17 and 3-18**) and is mainly in a Poor condition with areas of Moderate condition vegetation present on both sides of the Princes Highway on Jaspers Brush Creek. Approximately 0.74 hectares of RFEFCF is likely to be indirectly impacted as result of the operation of the proposal. These ongoing impacts will result in a range of edge effects to an area equating to 1.5 per cent of the community mapped in the locality by Tozer *et al* (2010).

ILGW occurs as several scattered patches on the northern side of the Princes Highway to the west of Strongs Road (**Figures 3-13 and 3-14**). All stands of the community are considered to be in a low condition and are affected by ongoing impacts including weed invasion and livestock grazing. In summary approximately 0.01 hectares is likely to be subject to ongoing indirect impacts during the operation of the proposal equating to 0.004 per cent of the community mapped in the locality by Tozer *et al* (2010).

Assessment of the potential impact of the proposal on TSC Act listed threatened ecological communities inclusive of indirect impacts during the operational phase is detailed in **Chapter 5**.



### *Impacts to threatened flora species habitat*

Four threatened flora species are assessed as having a medium likelihood of occurrence in the study. Three of these species *Pterostylis gibbosa*, *Cryptostylis hunteriana* and *Thesium australe* have dual listing under the TSC and EPBC Acts with one species *Genoplesium baueri* only listed under the TSC Act. Impacts to these species habitats based on the indirect impacts of the proposal such as ongoing edge effects include:

- Combined indirect impacts of 2.48 hectares to Currumbene Batemans lowland forest and South Coast grassy woodland representing poor to good potential habitat for *Pterostylis gibbosa*.
- Combined indirect impacts of 3.92 hectares to Currumbene Batemans lowland forest and Shoalhaven sandstone forest representing poor to good potential habitat for *Cryptostylis hunteriana*.
- Indirect impacts of 1.56 hectares to Shoalhaven sandstone forest representing moderate to good potential habitat for *Genoplesium baueri*.
- Indirect impacts of 3.94 hectares to Currumbene Batemans lowland forest, Shoalhaven sandstone forest, Illawarra gully wet forest and South Coast grassy woodland representing poor to good potential habitat for *Thesium australe*.

Assessment of the potential impact of the proposal on TSC and EPBC Act listed threatened flora species including during operation is discussed in **Chapter 5**.

## 4.2 Loss of fauna habitat

### 4.2.1 Construction impacts

Vegetation clearing for the proposal would result in the loss of habitat for native fauna primarily due to direct impacts during construction. Impacts of clearing native and derived plant communities would result in the loss or modification of fauna habitat features that occur in the area. In the study area, this would include nesting habitat and roosting hollows, as well as feeding and shelter resources such provided by native and derived vegetation, constructed dams and drainage lines. There is also some potential for fauna mortality to occur during construction. **Table 4-2** shows the area of each main fauna habitat and corresponding native and derived vegetation community and other vegetation types recorded in the subject site and study area that would be impacted by the proposal. The specific impacts of the construction phase of the proposal resulting in the loss of fauna habitat are also discussed below.



**Table 4-2 Area of each main fauna habitat and corresponding vegetation community and type impacted by the proposal.**

Vegetation community	Habitat type	Subject site (direct) hectares	Subject site (indirect) hectares	Total subject site (direct and indirect) hectares	% impacted for locality	Study area/ ancillary facilities area avoided <sup>‡</sup> hectares
Currambene Batemans lowland forest	Open Forest	1.44	2.36	3.80	0.09	5.80
Illawarra gully wet forest	Open Forest	0.24	1.56	1.80	0.06	3.26
Shoalhaven sandstone forest	Woodland	0.98	0.74	1.72	0.13	3.30
South Coast grassy woodland (ILGW)*	Woodland	0.53	0.74	1.27	2.61	2.23
Riverbank forest (RFEFCF)*	Riparian corridor	0.30	0.01	0.31	0.13	0.19
Reedland #	Aquatic/semi aquatic	0.12	0.19	0.31	Not calculated	0.75
Acacia scrub #	Scrubland/Planted	1.50	0.49	1.99	Not calculated	0.82
Planted #^	Scrubland/Planted	4.80	3.89	8.69	Not calculated	3.82

‡ Estimated areas of fauna habitat including native plant communities, derived plant communities and other vegetation that will remain in the study area and are unlikely to be directly impacted by the proposal

\* TECs

# Not mapped at a Locality scale by current or published studies

^ Not considered to be a native or derived native vegetation community

### *Impacts to habitat trees*

Approximately 75 habitat trees (both dead stags and alive) containing hollows or exfoliating bark were recorded in the field surveys. Of these, 37 are confirmed hollow-bearing trees, eight contain fissures in the bark suitable for threatened microbat roosts and the remaining were located in clusters containing both hollows and fissures. These habitat trees may provide habitat for tree-roosting threatened and/or non-threatened microbats, parrots and arboreal mammals.

Habitat trees are mapped in **Figures 3-1 to 22** and the assessment of the likelihood of each tree to contain habitat for threatened species is documented in **Appendix C Table A3-1**. A total of 18 habitat trees or clusters of habitat trees would be directly impacted by the proposal.



The following nine hollow-bearing trees would require removal from the subject site as part of the construction of the proposal:

- Tree 9 - Spotted Gum with one moderate sized hollow in main leader. Potential for threatened species nesting/roost including cockatoos, parrots and microbats.
- Tree 15 - Isolated Spotted Gum with two medium sized hollows. Potential for threatened species nesting/roost including cockatoos, parrots and microbats.
- Tree 21 - Spotted Gum with medium sized hollow in main leader. Moderate potential for threatened species nesting/roost including cockatoos, parrots and microbats.
- Tree 22 - Spotted Gum with medium sized pipe hollows. Moderate potential for threatened species nesting/roost including parrots and microbats.
- Tree 26 - Spotted Gum with two medium hollows in the main leader. Moderate potential for threatened species nesting/roost including cockatoos, parrots and microbats.
- Tree 35 – Eucalypt with medium sized pipe hollows. Moderate potential for threatened species nesting/roost including parrots and microbats.
- Tree 36 - Eucalypt with medium sized pipe hollows. Moderate potential for threatened species nesting/roost including parrots and microbats.
- Tree 42 - Medium sized hollows and fissures. Moderate potential for threatened species nesting/roost including parrots and microbats.
- Tree 49 - Medium sized hollow in main leader. Moderate potential for threatened species nesting/roost including parrots and microbats.

The following three clusters of hollow-bearing trees and stags would require removal from the subject site as part of the construction of the proposal:

- Group 14 - Up to five Spotted Gums and/or Stags containing medium and large sized hollows and pipe hollows, with threatened species potential, including cockatoos and forest owls. Stags contain fissures suitable for threatened microbat roosts.
- Group 16 - Up to five Spotted Gums and/or Stags containing medium and large sized hollows and pipe hollows, with threatened species potential, including cockatoos and forest owls. Stags contain fissures suitable for threatened microbat roosts.
- Group 17 - Up to five Spotted Gums and/or Stags containing medium and large sized hollows and pipe hollows, with threatened species potential, including cockatoos and forest owls. Stags contain fissures suitable for threatened microbat roosts.

The following five dead stags would require removal from the subject site as part of the construction of the proposal:

- Tree 28 - Fissures in bark. Potential threatened microbat roost habitat.
- Tree 31 - One medium size hollows in the main leader. Fissures may be suitable for microchiropteran bats. Moderate potential for threatened species.
- Tree 32 - Two medium size hollows in the main leader. Fissures may be suitable for threatened microbat roosting. Moderate threatened microbat roost habitat.
- Tree 43 - Fissures in bark. Potential threatened microbat roost habitat.
- Tree 44 - Fissures in bark. Potential threatened microbat roost habitat.



The following single dead stags would require removal from the subject site for temporary construction ancillary facilities:

- Tree 29 - Two medium size hollows in the main leader. Moderate threatened microbat roost habitat.

Safeguards have been included in **Chapter 6** to avoid, minimise and mitigate these direct impacts.

### *Impacts to threatened fauna habitats*

A total of 9.9 hectares of habitat used by significant fauna species may directly impacted as part of the proposal including foraging, sheltering, and breeding habitat in the form of vegetation and hollow bearing trees. Specifically, the proposal would result in the following impacts to threatened fauna during the construction phase:

- Australasian Bittern and Black Bittern:
  - Approximately four water bodies containing potential foraging and nesting habitat in the form of farm dams and pooling sections of creeks would be removed.
- Bush Stone-curlew:
  - Approximately 3.48 hectares of potential foraging and breeding habitat would be cleared. These impacts equate to only 0.02 per cent of similar plant communities occurring in the locality (19,473.83 hectares).
- Forest owls (Powerful Owl, Barking Owl, Sooty Owl and Masked Owl):
  - Approximately 2.94 hectares of potential foraging, roosting or breeding habitat (including hollow-bearing trees) would be cleared. These impacts equate to only 0.01 per cent of similar plant communities occurring in the locality (19,473.83 hectares).
  - The loss of up to 15 habitat trees containing large hollows located in Groups 14, 16 and 17, although none are located in suitable habitat (ie Rainforest, Moist Gully Gum Forest etc).
- Gang-gang Cockatoo:
  - Approximately 3.48 hectares of potential breeding and foraging habitat for the Gang-gang Cockatoo would be cleared. These impacts equate to only 0.02 per cent of similar plant communities occurring in the locality (17,789.45 hectares).
  - The loss of up to ten isolated, roadside habitat trees containing medium sized hollows and up to 15 habitat trees containing medium and large hollows located in Groups 14, 16 and 17.
- Glossy Black-cockatoo:
  - Approximately 2.2 hectares of potential foraging habitat containing Allocasuarina species would be cleared. This equates to only 0.03 per cent of potential foraging habitat occurring in the locality (7072.49 hectares) and 0.01 per cent of the potential breeding habitat (assumed to contain hollow-bearing trees) occurring in the locality (17,795.50 hectares).
  - The loss of up to ten isolated, roadside habitat trees containing medium sized hollows and up to 15 habitats trees containing medium and large hollows located in Groups 14, 16 and 17.
- Little Lorikeet:
  - Approximately 3.48 hectares of potential breeding and foraging would be cleared. The direct impacts equate to only 0.02 per cent of similar plant communities occurring in the locality (17,789.45 hectares).
  - Most breeding records however come from the western slopes. The loss of up to ten isolated, roadside habitat trees containing suitably sized hollows and up to 15 habitats trees containing hollows located in Groups 14, 16 and 17.



- Little Eagle and Square-tailed Kite:
  - Approximately 2.94 hectares of potential foraging, roosting or breeding habitat (including hollow-bearing trees for prey items) would be cleared. These impacts equate to only 0.01 per cent of similar plant communities occurring in the locality (19,473.83 hectares).
- Turquoise Parrot:
  - Approximately 3.48 hectares of potential breeding and foraging would be cleared. The direct impacts equate to only 0.01 per cent of similar plant communities occurring in the locality (17,789.45 hectares).
- The loss of up to ten isolated, roadside habitat trees and up to 15 habitats trees located in Groups 14, 16 and 17 containing small to medium sized hollows. Only one of these, Tree 19, contains a vertical or near-vertical hollow suitable for nesting however.
- Scarlet Robin:
  - Approximately 2.41 hectares of foraging habitat and to a lesser extent potential breeding would be cleared for construction of the proposal. This represents 0.01 per cent of potential habitat for the species within the locality (18,644.75 hectares).Swift Parrot.
  - Approximately 1.98 hectares of potential foraging habitat in the form of eucalypt forest would be cleared. The direct impacts equate to only 0.01 per cent of eucalypt forest within the locality (17457.50 hectares).
  - No breeding habitat would be removed.
- Varied Sittella:
  - Approximately 1.98 hectares of potential foraging and breeding habitat in the form of eucalypt forest would be cleared. The direct impacts equate to only 0.01 per cent of eucalypt forest within the locality (17457.50 hectares).
- Green and Golden Bell Frog:
  - Approximately four water bodies containing potential breeding habitat in the form of farm dams and pooling sections of creeks would be removed. This would occur on both sides of Abernethys Creek (**Figure 3-3**), west of Meroo Road and Fletchers Lane (**Figure 3-4**) and east of the corner of Princes Highway and Morschels Lane (**Figure 3-10**).
  - An additional 120.15 hectares of potential dispersal or sheltering habitat has been mapped in an area surrounding 200 metres of each of the potential breeding habitats identified, resulting in 20.97 hectares of dispersal or sheltering habitat would be removed.
- Eastern Bentwing-bat and Large-eared Pied Bat:
  - Approximately 3.48 hectares of potential foraging habitat would be cleared. The direct impacts during construction equate to only 0.02 per cent of similar plant communities occurring in the locality (18,644.75 hectares).
  - Direct removal of up to 17 potential non-maternity roost habitats in the form of culverts and bridges, including one known roost in the bridge crossing Flying Fox Creek, considered to be of high value in the locality. These would be replaced as part of the proposal.
- Grey-headed Flying-fox:
  - Approximately 7.75 hectares of potential foraging habitat would be cleared during construction of the proposal. The direct impacts equate to only 0.04 per cent of similar plant communities occurring in the locality (18,644.75 hectares).
  - No breeding habitat would be removed.



- Hollow-dwelling microbats (Yellow-bellied Sheath-tail Bat, Eastern Freetail Bat, Eastern False and Greater Broad-nosed Bat):
  - Approximately 3.48 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be cleared during construction of the proposal. The direct impacts equate to only 0.02 per cent of similar plant communities occurring in the locality (18,644.75 hectares).
  - The loss of 75 habitat trees (both dead stags and alive) containing hollows or exfoliating bark and an additional nine that may be indirectly impacted.
- Southern Myotis:
  - Approximately 1.62 hectares of potential foraging habitat in the form of water bodies would be modified or removed. Approximately 1.99 hectares of potential foraging habitat in the form of water bodies would be indirectly impacted.
  - Direct removal of 1.62 hectares of potential foraging habitat considered to have low to moderate value in the locality.
  - Direct removal of up to 17 potential artificial roost habitats in the form of culverts and bridges. The loss of 75 habitat trees (both dead stags and alive) containing hollows or exfoliating bark. The culverts and bridges would be replaced as part of the proposal.
- Spotted-tailed Quoll:
  - Approximately 3.18 hectares of potential foraging habitat that may also contain denning/breeding habitat would be cleared. This equates to 0.01 per cent of the potential habitat (in the form of eucalypt and riparian forest, rainforest and heathland) available within the locality (23,519.93 hectares).
- Yellow-bellied Glider:
  - Approximately 2.41 hectares of foraging habitat and to a lesser extent potential breeding (containing hollow-bearing trees) would be cleared for construction of the proposal. This represents 0.01 per cent of potential habitat for the species within the locality (17,461.70 hectares).
  - The loss of up to 15 habitats trees containing large hollows located in Groups 14, 16 and 17, although it unlikely that Yellow-bellied Glider would rely heavily on these tree hollows and feed trees given the species preference for large expanses of old growth forest. The species is also unlikely to use the study area as a dispersal corridor given the lack of continuous habitat to the east of the existing highway and current development.

Safeguards have been included in **Chapter 6** to avoid, minimise and mitigate the construction related impacts.

#### *Impacts to other resident or visiting fauna*

Fauna injury or death could occur as a result of the construction of the proposal. During the break-out phase of construction (when vegetation is removed and bulk earthworks commence) habitat clearance may result in the injury or death of resident or visiting fauna. Some species can more readily evade injury by flying (birds) or 'running' away (eg larger mammals). Many species, however, are unlikely to move quickly enough to avoid being caught. For example, many nocturnal species (possums, gliders, bats) shelter during the day and smaller ground-dwelling species, such as lizards and snakes, are unable to move rapidly and over large distances.

Safeguards have been included in **Chapter 6** to avoid, minimise and mitigate the construction phase impacts.



## 4.2.2 Operation impacts

Potential impacts on fauna and during operation of the proposal would mainly be indirect impacts such as those associated with edge effects including reduction in fauna habitat values (eg alteration of microclimate, soil conditions, weeds outcompeting native flora species), continuation of barrier effects and fauna mortality. The majority of vegetation and fauna habitat that would be subject to ongoing impacts during the operation phase will be the Grassland vegetation type. This vegetation supports the lowest quality native fauna habitat and the area that would be subject to indirect impacts is estimated at 129 hectares.

In summary **Table 4-2** shows that up to 9.98 hectares of fauna habitats including native and derived plant communities and planted vegetation ranging in condition from poor to good would be indirectly impacted during the operation phase including:

- Approximately 3.1 hectares of the Open Forest fauna habitat.
- Approximately 1.57 hectares of the Woodland fauna habitat.
- Approximately 0.74 hectares the Riparian corridor fauna habitat.
- Approximately 4.38 hectares of the Scrubland/Planted fauna habitat.
- Approximately 0.19 hectares of the Aquatic/semi aquatic fauna habitat.

### *Impacts to habitat trees*

Habitat trees are mapped in **Figure 3-1 to 22** and the assessment of the likelihood of each tree to contain habitat for threatened species is documented in **Appendix C Table A3-1**. Nine trees may be indirectly impacted as a result of the operation of the proposal. Indirect impacts on fauna habitat values of retained habitat trees may include, removal at a later date post construction, due to decline of the tree as a result of edge effects (eg changed soil conditions) and decrease in preferential breeding and foraging resources due to increased noise and vibration.

### *Impacts to threatened fauna habitats*

Up to 10.15 hectares of foraging habitat in the form of native, derived and planted vegetation may be indirectly impacted as part of the proposal during the operation phase. Specifically, the proposal would result in the following indirect impacts to the potential habitats of threatened fauna:

- Australasian Bittern and Black Bittern:
  - Three water bodies in the form of farm dams and pooling section of creeks containing potential foraging and nesting habitat would be indirectly impacted.
- Bush Stone-curlew:
  - Approximately 5.41 hectares of potential foraging and roosting habitat would be indirectly impacted. These impacts equate to only 0.03 per cent of similar plant communities occurring in the locality (18,644.75 hectares).
- Forest owls (Powerful Owl, Barking Owl, Sooty Owl and Masked Owl):
  - Approximately 3.84 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be indirectly impacted. These impacts equate to 0.03 per cent of similar plant communities occurring in the locality (19,473.83 hectares).
- Gang-gang Cockatoo:
  - Approximately 4.67 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be indirectly impacted. These impacts equate to only 0.03 per cent of similar plant communities occurring in the locality (17,789.45 hectares).



- Glossy Black-cockatoo:
  - Approximately 5.41 hectares of foraging habitat and 4.66 hectares of breeding habitat would be indirectly impacted. This equates to 0.08 per cent of potential foraging habitat occurring in the locality (7072.49 hectares) and 0.03 per cent of the potential breeding habitat (assumed to contain hollow-bearing trees) occurring in the locality (17,795.50 hectares).
- Little Lorikeet:
  - Approximately 4.67 hectares of potential foraging and breeding habitat (assumed to contain hollow-bearing trees) would be indirectly impacted. These impacts equate to only 0.03 per cent of similar plant communities occurring in the locality (17,789.45 hectares).
- Little Eagle and Square-tailed Kite:
  - Approximately 5.41 hectares of potential foraging and breeding habitat (including hollow-bearing trees for prey items) would be indirectly impacted. These impacts equate to 0.03 per cent of similar plant communities occurring in the locality (19,473.83 hectares).
- Turquoise Parrot:
  - Approximately 4.67 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be indirectly impacted. These impacts equate to only 0.03 per cent of similar plant communities occurring in the locality (17,789.45 hectares).
- Scarlet Robin:
  - Approximately 5.41 hectares of potential foraging and breeding habitat would be indirectly impacted during operation of the proposal. These impacts equate to only 0.02 per cent of similar plant communities occurring in the locality (18,644.75 hectares).
- Swift Parrot:
  - Approximately 4.68 hectares of potential foraging habitat would be indirectly impacted. The indirect impacts equate to only 0.03 per cent of eucalypt forest within the locality (17457.50 hectares).
- Varied Sittella:
  - Approximately 4.68 hectares of potential foraging habitat would be indirectly impacted. The indirect impacts equate to only 0.03 per cent of eucalypt forest within the locality (17457.50 hectares).
- Green and Golden Bell Frog:
  - Three water bodies in the form of farm dams and pooling section of creeks containing potential breeding habitat would be indirectly impacted.
  - Up to 29.90 hectares of dispersal or sheltering habitat would be indirectly impacted during operation phase of the proposal.
- Eastern Bentwing-bat and Large-eared Pied Bat:
  - Approximately 5.41 hectares of potential foraging would be indirectly impacted during the operational phase of the proposal. These impacts equate to only 0.03 per cent of similar plant communities occurring in the locality (18,644.75 hectares).
  - Direct removal of up to 17 potential non-maternity roost habitats in the form of culverts and bridges, including one known roost in the bridge crossing Flying Fox Creek, considered to be of high value in the locality.
- Grey-headed Flying-fox:
  - Approximately 10.15 hectares of potential foraging habitat would be cleared during construction of the proposal. The direct impacts equate to only 0.05 per cent of similar plant communities occurring in the locality (18,644.75 hectares).
  - No breeding habitat would be removed.



- Hollow-dwelling microbats (Yellow-bellied Sheath-tail Bat, Eastern Freetail Bat, Eastern False and Greater Broad-nosed Bat):
  - Approximately 5.41 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be indirectly impacted. These impacts equate to only 0.03 per cent of similar plant communities occurring in the locality (18,644.75 hectares).
- Southern Myotis:
  - Approximately 1.19 hectares of potential foraging habitat in the form of water bodies would be indirectly impacted.
  - Up to nine habitat trees (both dead stags and alive) containing hollows or exfoliating bark may be indirectly impacted.
- Spotted-tailed Quoll:
  - Approximately 5.41 hectares of potential foraging habitat would be indirectly impacted. This equates to 0.02 per cent of the potential habitat (in the form of eucalypt and riparian forest, rainforest and heathland) available within the locality (23,519.93 hectares).
- Yellow-bellied Glider:
  - Approximately 5.41 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be indirectly impacted during operation of the proposal. These impacts equate to only 0.03 per cent of similar plant communities occurring in the locality (17,457.50 hectares).

Safeguards have been included in **Chapter 6** to avoid, minimise and mitigate the indirect impacts during construction.

## 4.3 Habitat fragmentation, edge effects and barrier effects

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with a new habitat type occurring in the area between the fragments. This new dividing habitat type is often artificial and inhospitable to the fauna species remaining within the fragments (MacNally 1999) and can provide suitable conditions for weed species to establish, which may outcompete native plant species. Although the newly created habitat would be used by some species, they are usually generalist species and are often considered aggressive (eg Noisy Miners, Loyn *et al.* 1983), further decreasing population levels of the species remaining in the fragments. In addition to the loss of total habitat area, the process of fragmentation can impact on the species within the newly created fragments in a number of ways (eg barrier effects, genetic isolation and edge effects). The degree to which these potential impacts affect the flora and fauna within the newly created fragments depends on a number of variables, including distance between fragments, local environmental conditions, the species present and mitigation measures (see **Chapter 6**). Some of the potential impacts are summarised below.

### 4.3.1 Barrier effects

Barrier effects occur where particular species are either unable or are unwilling to move between suitable areas of fragmented habitat. This could result in either a complete halt to movement or a reduced level of movement between fragments. Roads through areas of native vegetation can act as barriers, with barrier effects greater for some species than others (Goosem, 2002). Species most vulnerable to barrier effects include rare species (even a small reduction in movements can reduce genetic continuity within the population hence reducing the effective population size), smaller ground-dwelling species and species with low mobility, such as the Common Wombat *Vombatus ursinus* and Short-beaked Echidna *Tachyglossus aculeatus* which are frequently recorded as road kill on the south coast. Species least vulnerable to barrier effects tend to be those that are highly mobile (eg birds and large mammals), although even these species can vary in their response to barriers.



The study area is characterised by a highly modified landscape with low connectivity of the remnant vegetation and flora and fauna habitats that persist in Seven Mile Beach National Park to the east and the Cambewarra Range onwards to Morton National Park further to the west. This low level of connectivity acts as a broad scale barrier to the dispersal of a range of flora and fauna. In addition the current alignment of the Princes Highway creates an additional barrier to the movement of native fauna with secondary roads and fencing for agricultural also contributing to barrier effect.

Temporary barriers defining retained native vegetation and on watercourses may have some minor short term restriction on the dispersal and movement of native fauna during the construction phase and this is discussed further in Section 4.4.4. Areas where permanent, man-made barriers (such as noise barriers, cuttings and median dividers) are constructed will create and increase more permanent barriers during the operation phase of the proposal.

The proposal is not considered likely to substantially increase the existing barrier effect of the Princes Highway for the immediate surrounds or at a locality scale.

#### 4.3.2 Genetic isolation

Genetic isolation occurs where individuals from a population within one fragment are unable to interbreed with individuals from populations in adjoining fragments. Genetic isolation can lead to inbreeding and genetic drift problems for populations isolated within a fragment. Based on the substantial lack of native vegetation and degraded condition of riparian areas, corridor structural and functional connectivity in the study area and immediate surrounds is low. The low level of structural and functional connectivity supports dispersal pathways for a narrow range of fauna species, and does not provide for favourable conditions such as continuous cover through multiple structural layers of vegetation for dispersal of native flora including propagules and pollen. The proposal is not considered likely to result in a significant increase in the process of genetic isolation throughout the construction and operation phases.

#### 4.3.3 Edge effects

Edge effects manifest as a zone of changed environmental conditions along the edges of habitat fragments. These changes include disruptions to ecological processes, such as predation, seed dispersal and animal movements. Edge effects can ultimately result in altered patterns of species abundance and species composition for a particular area (Stevens *et al*, 2008). The magnitude of indirect impacts caused by edge effects varies depending on ecological context. The ecological context is determined by factors such as location (eg tropical, temperate or arid regions), species of interest (ie flora or fauna and their sub groups) and ecological process ranging from natural undisturbed ecosystems to partially or highly modified ecosystems (Stevens *et al*, 2008).

The study area has been highly disturbed and contains small isolated patches of native vegetation subject to edge effects from the current alignment of the Princes Highway. The impacts of edge effects in the study area are most evident where remnant native vegetation is narrow and has long edges to highly disturbed areas such as riparian corridors. The proposal generally follows the path of the existing Princes Highway, thereby minimising further fragmentation of habitats and barrier effects in new locations. The proposal is unlikely to increase the impact of fragmentation and exacerbate edge effects on threatened species habitat, threatened ecological communities and general biodiversity values during the construction and operation phases of the proposal.

#### 4.3.4 Corridors and connectivity

As discussed the majority of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation and have not been mapped or described as a native plant community. Wildlife corridors in the study area are limited and mainly characterised by fragmented narrow strips of native and exotic vegetation on drainages lines such as Jaspers Brush Creek and Wileys Creek.



Riparian zones often act as wildlife corridors facilitating the movement of wildlife (Harris and Bamford 2011). The existing Princes Highway in the study area has a total of 17 bridge or culvert crossings over a number of temporary and permanent watercourses, with eight (located at RMS' proposed creek crossings) being suitable for both ground-dwelling fauna such as reptiles, frogs and mammals, as well as avifauna including microbats and birds (particularly Fairy Martins and swallows).

The proposal would temporarily limit connectivity through these locations through clearing of vegetation, increased traffic, noise and heavy vehicles, indirect impacts to creeklines such as sedimentation and the removal of artificial structures that provide nesting or roosting habitat for birds and microbats. It is likely that during this construction phase there would be limited opportunity for wildlife to utilise the eight bridge or culvert crossings. Post-construction however, the proposal would not significantly impact upon the existing level of connectivity at these locations.

Riparian corridors, falling into the environmental corridors class from the *South Coast Regional Conservation Plan* (DECCW, 2010) traverse the study area at Wileys Creek and Jaspers Brush Creek (**Figures 7-1 and 7-2**). The environmental corridors at these locations are likely to fall into the riparian corridors sub class that includes second-order and above streams (see **Section 3.8.1**). The proposal would directly impact on a total of 0.27 hectares of environmental corridor mapped by DECCW (2010) during construction. During the operation phase it is estimated that the proposal would indirectly impact on 0.49 hectares of environmental corridor mapped by DECCW (2010). In view of the low level of connectivity in riparian vegetation at a landscape scale and the existing impacts of edge effects to riparian zones, the proposal is not considered likely to significantly impact on corridors assessed and mapped by DECCW (2010) during construction and operation.

#### 4.4 Weeds

Weed invasion can be a considerable problem along the edges of native plant communities and the habitat these provide for native flora and fauna. Along these boundaries there are changes in the environment (edge effects) including, altered light levels, wind speed, temperature, humidity and runoff. These altered conditions allow the colonisation and growth of weeds which would themselves result in further environmental changes that promote the colonisation and growth of other weed species within the area. Due to these environmental changes, weeds may be able to out-compete native plant species and (at worst) could result in the loss of the native plant community in that area. In addition activities associated with land use including agriculture, urban development and infrastructure provide pathways for the introduction and establishment of new weeds through a range of dispersal mechanisms.

Overall the study area is a highly disturbed and modified landscape characterised by large areas of grazed and managed pastures. Remnant and derived native plant communities and reconstructed vegetation consisting of native flora species within the study area are impacted by edge effects as a result of agricultural practices, urban expansion and infrastructure use and maintenance including services easements and the Princes Highway.

The main threat and potential impact for the dispersal and establishment of weed species already established in the study area and dispersal and establishment of new weed species would be as a result of the new edges to native plant communities in the study area from the proposal. In this instance the impacts are likely to be greatest where the native plant communities maintain a high resilience and corresponding higher flora and fauna habitat values. Overall the proposal is not likely to considerably increase the impact of weed invasion in the study area during construction and operation. Mitigation measures are recommended to reduce the likelihood of increased weed invasion in the impacted patches (see **Chapter 6**).



## 4.5 Pests and pathogens

Pest vertebrate fauna species have been recorded in the current and previous fauna surveys in the study area and include European fox *Vulpes vulpes*, Rusa deer *Cervus timorensis* and European rabbit *Oryctolagus cuniculus*. Although the proposal would add to some processes and features that promote and provided for the dispersal and establishment of pest fauna species such as edge effects and increased or improved passage (eg larger culverts), it is not considered likely that there would be a significant increase in the existing pest species populations or introductions of new pest vertebrate fauna as a result of the construction and operation phases of the proposal.

According to the Myrtle Rust management zone mapping by the NSW Department of Primary Industries (2012), Myrtle Rust is considered to be widely distributed over the entire NSW eastern seaboard including the Shoalhaven LGA. Although this plant fungus was not observed in the study area, it is known from Jervis Bay and other locations (Shoalhaven City Council pers comm, 2013). It is assumed that this plant fungus is present in the locality therefore Myrtle Rust would not be introduced to the study area or surrounds as result of the construction and operation of the proposal.

*Phytophthora cinnamomi* is not widely reported from the Shoalhaven LGA and adjoining areas. There is some level of risk during the construction phase that this pathogen could be introduced to the study area in soil on machinery or plant that has been used in an infected area.

The presence of amphibian chytrid fungus is not confirmed in the locality, or specifically at Coomonderry Swamp (Lachlan Wilmott, OEH, pers. comm.); however it has been recorded in the Shoalhaven LGA at South Nowra (Angie Radford, RMS pers. comm.). In this instance there is some chance the proposal may introduce amphibian chytrid fungus to the study area during the construction phase through the transport on vehicles or personnel working in various wetland habitats of the LGA (DECC 2008).

The implementation of site hygiene protocols and management measures according to Biodiversity Guide 7 – Pathogen management from RMS (2011) would reduce the risk of localised or regional introduction of Myrtle Rust, *Phytophthora cinnamomi* and the amphibian chytrid fungus as result of the proposal.

## 4.6 Impact on relevant key threatening processes (TSC Act and EPBC Act)

The following TSC Act key threatening processes would operate as a result of the proposal during construction and operation of the proposal:

- Clearing of native vegetation (NSW Scientific Committee 2001).
- Loss of hollow-bearing trees (NSW Scientific Committee 2007).
- Removal of dead wood and dead trees (NSW Scientific Committee 2003a).

It is considered unlikely that the proposal would result in the operation of the three key threatening processes listed above at levels that would substantially contribute to the impacts on biodiversity values of the locality. The implementation of the safeguards and management measures detailed in **Chapter 6** would assist in reducing the impacts of these processes.



The following TSC Act key threatening processes may be introduced during the construction phase and commence during the operation phase of the proposal:

- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis (NSW Scientific Committee 2003b).
- Infection of native plants by *Phytophthora cinnamomi* (NSW Scientific Committee 2002a).
- Invasion of native plant communities by exotic perennial grasses (NSW Scientific Committee 2003c).
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (NSW Scientific Committee 2002b).
- Invasion of native plant communities by exotic perennial grasses (NSW Scientific Committee 2006).

The EPBC Act key threatening processes Land clearance would operate during the construction and operation phases of the proposal. The following EPBC Act key threatening processes may be introduced during the construction phase and commence during the operation phase of the proposal:

- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.

The implementation of the safeguards and management measures detailed in **Chapter 6** would assist in reducing the likelihood for the TSC and EPBC Act key threatening processes to operate and the potential impact that may occur as a result of the proposal.

## 4.7 Cumulative impacts

The proposal is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jarvis Bay Road, Falls Creek to improve road safety and traffic efficiency, including for freight. This assessment of the cumulative impacts associated with the proposal focuses on overall upgrade of the highway between Mount Pleasant and Bomaderry (about 30 kilometres in total) which provides a discrete and interconnected area for analysis.

**Table 4-3** provides a summary of impacts to vegetation (including fauna habitat) within the subject site (area of direct and indirect impacts) for each of the three main sections of the Princes Highway upgrade, including the Gerringong upgrade proposal (commenced), the Foxground and Berry bypass project (now approved) and the current proposal. About nine per cent of direct impacts and nine per cent of the overall impacts on plant communities and fauna habitats associated with the upgrade of these three sections of highway are attributable to the proposal.

## 4.8 Koala habitat

Following the habitat assessment in accordance with the Interim koala referral advice for proponents (DSEWPaC 2012a) and SEPP 44 criteria, three preferred feed tree species were recorded within the study area including *Eucalyptus microcorys*, *Eucalyptus robusta*, and *Eucalyptus tereticornis*. *Eucalyptus microcorys* was recorded as plantings comprising of less than 15 per cent canopy within the study area. *Eucalyptus robusta* occurs within a small roadside, forest patch, on the eastern side of the Princes Highway between Cambewarra Road, and Abernethys Lane in Bomaderry. Mapped as Shoalhaven sandstone forest, the patch covers approximately five hectares, and is completely surrounded by urban development (**Figure 3-2**). As *Eucalyptus robusta* within the patch make up more than 15 per cent of the total number of upper strata species, this area classifies as 'potential koala habitat' under SEPP 44.



*Eucalyptus tereticornis* occurs only as scattered roadside trees on the western side of the Princes Highway, between Strongs Road and Wileys Creek. Mapped as five small patches of Illawarra lowlands grassy woodland (**Figures 3-13 to 3-14**), this vegetation type does not classify as 'potential koala habitat' under SEPP 44 as the small stands of trees do not equal or exceed one hectare in area. Due to the isolation of these patches within the landscape, it is unlikely that they would provide habitat for the koala.

In reference to the DSEWPac (2012a) guidelines, records of Koala were mapped using data obtained from the OEH Wildlife Atlas. Only five records have been documented for the species in the locality to the northeast, east, south and west of the study area, however many of the records are dated. The only recent records for the Koala within the locality are within the Seven Mile Beach Reserve. According to the National Recovery Plan, one primary feed tree for the South Coast Koala Management Area, *Eucalyptus tereticornis* is present within the study area; however, despite thorough searches around the base of feed trees and investigation of trunk for scratches, no signs of the Koala were identified.

It is considered unlikely that the study area supports (or could support) a population of Koala, and the species has a low likelihood to occur in areas of potential koala habitat and the remainder of the study area.

## 4.9 Coastal wetlands

The nearest SEPP 14 wetland is approximately 2.5 kilometres to the south east of the study area (**Figures 7-1 and 7-2**). SEPP14 wetlands are also mapped including Coomonderry Swamp six kilometres to the east and at Shoalhaven Heads and Comerong Island Nature Reserve over nine kilometres to the southeast (**Figure 7-1**). The proposal would not directly impact on SEPP 14 wetlands and is unlikely to indirectly impact on SEPP 14 wetlands.



**Table 4-3 Area of each native and derived vegetation community impacted by the upgrade of the three main Princes Highway upgrade projects between Mount Pleasant and Bomaderry.**

Plant community	TEC	Gerringong upgrade		Foxground and Berry bypass		Berry to Bomaderry upgrade		Cumulative total (direct and indirect)
		Direct impact (hectares)	Indirect impact (hectares)	Direct impact (hectares)	Indirect impact (hectares)	Direct impact (hectares)	Indirect impact (hectares)	
Closed grassland/sedgeland				2.2	0.3			<b>2.50</b>
Coastal saltmarsh	Yes		1.06					<b>1.06</b>
Constructed wetland (incl Reedland)				0.4	0.3	0.12	0.19	<b>1.01</b>
Currambene-Batemans lowlands forest				0.0002	2.44	1.44	2.36	<b>6.24</b>
Disturbed riparian open woodland				2.6	1.2			<b>3.80</b>
Illawarra gully wet forest				15.4	10.1	0.98	0.74	<b>27.22</b>
Riverbank forest	Yes			2.9	7.1	0.53	0.74	<b>11.27</b>
Subtropical dry rainforest	Yes	0.1	0.52					<b>0.62</b>
Shoalhaven sandstone forest						0.24	1.56	<b>1.80</b>
Warm temperate layered forest				6.9	5.3			<b>12.20</b>
South coast grassy woodland	Yes					0.30	0.01	<b>0.31</b>
<b>Totals (hectare)</b>		<b>0.1</b>	<b>1.58</b>	<b>30.4002</b>	<b>26.74</b>	<b>3.61</b>	<b>5.6</b>	<b>68.03</b>
<b>% of cumulative total (direct and indirect)</b>		<b>0.15</b>	<b>2.32</b>	<b>44.69</b>	<b>39.31</b>	<b>5.31</b>	<b>8.23</b>	<b>-</b>



## 5 Assessments of significance

### 5.1 TSC and EPBC Act assessments of significance

Assessments of significance, undertaken in accordance with the provisions of Section 94 of the TSC Act have been prepared for two TECs, four threatened flora species and 18 threatened fauna species listed under the TSC Act. The outcomes of the TSC Act assessments of significance are provided in **Appendix D** and summarised in **Table 5-1** and **Chapter 5** of this report.

**Table 5-1 TSC Act assessments of significance summary**

Threatened biodiversity	Significance assessment question <sup>@</sup>							Likely significant impact?
	a	b	c	d	e	f	g	
<b>Threatened ecological communities</b>								
River-flat eucalypt forest on coastal floodplains	X	X	N	N	N	X	Y	No
Illawarra lowlands grassy woodland	X	X	N	N	N	X	Y	No
<b>Threatened flora species</b>								
<i>Pterostylis gibbosa</i>	N	X	X	N	N	Y	Y	No
<i>Cryptostylis hunteriana</i>	N	X	X	N	N	X	Y	No
<i>Genoplesium baueri</i>	N	X	X	N	N	X	Y	No
<i>Thesium australe</i>	N	X	X	N	N	X	Y	No
<b>Threatened fauna species</b>								
<i>Ninox strenua</i>	N	X	X	N	N	Y	Y	No
<i>Ninox connivens</i>	N	X	X	N	N	Y	Y	No
<i>Tyto tenebricosa</i>	N	X	X	N	N	Y	Y	No
<i>Tyto novaehollandiae</i>	N	X	X	N	N	Y	Y	No
<i>Callocephalon fimbriatum</i>	N	X	X	N	N	X	Y	No
<i>Calyptorhynchus lathami</i>	N	X	X	N	N	X	Y	No
<i>Lathamus discolor</i>	N	X	X	N	N	Y	Y	No
<i>Glossopsitta pusilla</i>	N	X	X	N	N	X	Y	No
<i>Neophema pulchella</i>	N	X	X	N	N	X	Y	No
<i>Dasyurus maculatus maculatus</i>	N	X	X	N	N	X	Y	No
<i>Petaurus australis</i>	N	X	X	N	N	Y	Y	No
<i>Falsistrellus tasmaniensis</i>	N	X	X	N	N	X	Y	No
<i>Mormopterus norfolkensis</i>	N	X	X	N	N	X	Y	No
<i>Saccolaimus flaviventris</i>	N	X	X	N	N	X	Y	No
<i>Scoteanax rueppellii</i>	N	X	X	N	N	X	Y	No
<i>Litoria aurea</i>	N	X	X	N	N	Y	Y	No
<i>Miniopterus schreibersii oceanensis</i>	N	X	X	N	N	X	Y	No
<i>Myotis macropus</i>	N	X	X	N	N	X	Y	No

Notes Y= Yes (negative impact), N= No (no or positive impact), X= not applicable, ?= unknown impact.  
 @ Assessment of significance question set out in the TSC Act and EP&A Acts.



Three flora and three fauna species listed as threatened under the TSC Act are also threatened under the EPBC Act. Assessments of significance were undertaken for these six species in accordance with the requirements of the Matters of National Environment Significance Impact Guidelines 1.1 (DEWHA 2009). Assessments of significance for the six subject species are provided at **Appendix E** and summarised in **Table 5-2** and **Chapter 5** of this report.

**Table 5-2 EPBC Act assessments of significance summary**

Threatened biodiversity	Population <sup>&gt;</sup>	Important population <sup>&lt;</sup>	Likely significant impact?
<b>Threatened flora species</b>			
<i>Pterostylis gibbosa</i>	No	-	No
<i>Cryptostylis hunteriana</i>	-	No	No
<i>Thesium australe</i>	-	No	No
<b>Threatened fauna species</b>			
<i>Lathamus discolor</i>	No	-	No
<i>Dasyurus maculatus maculatus</i>	No	-	No
<i>Litoria aurea</i>	-	No	No

> Population of critically endangered or endangered species as defined by DEWHA (2009).

< Population of vulnerable species as defined by DEWHA (2009).

## 5.2 Potential impacts on threatened ecological communities

Two TECs listed under the TSC Act were recorded in the study area. RFEFCF occurring as Riverbank forest is present on Jaspers Brush Creek, Wileys Creek and Flying Fox Creek in the subject site and study area (**Table 3-4**). The condition of the RFEFCF is mainly poor with some moderate condition areas of the community on Jaspers Brush Creek. The proposal would result in direct impacts of 0.53 hectares and 0.74 hectares of indirect impacts to RFEFCF cumulatively equating to at least 2.61 per cent of the community mapped as Riverbank forest estimated from the locality.

The second TEC ILGW (**Table 3-5**) is present as a narrow strip of the community in the subject site and small patch in the study area just south of Strongs Road and is mapped as South coast grassy woodland. The proposal would result in direct impacts of 0.3 hectares and 0.01 hectares of indirect impacts to ILGW. Cumulatively direct and indirect impacts to ILGW equate to 0.13 per cent of the community mapped as South coast grassy woodland.

On the basis of the current proposal, assessments of significance under Section 5A of the EP&A Act (**Appendix D**) concluded that there is unlikely to be a significant impact on the two TECs as:

- The areas likely to be impacted are not of high conservation significance.
- The proposal would not result in a significant further fragmentation or isolation of any patches of these communities.
- The communities are likely to persist as poor condition vegetation or better in the locality including areas in good condition in conservation reserves.



## 5.3 Potential impacts on threatened flora species

No threatened plant species were recorded in the study area. However four threatened plant species listed under either or both the TSC and EPBC Acts are considered to have a medium likelihood of occurrence to be present in the subject site and study area as assessed according to the criteria outlined in **Table 2-3**.

Although the targeted flora survey effort for threatened flora species spans a range of seasons including optimal detection periods, all four species are cryptic making them difficult to detect. Due to the presence of preferred habitat and the subject species habits, TSC Act assessments of significance have been carried out for *Pterostylis gibbosa*, *Cryptostylis hunteriana*, *Genoplesium baueri* and *Thesium australe* (**Appendix D**). Three of these species, *Cryptostylis hunteriana*, *Pterostylis gibbosa* and *Thesium australe* are also listed under the EPBC Act and have been assessed against the EPBC Act significant impact guidelines (DEWHA, 2009) and are presented in **Appendix E**.

### 5.3.1 TSC Act threatened flora assessments of significance

**Appendix B Table A2-1** assesses the likelihood of occurrence for all threatened flora species recorded or predicted to occur within the locality and determines a list of subject species for the preparation of seven part tests. Four TSC Act threatened flora species *Pterostylis gibbosa*, *Cryptostylis hunteriana*, *Genoplesium baueri* and *Thesium australe* have been assessed according to the provisions of the seven-part test.

The impact assessments concluded that the proposal would have a minimal impact on threatened plant species or their potential habitat in the locality based on the following:

- No individuals were recorded in the study area despite targeted surveys, including for those that are considered relatively inconspicuous.
- The majority of impacts of the proposal would mostly be limited to areas that are cleared and disturbed.
- The proposal would not result in further isolation or fragmentation of potential habitat for any of the subject flora species.
- The proposal is unlikely to interfere with important lifecycle functions of the subject species.

The seven part tests determined that a Species Impact Statement (SIS) is not necessary for any of the subject flora species.

### 5.3.2 EPBC Act threatened flora assessments of significance

Three EPBC Act threatened flora species *Pterostylis gibbosa*, *Cryptostylis hunteriana* and *Thesium australe* have been assessed according to the provisions of the EPBC Act significant impact criteria assessments. In summary it was considered that the proposal is unlikely to significantly impact any of these species and a Referral under the provisions of the EPBC Act is not considered necessary for any threatened flora species.

## 5.4 Potential impacts on threatened fauna

Where there is potential habitat (foraging or breeding resources) for threatened species in the study area, further consideration must be given to the potential impact of the proposal on these species. The proposal may impact on threatened species by causing any of the following:

- Death or injury of individuals.
- Loss or disturbance of limiting foraging resources.
- Loss or disturbance of limiting breeding resources.



Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest/maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However, for some species, limiting resources include specialised foraging habitats that have a restricted distribution (eg Koalas *Phascolarctos cinereus* feeding only on specific tree species).

#### 5.4.1 TSC Act threatened fauna assessments of significance

Eight threatened fauna species listed on the TSC Act were recorded during the field surveys: Glossy Black-Cockatoo, Yellow-Bellied Sheath-tail-bat, Eastern Freetail-bat, Grey-headed Flying-Fox, Eastern Bentwing-bat, Large-Eared Pied Bat, Southern Myotis And Greater Broad-Nosed Bat.

**Appendix B Table A2-2** outlines the likelihood of occurrence for all fauna species recorded or predicted to occur within the locality, and summarises the possible predicted impacts from the proposal on all 30 TSC Act-listed threatened fauna species with known and/or potential habitat in the study area, and determines the need for seven-part tests (TSC Act).

Seven part tests have been prepared for 27 species: Australasian Bittern, Barking Owl, Black Bittern, Bush Stone-curlew, Eastern Bentwing-bat, Eastern False Pipistrelle, Eastern Freetail Bat, Gang-gang Cockatoo, Glossy Black-cockatoo, Greater Broad-nosed Bat, Green and Golden Bell Frog, Grey-headed Flying-fox, Large-eared Pied Bat, Little Eagle, Little Lorikeet, Masked Owl, Powerful Owl, Scarlet Robin, Sooty Owl, Southern Myotis, Spotted-tailed Quoll, Square-tailed Kite, Swift Parrot, Turquoise Parrot, Varied Sittella, Yellow-bellied Glider and the Yellow-bellied Sheath-tail Bat (**Appendix D**). The assessments concluded that the proposal is unlikely to have a significant effect on any of these species. A Species Impact Statement (SIS) is not considered necessary.

#### 5.4.2 EPBC Act threatened fauna assessments of significance

**Appendix B Table A2-2** outlines the likelihood of occurrence for all fauna species recorded or predicted to occur within the locality, and summarises the possible predicted impacts from the proposal on all six EPBC Act-listed threatened fauna species with known and/or potential habitat in the study area. Additionally **Appendix B Table A2-2** determines the need for EPBC Act significant impact criteria assessments (EPBC Act).

EPBC Act significant impact criteria assessments have been prepared for six species: Green and Golden Bell Frog, Australasian Bittern, Grey-headed Flying-fox, Large-eared Pied Bat, Spotted-Tailed Quoll and the Swift Parrot. EPBC Act significant impact criteria assessments have been provided for all species using DEWHA (2009a) while the assessment for the Green and Golden Bell Frog was undertaken according to both DEWHA (2009a) and DEWHA (2009b). Assessments are presented in **Appendix E**. The assessments concluded that the proposal is unlikely to have a significant impact on any of these species. A referral to the Federal Environment Minister is not considered necessary for any EPBC Act-listed threatened fauna species.

#### 5.4.3 Potential impacts on migratory fauna

The list of migratory species under the EPBC Act is a compilation of species listed under four international conventions: China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Forty-eight migratory species (or their habitat) have been previously recorded within 10 kilometres of the study area. Four of these species were recorded during the field surveys namely White-Bellied Sea-eagle, Cattle Egret, Black-faced Monarch and Rufous Fantail. Potential habitat exists in the study area for an additional 18 migratory species (**Appendix B Table A2-2**).



Migratory waders are the most common migratory species recorded within the locality. While Coomonderry Swamp, Seven Mile Beach National Park, Shoalhaven Heads and Shoalhaven River are used on occasion or regularly by these species, individuals of these species that have been or may be recorded in the study area are not considered likely to be an ecologically significant proportion of their populations. Similarly, individuals of other migratory birds (eg forest/woodland birds) that have been or may be recorded in the study area are not considered likely to be an ecologically significant proportion of their populations. Known and/or potential habitat in the study area is not considered important for the migratory species listed in **Appendix B**. Only previously disturbed and edge-effected areas of forest and farmland (including farm dams), would be impacted by the proposal and indirect impacts are not expected to extend further than 50 metres from the subject site (direct impact). Further, the proposed upgrade is unlikely to result in a significant level of habitat fragmentation. Given the minimal impact expected on the known and/or potential habitat for these species in the study area, no assessments have been carried out for these species, in accordance with the significant impact criteria (DEH 2006).

A referral to the Commonwealth Minister for Environment, Heritage and Water is not considered necessary for any EPBC Act-listed migratory species.



## 6 Managing potential impacts on biodiversity

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### 6.1 Safeguards and management measures

RMS' Biodiversity Guidelines (RTA 2011) provide guidance on addressing biodiversity management during the planning, construction, operation and maintenance of projects in view of the following key aims:

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

Where possible, important ecological features identified in the local area in Biosis (2009), have been avoided during the options and route selection stage and the proposal has been designed, where feasible and reasonable, to minimise impacts on habitat.

Additionally the location of temporary construction ancillary facilities associated with the proposal has been informed by a preliminary environmental constraints analysis. This proactive planning includes consideration of key environmental values such as amenity (noise, visual and air), water quality and flooding and terrestrial and aquatic ecology. Specifically, to avoid and minimise impacts to terrestrial biodiversity values the proposal has applied the following selection criteria:

- No substantial vegetation clearing (unless required for project alignment) with sites to have low conservation significance for flora and fauna.
- No removal of TECs unless area is to be cleared for the highway footprint.

Temporary construction ancillary facility site 17 on the north side of Pestells Lane may be used as a permanent road maintenance facility in the future. If required, the facility would be subject to a separate assessment process at that time.

Targeted surveys for some threatened species have been postponed due to issues of timing and in order to thoroughly assess the magnitude of potential impacts with reference to the detailed design. The outcomes of any future targeted threatened species surveys may further influence design to avoid impacts. The assessments of significance following targeted species survey would need to be updated to assess the final detailed design for the proposal.

RMS' 'Biodiversity Guidelines' (RTA 2011) provide the key reference to implementing safeguards and management measures and have been drawn on in the following sections.

#### 6.1.1 Vegetation clearing and flora habitat loss

In order to mitigate some of the impacts of vegetation clearing and habitat loss it is recommended that:

- Vegetation clearing is restricted to those areas where it is necessary, and opportunities to minimise clearing would be considered as part of the detailed design. Where reasonable and feasible, effort would be made to retain habitat trees within the subject site and study area. Specifically Habitat Tree 29 that falls within the temporary construction ancillary facility area shown in **Figure 3-12** should be retained where feasible and reasonable.
- Where clearing does occur, each area would be fenced with highly visible temporary marking/fencing establish and maintain exclusion zones in accordance with Guide 2 Exclusion zones of RMS' Biodiversity Guidelines (RTA 2011) to ensure that clearing does not extend beyond the area necessary.



- Clearing of vegetation would comply with Guide 1 Pre-clearing process of RMS' Biodiversity Guidelines (RTA 2011). The guidelines cover the felling of both non-habitat and habitat trees and the rescue and relocation of fauna.
- Vegetation within the road reserve and adjacent to areas of vegetation clearing would be managed to reduce invasion of noxious weed species. This may include controlling weeds at their point of source (ie the area of clearing) and in accordance with Guide 6 Weed management and Guide 10 Aquatic habitats and riparian zones of RMS' Biodiversity Guidelines (RTA 2011). The recommendations of Guide 6 and Guide 10 (RTA 2011) would be considered in the preparation of a construction Vegetation Management Plan (VMP) prepared for the proposal following detailed design and prior to construction. The construction VMP would be included in the CEMP.
- A construction VMP would be prepared prior to construction. This would also detail restoration, regeneration and rehabilitation of areas of native vegetation in the subject site (indirect impacts) of the proposal with reference to Guide 3: Re-establishment of Native Vegetation. The VMP would also detail appropriate management for the potential habitat of threatened flora and fauna species in the subject site (indirect impacts) of the proposal. Appropriate management may include fencing the habitat, signage and educating contractors on the presence of habitats, their significance and no-go zones. Post-construction revegetation works should include locally indigenous species that promote habitat fauna habitat (for example, the planting of *Allocasuarina* species for the Glossy Black Cockatoo).
- The VMP would be integrated with the landscape plan for the proposal.

### 6.1.2 Loss of fauna habitat

The principal means to reduce impacts to native fauna within the study area will be to minimise removal of native vegetation and fauna habitat. In addition to the relevant guides (RTA 2011) cited in **Section 6.1.1**, the following recommendations refer specifically to avoiding and/or minimising harm to native fauna during the construction phase:

- Prior to construction, a survey of any bridges or culverts scheduled for removal including at Flying Fox Creek (targeting threatened and non-threatened microbats) would be carried out in order to detect roosting microbats. Detailed survey guidelines are included in **Section 3.5.3**. If no microbats are located during the pre-construction surveys, it would be assumed that they are not roosting within the study area and no Microbat Management Plan would be required. If detected, a Microbat Management Plan would be prepared that details the short- and long-term management measures addressing at a minimum:
  - Determining the type of and locations to install replacement roost habitat for example installation of roost boxes or replication roost features in construction elements such as culverts.
  - Staged habitat removal including removal of secondary or less preferential roosting habitat prior to removal of primary habitat.
  - Pre demolition inspection and exclusion measures to prevent the continuing use of roosts. These would be prepared to address the subject species(s), specific habitat, roosting habits at each location and capture and handling procedures if this were required.
  - Monitoring of replacement habitat on a predetermined number of occasion and length of time that considers seasonal movements and habits of the subject specie(s).
- Prior to construction, targeted surveys for Large Forest Owls would be carried out to determine if listed Forest Owls occur within the study area, and determine any roosting or nest locations (where possible). Detailed survey guidelines are included in **Section 3.5.3**. Surveys should be undertaken on four to nine occasions between December and June. Surveys should be undertaken between dawn and dusk using a combination of call playback and spotlighting.



- Prior to construction, a hollow-bearing tree survey and stag-watching would be carried out (targeting threatened parrots, cockatoos, forest owls, arboreal mammals and microbats) in order to identify the number and type of nest boxes required and the appropriate locations to install them. Installation of bat roost and nest boxes would take place at least one month prior to the commencement of construction. The optimal season for stag-watching is spring however a hollow-bearing tree/stag survey can be conducted any time of year. Bat roost and nest boxes would be installed at a ratio of 1:1 for each hollow removed by the proposal and in accordance with Table 8.1 of Guide 8 Nest boxes of RMS' Biodiversity Guidelines (RTA 2011).
- Targeted surveys would be carried out for GGBF in areas identified as providing potential breeding habitat for the species in the current surveys. Detailed survey guidelines are included in **Section 3.5.3**. If detected, a GGBF Management Plan would need to be prepared that details the short- and long-term management measures to minimise and mitigate impacts to GGBF. This plan would require the investigation of additional habitats inaccessible in the current survey to obtain a full understanding of the population across the study area. At a minimum, the plan would address:
  - Determining the type of and locations for temporary and permanent replacement habitat including consideration of staged habitat removal.
  - Recommending the most optimal alignments for frog exclusion fencing.
  - Diurnal and nocturnal pre-clearing surveys.
  - Environmental induction training for construction contractors.
  - Site hygiene management including prevention of chytrid fungus.
  - GGBF relocation procedures.
  - Construction works procedures (including timing of works).
  - Reporting procedures.
- Clearing of mature and hollow-bearing trees within the study area would be minimised where feasible and reasonable. Specifically Habitat Tree 29 that falls within the temporary construction ancillary facility area shown in **Figure 3-12** should be retained where feasible and reasonable.
- All site personnel would be made aware of the biodiversity values of the study area including threatened species, no-go areas and responsibilities under legislation during their site induction prior to works commencing.
- Appropriate tree removal procedure requiring the presence of a qualified ecologist or wildlife expert experienced in the rescue of fauna should be adopted as detailed in RMS Guide 4: Clearing of vegetation and removal of bushrock including the staged removal process.
- Tree hollows and woody debris removed for the proposal should be salvaged and relocated to appropriate fauna friendly bridges for use as fauna furniture (RMS Guide 5: Re-use of woody debris and bushrock).
- Should unexpected threatened fauna be located at any time during the proposed activities, all works would cease immediately in the area to prevent any further harm to the individual, the Senior Environment Officer Southern Region would be contacted in the first instance and a suitably qualified ecologist consulted to determine if further assessment or management plans may be required.



### 6.1.3 Edge effects

Mitigation measures related to edge effects relate generally to reducing impacts outside of the direct area of impact, controlling possible impacts at their source within the road reserve and temporary construction ancillary facility areas and reducing the hardness of the edge between the extent of earthworks and native vegetation. In addition to the relevant guides (RTA 2011) cited in **Sections 6.1.1 and 6.1.2**, further measures that are relevant to the proposal include:

- Minimising disturbance, wherever reasonably practicable, to stream banks through avoidance of the use of in-stream structures. This would be achieved in the case of permanent and creek crossings (ie bridges with no in-stream structures would be used). However this would be impossible in the case of culverts.
- Implementing soil erosion and sedimentation control measures as detailed in the Princes Highway Upgrade - Berry to Bomaderry – Technical Paper: Surface Water, Groundwater and Flooding (AECOM, 2013).

### 6.1.4 Corridors and connectivity

Wildlife corridors and connectivity are not a prominent feature of the study area, however, maintenance of the existing connectivity can be achieved. Potential corridors in the study area are confined to degraded native and exotic riparian vegetation, which generally provide a discontinuous strip of vegetative cover through an otherwise cleared landscape. Therefore, the greatest opportunity for maintaining or improving connectivity across the proposal is through the design of 'fauna friendly' bridges and box culverts over creeks, so that they provide sufficient dry passage and or clearance (both height and the space between the embankments and the watercourse) for fauna to move through or under them.

The detailed design of the proposed bridges would accommodate fauna friendly bridge design where appropriate, feasible and reasonable. Watercourse crossings that have and would continue to have the highest levels of vegetation connectivity and potential as fauna movement corridors include at Wileys Creek (**Figure 3-11**), Jaspers Brush Creek (**Figures 3-15 to 3-17**) and Flying Fox Creek (**Figures 3-17 to 3-18**). The design of upgraded creek crossings at these locations would consider features to maintain or improve fauna passage under the Princes Highway. Where fauna friendly design features are included in the bridge design, consideration would be given to the use of appropriate fencing to funnel wildlife beneath the road and prevent wildlife from accessing the highway.

## 6.2 Mortality

The implementation of the measures from the relevant guides (RTA 2011) cited in **Sections 6.1.1 to 6.1.3** would reduce the risk of mortality prior to and during construction. The most important measure to reduce the impact of fauna mortality would be maintaining or improving fauna passage under the Princes Highway as part of the detailed design of the proposed bridges in locations identified in **Section 6.1.4**.

## 6.3 Weeds

A construction VMP is recommended to be prepared, prior to the commencement of construction and consider specific weed issues and site conditions as close as possible to the commencement of construction. The preparation of the construction VMP should involve consultation with Shoalhaven City Council where Council reserves will be directly or indirect impacted by the proposal. In addition to the relevant guides (RTA 2011) and documents cited in **Sections 6.1.1 to 6.1.3**, the following recommendations should be implemented to reduce the impact of weed invasion on native plant communities:

- Use weed-free topsoil in landscaping and revegetate disturbed sites with locally indigenous species (local provenance). Revegetation using stockpiled soil should also include planting local native species to stabilise the soil as well as ongoing weed control.



- Monitor and control weed populations that establish on disturbed areas, with particular attention to eradication of noxious weeds. Weed invasions should be monitored and controlled by a person experienced in weed management.
- Weed management strategies should be incorporated into the construction VMP, detailing necessary weed control works, particularly in areas where the weeds may impact on threatened species and/or their habitats.

## 6.4 Offset strategies

RMS tries to minimise and mitigate its impact on biodiversity through its road development and management practices, however it is not always possible to avoid impacts. To address significant unavoidable and residual loss to biodiversity, RMS has developed the 'Guideline for Biodiversity Offsets' (RMS 2011b).

An analysis of the proposal against the thresholds of RMS' (2011b) guidelines has been made and in summary:

- Less than five hectares (ie 3.48 hectares, **Table 4-3**) of native vegetation, including habitat for threatened species is would be directly impacted (cleared) by the proposal (Threshold 4).
- No area of high conservation value native vegetation would be directly impacted (cleared) by the proposal (Threshold 5).
- No area of very high conservation value native vegetation or very high value threatened species habitat would be directly impacted (cleared) by the proposal (Threshold 6).
- No works, other than clearing, as a result of the proposal are likely to lead to an impact on the long term survival of the species in the region which cannot be reasonably or feasibly mitigated for (Threshold 7).

In consideration of the outcomes of RMS (2011b) thresholds summarised above, an offset for the proposal is not required.

Should changes to the concept design occur during the detailed design phase of the proposal, and should the design changes result in changes in the level of impact, these changes would be considered separately and the need for offsets reconsidered at that time.



# 7 Conclusion

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This report assesses the ecological significance of the general terrestrial biodiversity values and threatened plant and animal species, endangered populations and TECs that occur, or have a likelihood to occur, within the area affected by the proposal, in accordance with the EP&A Act, the TSC Act and the EPBC Act.

## 7.1 General terrestrial biodiversity

Native vegetation and other vegetation types providing habitat for native flora and fauna in the study area have been, and continue to be, considerably impacted by land use in the study area and surrounds. These long term impacts have resulted in simplification of flora and fauna habitats reducing the range of resources available for the recruitment, reproduction occupation and persistence of native flora and fauna in the study area. At a locality scale the study area is located on the landward margin of a coastal floodplain that is characterised by a substantially depleted native vegetation and habitat connectivity to the coastal foothills and adjacent Cambewarra Range.

Overall the proposal is likely to have some impact on biodiversity values of the locality. Given the landscape, condition of flora and fauna habitats and RMS' commitment to continue to follow due diligence according to RMS policy and guidelines and adhere to relevant State and Commonwealth legislation, the proposal is unlikely to have a significant impact on the general terrestrial biodiversity values of the study area and locality.

## 7.2 Threatened biodiversity

Two TECs were recorded in the study area and would be impacted by the proposal. Approximately 1.27 hectares of the TEC ILGW would be impacted by the proposal; 0.53 hectares directly and 0.74 hectares indirectly. The second TEC, RFEFCF would be subject to direct impacts of 0.30 hectares and 0.01 hectares of indirect impacts. Impact assessments were undertaken for each TEC and concluded the proposal was unlikely to have a significant impact.

No threatened plant species were recorded in the study area, however, potential habitat exists for four highly cryptic and difficult to detect threatened plant species: *Cryptostylis hunteriana*, *Genoplesium baueri*, *Pterostylis gibbosa* and *Thesium australe*.

Eight threatened and four migratory animal species were recorded within and/or surrounding the study area during the cumulative field surveys spanning 2007 to 2009. An additional nineteen species are considered to have a medium or greater likelihood of occurrence. Impact assessments have been prepared for these 27 species: Australasian Bittern, Barking Owl, Black Bittern, Bush Stone-curlew, Eastern Bentwing-bat, Eastern False Pipistrelle, Eastern Freetail Bat, Gang-gang Cockatoo, Glossy Black-cockatoo, Greater Broad-nosed Bat, Green and Golden Bell Frog, Grey-headed Flying-fox, Large-eared Pied Bat, Little Eagle, Little Lorikeet, Masked Owl, Powerful Owl, Scarlet Robin, Sooty Owl, Southern Myotis, Spotted-tailed Quoll, Square-tailed Kite, Swift Parrot, Turquoise Parrot, Varied Sittella, Yellow-bellied Glider and the Yellow-bellied Sheath-tail Bat (**Appendix D**). Impact assessments for these species concluded that the proposal is unlikely to have a significant effect on any of these species.

The assessments concluded that the proposal is unlikely to have a significant impact on any of these species. A SIS is not considered necessary for any TSC Act-listed threatened species. A referral to the Federal Environment Minister is not considered necessary for any EPBC Act-listed threatened species.

Notwithstanding the outcomes of the assessments of significance for threatened biodiversity, targeted surveys for some threatened species have been postponed for the reasons outlined in **Section 2.9**. The outcomes of any future targeted threatened species surveys may further influence detailed design to avoid impacts. The assessments of significance for species requiring targeted surveys would need to be updated to assess the final upgrade detailed designs.

## 8 References

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- AMBS (2002) *Fauna Underpass Monitoring Stage Two, Episode Five. Bulahdelah to Coolongolook*. AMBS Consulting for RTA, Sydney.
- Anon (1996). *Prevention of Human Lyssavirus Infection*. Communicable Disease Intelligence 20: 505–507.
- Belcher C *et al.* (2008) Spotted-tailed Quoll *Dasyurus maculatus*. Pp. 60-62 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.
- Bennett AF (1990) *Habitat Corridors: Their Role in Wildlife Management and Conservation*. Department of Conservation and Environment, Sydney.
- Benson, D. & McDougall, L. (2001) Ecology of Sydney plant species Part 8: Dicotyledon families Rutaceae to Zygophyllaceae. *Cunninghamia* 7(2): 241-462.
- Barrett GW, Silcocks AF, Cunningham R, Oliver DL, Weston MA, Baker J (2007) *Comparison Of Atlas Data To Determine The Conservation Status Of Bird Species In New South Wales, With An Emphasis On Woodland-Dependent Species*. Australian Zoologist **34**, 37-77.
- Biodiversity Group Environment Australia (1999a). Threat abatement plan for predation by Feral Cats, <http://www.environment.gov.au/biodiversity/threatened/publications/tap/cats/index.html>, Environment Australia, Canberra.
- Biodiversity Group Environment Australia (1999b). *Threat abatement plan for predation by the European Red Fox*, <http://www.environment.gov.au/biodiversity/threatened/publications/tap/foxes/index.html>.
- Biosis (2012) *Foxground and Berry bypass Princes Highway upgrade. Environmental assessment Volume 2 – Appendix F Technical paper: Terrestrial flora and fauna*. Biosis, Wollongong.
- Biosis (2009) *Gerringong to Bomaderry, Princes Highway Upgrade. Flora and Fauna Assessment*. Biosis, Sydney.
- Birds Australia. (2013) *The Atlas of Australian Birds - database search*.
- Breckwoldt (1990) *Living Corridors. Conservation and management of roadside vegetation*. Greening Australia Ltd, Canberra.
- Cardno Ecology Lab (2013). *Princes Highway upgrade - Berry to Bomaderry upgrade. Technical Paper: Aquatic ecology and water quality management*. Cardno Ecology Lab, Sydney.
- Churchill S (2008) *Australian Bats*. Second Edition. Allen & Unwin, Sydney
- Cropper SC (1993) *Management of Endangered Plants*. CSIRO Australia, Melbourne.
- Daly, G. (1996) Some problems in the management of the GGBF *Litoria aurea* (Anura: Hylidae) at Coomonderry Swamp on the South Coast of New South Wales. Australian Zoologist 30(2).
- Debus S (2006) *Breeding Biology And Behaviour Of The Scarlet Robin Petroica Multicolor And Eastern Yellow Robin Eopsaltria Australis In Remnant Woodland Near Armidale, New South Wales*. Corella **30**, 59-65.
- DEC (2004) *Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft)*. New South Wales Department of Environment and Conservation, Hurstville.
- DEC (2005a) *GGBF - draft recovery plan*. Office of Environment and Heritage NSW, Hurstville, NSW.
- DEC (2005b) *Swift Parrot: Threatened Species Profile*, Department of Environment and Conservation, Accessed 09 <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10455>.
- DEC (2005c). *Spotted-tailed Quoll - Threatened Species Profile*, Department of Environment and Conservation, Accessed 09 <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10207>
- DEC (2005d). *Turquoise Parrot: Threatened Species Profile*, <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10555>.



DEC (2005e). *Gang-gang Cockatoo - Threatened Species Profile*, Department of Environment and Conservation <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10975>.

DEC (2005fl). *Glossy Black-cockatoo: Threatened Species Profile*, <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10140>.

DEC (2005g). *Bush Stone-curlew: Threatened Species Profile*, <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10495> Accessed Sept 2013

DEC (2005h). *Square-tailed Kite: Threatened Species Profile*, <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10495> Accessed Sept 2013

DEC (2006). *NSW Recovery Plan for the Bush Stone-curlew *Burhinus grallarius**. Department of Environment and Conservation NSW, Sydney. <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10441> Accessed 11 Sep 2013

DECC (2007) *River-flat Eucalypt Forest on Coastal Floodplains, Identification Guidelines for Endangered Ecological Communities*, [http://www2.nationalparks.nsw.gov.au/PDFs/EEC\\_River\\_flat\\_Eucalypt\\_201207\\_High\\_Res.pdf](http://www2.nationalparks.nsw.gov.au/PDFs/EEC_River_flat_Eucalypt_201207_High_Res.pdf), NSW Department of Environment and Climate Change.

DECC (2007). *Threatened species assessment guidelines. The assessment of significance*. Department of Environment and Climate Change, Hurstville.

DECC (2008) *Hygiene protocol for the control of disease in frogs*. Department of Environment and Climate Change (NSW).

DECC (2009) *DECCW Atlas of NSW Wildlife: Kiama & Moss Vale 1:100 000 map sheets*

DECC (2009). *BioBanking Assessment Methodology and Credit Calculator Operational Manual*. Department of Environment and Climate Change NSW, Sydney.

DECC (2009). *Threatened species survey and assessment guidelines: field survey methods for fauna.. Amphibians*, Department of Environment & Climate Change NSW, Sydney. <http://www.environment.nsw.gov.au/resources/threatenedspecies/09213amphibians.pdf>

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

DECCW (2010) *National Recovery Plan for *Zieria baeuerlenii**. Department of Environment, Climate Change and Water, Hurstville.

DECCW (2010) *South Coast Regional Conservation Plan*. Department of Environment, Climate Change and Water, Sydney.

DEH (2003) *Administrative guidelines on Significance – Supplement for the Grey-headed Flying-fox. What You Need To Know About The Grey-headed Flying-fox for the 2003-2004 fruit season*.

DEWHA (2007) *Census of Australian Vertebrates*, Department of the Environment, Water, Heritage and the Arts, <http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/cavs/index.html>.

DEWHA (2008a). *Approved Conservation Advice for *Cryptostylis hunteriana**. Department of Environment, Water, Heritage and the Arts. Canberra.

DEWHA (2008b). *Threat Abatement Plan for predation by feral cats, Commonwealth of Australia* <http://www.environment.gov.au/biodiversity/threatened/publications/tap/pubs/tap-cat-report.pdf>.

DEWHA (2009). *Census of Australian Vertebrates*, <http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/cavs/> . Department of Sustainability, Environment, Water, Population and Communities.

- DEWHA (2009a) *Matters of National Environmental Significance. Significant impact guidelines 1.1. Environment Protection and Biodiversity Conservation Act 1999*. Department of the Environment, Water, Heritage & the Arts. Australian Government, Canberra.
- DEWHA (2009a). *Register of Critical Habitat*, Department of Environment, Water, Heritage and the Arts, Accessed 09 <http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl>.
- DEWHA (2009b) *Background Paper to EPBC Act Policy Statement 3.19 - Nationally Threatened Species and Ecological Communities. Significant Impact Guidelines for the vulnerable green and golden bell frog (Litoria aurea)*. Department of Sustainability, Environment, Water, Population and Communities, Canberra. <http://www.environment.gov.au/epbc/publications/litoria-aurea.html>.
- DEWHA (2010) *Survey guidelines for Australia's threatened frogs: Guidelines for detecting frogs listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*. Department of the Environment, Water, Heritage & the Arts. Australian Government, Canberra.
- Dickman CR and Read DG (1992) *'The biology & management of dasyurids of the arid zone in NSW.'* NPWS, NSW, No. 11.
- DoP (1995). *State Environmental Planning policy no 44 - Koala Habitat Protection*. Department of Planning
- DERM (2011) *National recovery plan for the large-eared pied bat Chalinolobus dwyeri*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- DII (2010) *Bats and health risks*. Biosecurity Primefact 1069. Report by the Department of Industry and Investment, Orange.
- DSEWPaC (2012a). *Interim koala referral advice for proponents*. Department of Sustainability, Environment, Water, Population and Communities. Canberra.
- DSEWPaC (2012b). *Cryptostylis hunteriana. Species Profile and Threats Database*. Department of Sustainability, Environment, Water, Population and Communities. Canberra.
- DSEWPaC (2013) *Species Profile and Threats Database. Register of Critical Habitat*. Department of Sustainability, Environment, Water, Populations and Communities, Canberra. Accessed April 2013 <http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl>
- DSEWPaC (2013a) *Species Profile and Threats Database*. Accessed April 2013. <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl> . Department of Sustainability, Environment, Water, Populations and Communities, Canberra.
- DSEWPaC (2013b) *Species Profile and Threats Database. Register of Critical Habitat*. Accessed April 2013. <http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl> . Department of Sustainability, Environment, Water, Populations and Communities, Canberra.
- Environment Australia (2000) *The Action Plan for Australian Birds*. Report authors Stephen T. Garnett of Queensland Parks and Wildlife Service, and Gabriel M. Crowley of Birds Australia.
- Goldingay R (2008) Yellow-bellied Glider *Petaurus australis*. Pp. 228-230 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.
- Goldingay, R. & Lewis B. (1999) *Development of a conservation strategy for the GGBF Litoria aurea in the Illawarra Region of New South Wales*. Australian Zoologist. 31:376-387.
- Goosem, M., Harris, C., Chester, G., and Tucker, N. (2004) *Toward Sustainable Roads. Applying Research to Planning and Design Review*. Cooperative Research Centre for Tropical Rainforest Ecology and Management. Rainforest CRC, Cairns. Unpublished Report.
- Harden G (1990) *Flora of New South Wales Volume 1*. NSW University Press, Kensington.
- Harden G (1992) *Flora of New South Wales Volume 3*. NSW University Press, Kensington.
- Harden G (1993) *Flora of New South Wales Volume 4*. NSW University Press, Kensington.
- Harden G (2002) *Flora of New South Wales Volume 2 (Revised Edition)*. University of New South Wales Press Ltd., Kensington.
- Harris, I. and Bamford, M. (2011) *Roads and Wildlife A Review of Purpose-Built Fauna Underpasses*. Report for City of Armadale.



- Higgins & Peter (eds) (2002). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 6: Pardalotes to Shrike-thrushes*. Oxford University Press, Melbourne.
- Lindenmayer D (2002) *'Gliders of Australia: A natural history.'* UNSW Press, Sydney
- MacNally R (1999) *Habitat Fragmentation and Habitat Loss: Secondary, Cascading Effects and Predictability*. *Australian Biologist* 12, 138-151.
- Marchant, S., & P.J. Higgins (eds) (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings*. Oxford University Press, Melbourne.
- Marchant, S., & P.J. Higgins (eds) (1990). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 1: Ratites to Ducks*. Oxford University Press, Melbourne.
- Morris AK (1980) The status and distribution of the Turquoise Parrot in New South Wales. *Australian Birds* 14, 57-67.
- Niche (2012) *Green and Golden Bell Frog Assessment for the Princes Highway Upgrade – Gerringong*. Niche Environment and Heritage, Sydney.
- NPWS (1999b). *Black Bittern: Threatened Species Information*, NSW National Parks and Wildlife Service, Accessed 08b [http://www.nationalparks.nsw.gov.au/PDFs/tsprofile\\_black\\_bittern.pdf](http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_black_bittern.pdf),
- NPWS (1999h). *Spotted-tailed Quoll: Threatened Species Information*, New South Wales National Parks and Wildlife Service  
[http://www.nationalparks.nsw.gov.au/PDFs/tsprofile\\_spotted\\_tailed\\_quoll.pdf](http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_spotted_tailed_quoll.pdf).
- NPWS (1999j). *Yellow-bellied Glider: Threatened Species Information*, NSW National Parks and Wildlife Service, Accessed  
[http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile\\_yellowbellied\\_glider.pdf](http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_yellowbellied_glider.pdf),
- NPWS (2000) *Wildlife Management Manual for the Riverine Plains – Bush Stone-curlew*. NSW National Parks and Wildlife Service, Hurstville.
- NPWS (2002) *Recommendation for the Identification of Critical Habitat for the Bomaderry Zieria (Zieria baeuerlenii) - A recommendation report prepared for public exhibition pursuant to Part 3 of the Threatened Species Conservation Act 1995*. NSW National Parks and Wildlife Service, Hurstville.
- NPWS (2003a) *Environmental Impact Assessment Guidelines - Green and Golden Bell Frog*. NSW National Parks and Wildlife Service.
- NPWS (2003b) *Green and golden bell frog - species profile*. NSW National Parks and Wildlife Service.
- NPWS (2003c) *Predation by Gambusia holbrooki - The Plague Minnow*. Available from:  
<http://www.environment.nsw.gov.au/resources/nature/ThreatAbatementPlanPlagueMinnow.pdf>.
- NPWS (2003d). *Draft Recovery Plan for the Barking Owl, Ninox connivens*,  
[http://www2.nationalparks.nsw.gov.au/PDFs/recoveryplan\\_draft\\_barking\\_owl.pdf](http://www2.nationalparks.nsw.gov.au/PDFs/recoveryplan_draft_barking_owl.pdf).
- NSW Scientific Committee (1999) *Bushrock removal - key threatening process listing*. NSW Scientific Committee, Sydney
- NSW Scientific Committee (1999). *Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion - endangered ecological community listing. NSW Scientific Committee final determination*. NSW Scientific Committee, Sydney.
- NSW Scientific Committee (2001). *Clearing of Native Vegetation - Key Threatening Process listing final determination*,  
<http://www.environment.nsw.gov.au/determinations/ClearingNativeVegKTPListing.htm>, NSW Scientific Committee
- NSW Scientific Committee (2002a) *Infection of native plants by Phytophthora cinnamomi - key threatening process listing*. NSW Scientific Committee final determination. NSW Scientific Committee, Sydney.
- NSW Scientific Committee (2002b) *Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands*. NSW Scientific Committee final determination. NSW Scientific Committee, Sydney.

- NSW Scientific Committee (2003b) Infection of frogs by amphibian chytrid causing the disease chytridiomycosis. NSW Scientific Committee, Sydney.
- NSW Scientific Committee (2003c) *Invasion of native plant communities by exotic perennial grasses - key threatening process listing*. NSW Scientific Committee, Sydney.
- NSW Scientific Committee (2004) *River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing*. NSW Scientific Committee, Sydney.
- NSW Scientific Committee (2005). *Predation by the European Red Fox - key threatening process declaration*., NSW Scientific Committee, Accessed 09  
<http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Predation+by+the+European+red+fox+key+threatening+process+declaration>.
- NSW Scientific Committee (2007) *Loss of Hollow-bearing Trees - key threatening process determination*. NSW Scientific Committee, Sydney.
- NSW Scientific Committee (2008a). *Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners - key threatening process listing*, NSW Scientific Committee, Accessed 09  
<http://www.environment.nsw.gov.au/determinations/bellminerfd.htm>,
- NSW Scientific Committee (2008b). *Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations - key threatening process listing*, NSW Scientific Committee, Accessed 09b
- NSW Scientific Committee (2008c). *Little Lorikeet Glossopsitta pusilla - proposed vulnerable species listing*, <http://www.environment.nsw.gov.au/determinations/littlelorikeetpd.htm>,
- NSW Scientific Committee (2009) '*Predation and Hybridisation Of Feral Dogs (Canis lupus familiaris) - Key Threatening Process Declaration*, NSW Scientific Committee, Accessed 2013.  
<http://www.environment.nsw.gov.au/determinations/feraldogsFD.htm>
- NSW Scientific Committee (2011) *Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae - key threatening process listing*. NSW Scientific Committee, Sydney.
- OEH (2011) *NSW Critical habitat register*. Accessed April 2013, Office of Environment and Heritage, Sydney <http://www.environment.nsw.gov.au/criticalhabitat.htm>.
- OEH (2012a) *NSW threatened species database*. Office of Environment and Heritage, accessed April 2013, <<http://www.environment.nsw.gov.au/threatenedspecies/>>. Office of Environment and Heritage, Sydney.
- OEH (2012b) *Vegetation Types Database*. Office of Environment and Heritage, Sydney.
- OEH (2012c) Australasian Bittern species profile. Available from <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10105>. Accessed 11 Sep 2013
- OEH (2012d) Black Bittern *Lxobrychus flavicollis* Species Profile. Available from <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10105>. Accessed 11 Sep 2013
- OEH (2012e) Varied Sittella *Daphoenositta chrysoptera* threatened Species Profile <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20135> Accessed 11 Sep 2013
- OEH (2013a). *Atlas of NSW Wildlife*. Office of Environment and Heritage, Sydney.
- OEH (2013b) *Scarlet Robin Petroica Multicolor Threatened Species Profile* <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20133> Accessed 11 Sep 2013
- Pizzey G and Knight F (1997) '*The Field Guide to the Birds of Australia*.' Angus and Robertson, Sydney.
- Pyke A and White A (2001) A review of the biology of the GGBF *Litoria aurea*. Australian Zoologist 31, 563-598.



- Pyke GH and White AW (1996) Habitat requirements for the green and Golden Bell Frog *Litoria aurea* (Anura: Hylidae). *Australian Zoologist* 30, 224-232.
- RBGDT (2013). *PlantNET - The Plant Information Network System of The Royal Botanic Gardens and Domain Trust*, Sydney, Australia (Version 2). OEH, Sydney.
- Richard, T., Forman, T. and Alexander, E. (1998) *Roads and Their Major Ecological Effects*. *Annual Review of Ecology and Systematics* 29: 207 – 231.
- RMS (2011b) *Guideline for Biodiversity Offsets*. Roads and Maritime Services, Sydney.
- RMS (2012) *Environmental Impact Assessment Practice Note – Biodiversity Assessment*. Roads and Maritime Services, Sydney.
- RTA (2011) *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects Revision 0/September 2011*. Roads and Traffic Authority, Sydney.
- SCC (2004) *Shoalhaven City Council SOE Maps – Vegetation*. Accessed March 2013. <<http://gis.shoalhaven.nsw.gov.au/soemaps/viewer.htm>>. Shoalhaven City Council, Nowra.
- Scientific Committee (2007b). Predation by feral cats - key threatening process declaration, <http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Predation+by+feral+cats+-+key+threatening+process+declaration>, NSW National Parks and Wildlife Service, Accessed 09b
- Scotts D, Drielsma METRE, and Kingma L (2000) *Key habitats and corridors for fauna: A landscape framework for bioregional conservation planning in North-east New South Wales. II. Methods, decision rules, assumptions and mapped outputs*. NPWS, Coffs Harbour.
- SRCMA (2013) Southern Rivers Catchment Management Authority. Accessed April 2013. <http://www.southern.cma.nsw.gov.au/index.php>
- Stevens T C, Puotinen M L and Whelan R J (2008) Powerline easements: ecological impacts and contribution to habitat fragmentation from linear features. *Pacific Conservation Biology* Vol 14: 159-168. Surrey Beatty & Sons, Sydney.
- Swift Parrot Recovery Team (2001), Swift Parrot (*Lathamus discolor*) Recovery Plan 2001-2005, Swift Parrot Recovery Team  
<http://www.environment.gov.au/biodiversity/threatened/publications/recovery/swift-parrot/pubs/swift-parrot.pdf>.
- Thackway R and Cresswell I. (1995). *Biogeographic regionalisation for Australia: A framework for establishing the national system of reserves, Version 4.0*. Nature Conservation Agency, Canberra.
- Threatened Species Scientific Committee (2002) *Commonwealth Listing Advice on Infection of amphibians with chytrid fungus resulting in chytridiomycosis*. Department of Sustainability, Environment, Water, Population and Communities
- Threatened Species Scientific Committee (2001) *Commonwealth Listing Advice on Land clearance*. Department of Sustainability, Environment, Water, Population and Communities
- Tozer MG, Turner K, Keith DA, Tindall D, Pennay C, Simpson C, MacKenzie B, Beukers P (2010) Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. *Cunninghamia* 11, 359-406. Botanic gardens Trust, Sydney.
- White AW (2001) *GGBF Surveys on the mid north coast of New South Wales*. Report for NSW National Parks and Wildlife Service.
- White AW and Pyke GH (2008) Green and Golden Bell frogs in New South Wales: current status and future prospects. *Australian Zoologist* 34, 319-333.
- Wilson A and Lindenmayer DB (1995) *Wildlife Corridors and the Conservation of Biodiversity – a Review*. Centre for Resource and Environmental Studies, Australian National University, Canberra.

# Appendix A

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Flora and fauna species inventories



## Appendix A – Flora and fauna species inventories

Notes to table

### EPBC Act:

CR - Critically endangered  
EN - Endangered  
VU - Vulnerable

### General status

# - Native species outside natural range  
\* - Introduced species not native to Australia  
\*\* - Noxious weed species declared under the *Noxious Weeds Act 1993*

### TSC Act:

C1 – Critically endangered  
E1 – Endangered (Part 1, Schedule 1)  
E2 – Endangered (Part 2, Schedule 1)  
E4 – Presumed extinct (Part 4, Schedule 1)  
V1 – Vulnerable (Part 1, Schedule 2)

### Noxious weed status:

SP State prohibited species (Class 1)  
RP Regionally prohibited species (Class 2)  
RC Regionally controlled species (Class 3)  
RR Regionally restricted species (Class 4)  
R Restricted plant (Class 5)

**Table A1-1 Flora species inventory combining 2007 to 2013 surveys**

Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Caprifoliaceae	<i>Abelia x grandiflora</i>	Abelia	*		x
Rousseaceae	<i>Abrophyllum ornans</i>	Native Hydrangea		x	
Fabaceae - Mimosoideae	<i>Acacia baileyana</i>	Cootamundra Wattle	#		x
Fabaceae - Mimosoideae	<i>Acacia binervata</i>	Two-veined Hickory		x	x
Fabaceae - Mimosoideae	<i>Acacia decurrens</i>	Black Wattle		x	
Fabaceae - Mimosoideae	<i>Acacia falcata</i>	Acacia		x	
Fabaceae - Mimosoideae	<i>Acacia irrorata ssp. irrorata</i>	Green Wattle		x	
Fabaceae - Mimosoideae	<i>Acacia longifolia ssp. longifolia</i>	Sydney Golden Wattle			x
Fabaceae - Mimosoideae	<i>Acacia maidenii</i>	Maiden's Wattle		x	x
Fabaceae - Mimosoideae	<i>Acacia mearnsii</i>	Black Wattle		x	x
Fabaceae - Mimosoideae	<i>Acacia melanoxylon</i>	Blackwood		x	
Fabaceae - Mimosoideae	<i>Acacia myrtifolia</i>	Red-stemmed Wattle		x	
Fabaceae - Mimosoideae	<i>Acacia parramattensis</i>	Parramatta Wattle		x	
Fabaceae - Mimosoideae	<i>Acacia suaveolens</i>	Sweet Wattle		x	x
Fabaceae - Mimosoideae	<i>Acacia terminalis</i>	Sunshine Wattle		x	x
Fabaceae - Mimosoideae	<i>Acacia terminalis ssp. angustifolia</i>	Acacia		x	

Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Fabaceae - Mimosoideae	<i>Acacia ulicifolia</i>	Prickly Moses		x	
Polygonaceae	<i>Acetosella vulgaris</i>	Sheep Sorrel	*	x	
Myrtaceae	<i>Acmena smithii</i>	Lilly Pilly		x	
Adiantaceae	<i>Adiantum aethiopicum</i>	Common Maidenhair		x	
Asteraceae	<i>Ageratina adenophora</i>	Crofton Weed	** RR	x	
Asteraceae	<i>Ageratina riparia</i>	Mistflower	** RR	x	x
Poaceae	<i>Aira sp.</i>	Aira	*	x	
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black Sheoak		x	x
Araceae	<i>Alocasia brisbanensis</i>	Cunjevoi			x
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash			x
Amaranthaceae	<i>Amaranthus viridis</i>	Green Amaranth	*		x
Poaceae	<i>Andropogon virginicus</i>	Whisky Grass	*	x	x
Myrtaceae	<i>Angophora floribunda</i>	Rough-barked Apple		x	x
Haemodoraceae	<i>Anigozanthos sp</i>	Kangaroo Paw	*		x
Poaceae	<i>Anisopogon avenaceus</i>	Oat Speargrass		x	x
Araucariaceae	<i>Araucaria heterophylla</i>	Norfolk Island Pine	#		x
Apocynaceae	<i>Araujia sericifera</i>	Moth Vine	*	x	x
Poaceae	<i>Aristida ramosa var. ramosa</i>	Aristida		x	x
Poaceae	<i>Aristida vagans</i>	Threeawn Speargrass		x	
Anthericaceae	<i>Arthropodium milleflorum</i>	Vanilla Lily		x	
Poaceae	<i>Arundo donax</i>	Spanish Reed	*		x
Asparagaceae	<i>Asparagus asparagoides</i>	Bridal Creeper	** RR	x	
Aspleniaceae	<i>Asplenium flabellifolium</i>	Necklace Fern		x	
Asteraceae	<i>Aster subulatus</i>	Wild Aster	*		x
Poaceae	<i>Austrodanthonia sp.</i>	Austrodanthonia		x	
Poaceae	<i>Austrodanthonia tenuior</i>	Purplish Wallaby-grass		x	
Poaceae	<i>Austrostipa pubescens</i>	Austrostipa		x	
Poaceae	<i>Austrostipa ramosissima</i>	Stout Bamboo Grass		x	
Poaceae	<i>Austrostipa rudis ssp. rudis</i>	Veined Spear-grass		x	
Poaceae	<i>Austrostipa sp.</i>	Austrostipa		x	
Poaceae	<i>Axonopus affinis</i>	Narrow-leaved Carpet Grass	*	x	x
Myrtaceae	<i>Backhousia myrtifolia</i>	Grey Myrtle		x	x
Proteaceae	<i>Banksia spinulosa var. collina</i>	Banksia		x	



Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Proteaceae	<i>Banksia spinulosa var. spinulosa</i>	Banksia		x	x
Asteraceae	<i>Bidens pilosa</i>	Cobbler's Pegs	*	x	x
Pittosporaceae	<i>Billardiera scandens var. scandens</i>	Common Apple-berry		x	
Blechnaceae	<i>Blechnum cartilagineum</i>	Gristle fern			x
Cyperaceae	<i>Bolboschoenus caldwellii</i>				x
Fabaceae - Faboideae	<i>Bossiaea heterophylla</i>	Variable Bossiaea		x	
Sterculiaceae	<i>Brachychiton acerifolius</i>	Flame Tree			x
Sterculiaceae	<i>Brachychiton populneus ssp populneus</i>	Kurrajong			x
Euphorbiaceae	<i>Breynia oblongifolia</i>	Coffee Bush		x	x
Poaceae	<i>Briza maxima</i>	Quaking Grass	*	x	x
Poaceae	<i>Briza subaristata</i>		*		x
Poaceae	<i>Bromus catharticus</i>	Prairie Grass	*	x	x
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet		x	x
Acanthaceae	<i>Brunoniella pumilio</i>	Dwarf Blue Trumpet		x	
Araucaria	<i>Bunya pine</i>		#		x
Pittosporaceae	<i>Bursaria spinosa ssp. spinosa</i>	Sweet Bursaria		x	
Myrtaceae	<i>Callistemon rigidus</i>	Stiff Bottlebrush		x	x
Myrtaceae	<i>Callistemon salignus</i>	Willow Bottlebrush		x	x
Dicksoniaceae	<i>Calochlaena dubia</i>	Common Ground Fern		x	
Convolvulaceae	<i>Calystegia silvatica</i>	Greater Bindweed		x	
Theaceae	<i>Camellia sasanqua</i>	Camellia	*		x
Cyperaceae	<i>Carex fascicularis</i>	Tassel Sedge		x	x
Lauraceae	<i>Cassytha glabella f. glabella</i>	Slender Dodder-laurel		x	
Lauraceae	<i>Cassytha pubescens</i>	Cassytha		x	
Fabaceae - Faboideae	<i>Castanospermum australe</i>	Black Bean			x
Casuarinaceae	<i>Casuarina cunninghamiana ssp cunninghamiana</i>			x	x
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak			x
Apiaceae	<i>Centella asiatica</i>	Pennywort		x	x
Chenopodiaceae	<i>Chenopodium album</i>	Fat Hen	*		x
Poaceae	<i>Chloris gayana</i>	Rhodes Grass	*		x
Lauraceae	<i>Cinnamomum camphora</i>	Camphor Laurel	*	x	x
Asteraceae	<i>Cirsium vulgare</i>	Spear Thistle	*	x	x
Rutaceae	<i>Citrus limon</i>	Lemon	*		x

Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Rutaceae	<i>Citrus sp.</i>	Citrus	*	x	
Ranunculaceae	<i>Clematis aristata</i>	Mountain Clematis		x	
Verbenaceae	<i>Clerodendrum tomentosum</i>	Hairy Clerodendrum			x
Commelinaceae	<i>Commelina cyanea</i>	Native Wandering Jew		x	x
Sterculiaceae	<i>Commersonia fraseri</i>	Brush Kurrajong		x	x
Proteaceae	<i>Conospermum ericifolium</i>	Conospermum		x	
Asteraceae	<i>Conyza albida</i>	Tall Fleabane	*	x	
Asteraceae	<i>Conyza sp.</i>	Conyza	*	x	x
Asteraceae	<i>Coreopsis lanceolata</i>	Coreopsis	*	x	
Rutaceae	<i>Correa reflexa var. reflexa</i>	Native Fuschia		x	
Myrtaceae	<i>Corymbia gummifera</i>	Red Bloodwood		x	x
Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum		x	x
Malaceae	<i>Cotoneaster sp.</i>	Cotoneaster	*	x	x
Orchidaceae	<i>Cryptostylis subulata</i>	Large Tongue Orchid		x	
Cupressaceae	<i>Cupressus leylandii</i>	Cypress	*		x
Cyperaceae	<i>Cyathochaeta diandra</i>	Sheath Sedge		x	x
Orchidaceae	<i>Cymbidium suave</i>	Snake Orchid		x	
Poaceae	<i>Cymbopogon refractus</i>	Barbed Wire Grass			x
Poaceae	<i>Cynodon dactylon</i>	Common Couch		x	x
Cyperaceae	<i>Cyperus brevifolius</i>		*		x
Cyperaceae	<i>Cyperus eragrostis</i>	Umbrella Sedge	*	x	x
Cyperaceae	<i>Cyperus polystachyos</i>				x
Cyperaceae	<i>Cyperus sp.</i>	Cyperus		x	
Fabaceae - Faboideae	<i>Daviesia ulicifolia ssp. ulicifolia</i>	Gorse Bitter-pea		x	x
Fabaceae - Faboideae	<i>Desmodium rhytidophyllum</i>	Desmodium		x	
Fabaceae - Faboideae	<i>Desmodium varians</i>	Slender Tick-trefoil		x	
Phormiaceae	<i>Dianella caerulea var. producta</i>	Dianella		x	x
Phormiaceae	<i>Dianella longifolia var. longifolia</i>	Pale Flax-lily		x	x
Phormiaceae	<i>Dianella revoluta var. revoluta</i>	Dianella		x	
Poaceae	<i>Dichelachne micrantha</i>	Shorthair Plumegrass		x	
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed		x	x
Dicksoniaceae	<i>Dicksonia antarctica</i>	Soft Treefern		x	
Iridaceae	<i>Dietes sp</i>		*		x



Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Fabaceae - Faboideae	<i>Dillwynia retorta</i>	Dillwynia		x	
Fabaceae - Faboideae	<i>Dillwynia sp.</i>	Dillwynia		x	
Sapindaceae	<i>Dodonaea triquetra</i>	Large-leaf Hop-bush		x	
Blechnaceae	<i>Doodia aspera</i>	Prickly Rasp Fern		x	
Solanaceae	<i>Duboisia myoporoides</i>	Corkwood		x	
Poaceae	<i>Echinochloa crus-galli</i>	Barnyard Grass	*		x
Poaceae	<i>Echinopogon caespitosus var caespitosus</i>	Tufted Hedgehog-grass			x
Poaceae	<i>Echinopogon ovatus</i>	Forest Hedgehog Grass		x	x
Poaceae	<i>Ehrharta erecta</i>	Panic Veldtgrass	*	x	x
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush		x	x
Chenopodiaceae	<i>Einadia trigonos ssp trigonos</i>	Fishweed			x
Elaeocarpaceae	<i>Elaeocarpus reticulatus</i>	Blueberry Ash			x
Poaceae	<i>Entolasia marginata</i>	Bordered Panic		x	x
Poaceae	<i>Entolasia stricta</i>	Wiry Panic		x	x
Ericaceae	<i>Epacris microphylla var. microphylla</i>	Coast Coral Heath		x	
Ericaceae	<i>Epacris pulchella</i>	Epacris		x	
Poaceae	<i>Eragrostis brownii</i>	Brown's Lovegrass		x	
Poaceae	<i>Eragrostis sp.</i>	Eragrostis		x	
Asteraceae	<i>Erigeron karvinskianus</i>	Bony-tip Fleabane	*		x
Fabaceae - Faboideae	<i>Erythrina X sykesii</i>	Coral tree	*	x	x
Myrtaceae	<i>Eucalyptus botryoides</i>	Bangalay		x	x
Myrtaceae	<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark		x	
Myrtaceae	<i>Eucalyptus globoidea</i>	White Stringybark		x	x
Myrtaceae	<i>Eucalyptus longifolia</i>	Woollybutt		x	
Myrtaceae	<i>Eucalyptus microcorys</i>	Tallowwood			x
Myrtaceae	<i>Eucalyptus paniculata ssp. paniculata</i>	Eucalyptus		x	x
Myrtaceae	<i>Eucalyptus pilularis</i>	Blackbutt		x	x
Myrtaceae	<i>Eucalyptus piperita</i>	Sydney Peppermint		x	
Myrtaceae	<i>Eucalyptus racemosa</i>	Narrow-leaved Scribbly Gum		x	
Myrtaceae	<i>Eucalyptus robusta</i>	Swamp Mahogany			x
Myrtaceae	<i>Eucalyptus saligna X botryoides</i>	Blue gum Bangalay hybrid		x	x
Myrtaceae	<i>Eucalyptus scias ssp. scias</i>	Eucalyptus		x	
Myrtaceae	<i>Eucalyptus sclerophylla</i>	Hard-leaved Scribbly Gum		x	x

Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum		x	x
Euphorbiaceae	<i>Euphorbia peplus</i>	Petty Spurge	*	x	x
Santalaceae	<i>Exocarpos cupressiformis</i>	Native Cherry		x	
Moraceae	<i>Ficus coronata</i>	Creek Sandpaper Fig		x	x
Moraceae	<i>Ficus macrophylla ssp. macrophylla</i>	Moreton Bay Fig		x	
Moraceae	<i>Ficus obliqua</i>	Small-leaved Fig			x
Moraceae	<i>Ficus rubiginosa</i>	Port Jackson Fig			x
Cyperaceae	<i>Gahnia aspera</i>	Gahnia		x	
Asteraceae	<i>Galinsoga parviflora</i>	Potato Weed	*		x
Rubiaceae	<i>Galium propinquum</i>	Maori Bedstraw		x	
Asteraceae	<i>Gamochaeta americana</i>	Cudweed	*		x
Geraniaceae	<i>Geranium homeanum</i>	Northern Cranesbill		x	x
Euphorbiaceae	<i>Glochidion ferdinandi var. ferdinandi</i>	Cheese Tree		x	x
Fabaceae - Faboideae	<i>Glycine clandestina</i>	Twining Glycine		x	x
Fabaceae - Faboideae	<i>Glycine tabacina</i>	Variable Glycine		x	x
Apocynaceae	<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush	*		x
Fabaceae - Faboideae	<i>Gompholobium grandiflorum</i>	Large Wedge Pea		x	
Fabaceae - Faboideae	<i>Gompholobium minus</i>	Dwarf Wedge Pea		x	
Fabaceae - Faboideae	<i>Gompholobium pinnatum</i>	Pinnate Wedge Pea		x	
Haloragaceae	<i>Gonocarpus tetragynus</i>	Common Raspwort		x	
Haloragaceae	<i>Gonocarpus teucroides</i>	Germander Raspwort		x	
Goodeniaceae	<i>Goodenia hederacea ssp. hederacea</i>	Ivy Goodenia		x	
Proteaceae	<i>Grevillea linearifolia</i>	Small-flower Grevillea		x	
Proteaceae	<i>Grevillea robusta</i>	Silky Oak	#	x	x
Sapindaceae	<i>Guioa semiglauca</i>	Guioa		x	
Proteaceae	<i>Hakea dactyloides</i>	Finger Hakea		x	
Proteaceae	<i>Hakea sericea</i>	Bushy Needlewood		x	
Fabaceae - Faboideae	<i>Hardenbergia violacea</i>	False Sarsaparilla		x	x
Dilleniaceae	<i>Hibbertia aspera ssp. aspera</i>	Hibbertia		x	
Dilleniaceae	<i>Hibbertia diffusa</i>	Wedge Guinea-flower		x	
Dilleniaceae	<i>Hibbertia scandens</i>	Climbing Guinea Flower		x	x
Dilleniaceae	<i>Hibbertia sp.</i>	Hibbertia		x	
Poaceae	<i>Holcus lanatus</i>	Yorkshire Fog	*	x	x



Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Fabaceae - Faboideae	<i>Hovea linearis</i>	Hovea		x	
Apiaceae	<i>Hydrocotyle laxiflora</i>	Stinking pennywort			x
Apiaceae	<i>Hydrocotyle sp.</i>	Hydrocotyle		x	
Clusiaceae	<i>Hypericum gramineum</i>	Small St. John's Wort			x
Asteraceae	<i>Hypochaeris radicata</i>	Catsear	*	x	x
Hypoxidaceae	<i>Hypoxis sp.</i>	Hypoxis		x	
Poaceae	<i>Imperata cylindrica var. major</i>	Blady Grass		x	x
Bignoniaceae	<i>Jacaranda mimosifolia</i>	Jacaranda	*	x	x
Juncaceae	<i>Juncus usitatus</i>	Billabong Rush		x	x
Fabaceae - Faboideae	<i>Kennedia rubicunda</i>	Red Kennedy Pea		x	x
Myrtaceae	<i>Kunzea ambigua</i>	Tick Bush		x	x
Asteraceae	<i>Lagenifera stipitata</i>	Blue Bottle-daisy		x	
Lythraceae	<i>Lagerstroemia indica</i>	Crepe Myrtle	*		x
Proteaceae	<i>Lambertia formosa</i>	Mountain Devil		x	x
Verbenaceae	<i>Lantana camara</i>	Lantana		x	x
Anthericaceae	<i>Laxmannia gracilis</i>	Slender Wire-lily		x	
Cyperaceae	<i>Lepidosperma laterale</i>	Variable Sword-sedge		x	x
Santalaceae	<i>Leptomeria acida</i>	Sour Currant Bush		x	
Myrtaceae	<i>Leptospermum polygalifolium ssp polygalifolium</i>			x	
Myrtaceae	<i>Leptospermum trinervium</i>	Paperbark Tea-tree		x	x
Ericaceae - Styphelioideae	<i>Leucopogon juniperinus</i>	Long-flower Beard-heath		x	x
Ericaceae - Styphelioideae	<i>Leucopogon lanceolatus</i>			x	
Oleaceae	<i>Ligustrum lucidum</i>	Large-leaved Privet	** RR	x	x
Oleaceae	<i>Ligustrum sinense</i>	Small-leaved Privet	** RR	x	x
Lindsaeaceae	<i>Lindsaea linearis</i>	Screw Fern		x	x
Altingiaceae	<i>Liquidambar styraciflua</i>	Liquidambar	*		x
Arecaceae	<i>Livistona australis</i>	Cabbage Palm		x	
Lobeliaceae	<i>Lobelia alata</i>	Lobelia		x	
Poaceae	<i>Lolium perenne</i>	Perennial Ryegrass	*	x	
Lomandraceae	<i>Lomandra filiformis ssp. filiformis</i>	Wattle Mat-rush		x	
Lomandraceae	<i>Lomandra glauca</i>	Pale Mat-rush		x	
Lomandraceae	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		x	x
Lomandraceae	<i>Lomandra multiflora ssp. multiflora</i>	Many-flowered Mat-rush		x	

Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Lomandraceae	<i>Lomandra obliqua</i>	Lomandra		x	
Proteaceae	<i>Lomatia ilicifolia</i>	Holly Lomatia		x	
Proteaceae	<i>Lomatia silaifolia</i>	Crinkle Bush		x	
Caprifoliaceae	<i>Lonicera japonica</i>	Japanese Honeysuckle	*	x	x
Myrtaceae	<i>Lophostemon confertus</i>	Brush Box	#		x
Onagraceae	<i>Ludwigia peploides ssp montevidensis</i>	Water Primrose			x
Solanaceae	<i>Lycium ferocissimum</i>	African Boxthorn	** RR	x	
Moraceae	<i>Maclura cochinchinensis</i>	Cockspur Thorn		x	
Zamiaceae	<i>Macrozamia sp.</i>	Macrozamia		x	
Apocynaceae	<i>Marsdenia rostrata</i>	Common Milk Vine		x	x
Myrtaceae	<i>Melaleuca armillaris ssp. armillaris</i>	Giant Honey-myrtle		x	
Myrtaceae	<i>Melaleuca linariifolia</i>	Melaleuca		x	x
Myrtaceae	<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree		x	x
Meliaceae	<i>Melia azedarach</i>	White Cedar			x
Violaceae	<i>Melicytus dentatus</i>	Tree Violet		x	x
Euphorbiaceae	<i>Micrantheum ericoides</i>	Micrantheum		x	
Poaceae	<i>Microlaena stipoides var. stipoides</i>	Weeping Grass		x	x
Fabaceae - Faboideae	<i>Mirbelia rubiifolia</i>	Heathy Mirbelia		x	x
Araceae	<i>Monstera deliciosa</i>	Fruit Salad Plant	*		x
Moraceae	<i>Morus alba</i>	White Mulberry	*		x
Rutaceae	<i>Murraya paniculata</i>		*		x
Musaceae	<i>Musa sp</i>	Banana	*		x
Myrsinaceae	<i>Myrsine variabilis</i>			x	
Apocynaceae	<i>Nerium oleander</i>	Oleander	*		x
Oleaceae	<i>Notelaea longifolia</i>	Large Mock-olive			x
Oleaceae	<i>Notelaea longifolia</i>	Large Mock-olive		x	
Oleaceae	<i>Notelaea venosa</i>	Veined Mock-olive		x	
Oleaceae	<i>Olea europaea ssp cuspidata</i>	Olive	*		x
Asteraceae	<i>Olearia viscidula</i>	Wallaby Weed		x	
Euphorbiaceae	<i>Omalanthus populifolius</i>	Omalanthus		x	
Rubiaceae	<i>Opercularia diphylla</i>	Opercularia		x	x
Poaceae	<i>Oplismenus aemulus</i>	Oplismenus		x	x
Poaceae	<i>Oplismenus imbecillis</i>	Oplismenus		x	x



Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Oxalidaceae	<i>Oxalis corniculata</i>		*		x
Oxalidaceae	<i>Oxalis perennans</i>	Grassland Wood-sorrel		x	
Asteraceae	<i>Ozothamnus diosmifolius</i>	White Dogwood		x	
Bignoniaceae	<i>Pandorea pandorana ssp. pandorana</i>	Pandorea		x	x
Poaceae	<i>Panicum simile</i>	Two-colour Panic		x	
Fabaceae - Mimosoideae	<i>Pararchidendron pruinatum</i>			x	
Apocynaceae	<i>Parsonia straminea</i>	Common Silkpod		x	x
Poaceae	<i>Paspalidium distans</i>				x
Poaceae	<i>Paspalum dilatatum</i>	Paspalum	*	x	x
Poaceae	<i>Paspalum urvillei</i>	Vasey Grass	*		x
Iridaceae	<i>Patersonia glabrata</i>	Leafy Purple-flag		x	
Iridaceae	<i>Patersonia sericea</i>	Silky Purple-flag		x	
Malvaceae	<i>Pavonia hastata</i>		*		x
Adiantaceae	<i>Pellaea falcata</i>	Sickle Fern		x	
Poaceae	<i>Pennisetum clandestinum</i>	Kikuyu Grass	*	x	x
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed		x	x
Polygonaceae	<i>Persicaria lapathifolia</i>	Pale Knotweed			x
Polygonaceae	<i>Persicaria praetermissa</i>	Spotted Knotweed		x	
Polygonaceae	<i>Persicaria sp.</i>	Persicaria		x	
Polygonaceae	<i>Persicaria strigosa</i>				x
Proteaceae	<i>Persoonia levis</i>	Broad-leaved Geebung		x	x
Proteaceae	<i>Persoonia linearis</i>	Narrow-leaved Geebung		x	
Proteaceae	<i>Persoonia mollis ssp. leptophylla</i>	Persoonia		x	
Proteaceae	<i>Petrophile pulchella</i>	Petrophile		x	
Proteaceae	<i>Petrophile sessilis</i>	Petrophile		x	
Poaceae	<i>Phalaris aquatica</i>	Phalaris	*		x
Philydraceae	<i>Philydrum lanuginosum</i>	Woolly Waterlily			x
Areaceae	<i>Phoenix canariensis</i>	Canary Island Date Palm	*		x
Malaceae	<i>Photinia serratifolia</i>	Chinese Photinia	*		x
Poaceae	<i>Phragmites australis</i>	Common Reed			x
Poaceae	<i>Phyllostachys aurea</i>	Fishpole Bamboo	*		x
Phytolaccaceae	<i>Phytolacca octandra</i>	Inkweed	*		x
Thymelaeaceae	<i>Pimelea linifolia ssp. linifolia</i>	Slender Rice-flower		x	x

Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Pinaceae	<i>Pinus radiata</i>	Radiata Pine	*	x	x
Pinaceae	<i>Pinus sp.</i>	Pinus	*	x	
Pittosporaceae	<i>Pittosporum multiflorum</i>	Orange Thorn		x	x
Pittosporaceae	<i>Pittosporum revolutum</i>	Rough Fruit Pittosporum		x	x
Pittosporaceae	<i>Pittosporum undulatum</i>	Sweet Pittosporum		x	x
Plantaginaceae	<i>Plantago lanceolata</i>	Lamb's Tongues	*	x	x
Fabaceae - Faboideae	<i>Platylobium formosum ssp. formosum</i>	Platylobium		x	x
Apiaceae	<i>Platysace linearifolia</i>	Platysace		x	
Lamiaceae	<i>Plectranthus parviflorus</i>	Cockspur Flower		x	
Poaceae	<i>Poa affinis</i>	Poa			x
Poaceae	<i>Poa labillardierei var. labillardierei</i>	Tussock		x	
Poaceae	<i>Poa sp.</i>	Poa		x	
Convolvulaceae	<i>Polymeria calycina</i>				x
Rubiaceae	<i>Pomax umbellata</i>	Pomax		x	
Salicaceae	<i>Populus nigra</i>		*		x
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot		x	x
Amygdalaceae	<i>Prunus sp.</i>	Prunus	*	x	x
Acanthaceae	<i>Pseuderanthemum variabile</i>	Pastel Flower		x	
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken		x	x
Pteridaceae	<i>Pteris tremula</i>	Tender Brake			x
Orchidaceae	<i>Pterostylis erecta</i>				x
Fabaceae - Faboideae	<i>Pultenaea flexilis</i>	Pultenaea		x	
Fabaceae - Faboideae	<i>Pultenaea retusa</i>	Blunt Bush-pea		x	
Malaceae	<i>Pyracantha crenulata</i>	Nepal Firethorn	*	x	
Polypodiaceae	<i>Pyrrosia rupestris</i>	Rock Felt Fern		x	
Ranunculaceae	<i>Ranunculus inundatus</i>	River Buttercup			x
Ranunculaceae	<i>Ranunculus lappaceus</i>	Common Buttercup		x	
Malaceae	<i>Rhaphiolepis indica</i>	Indian Hawthorn	*		x
Ericaceae	<i>Rhododendron sp</i>	Azalea	*		x
Fabaceae - Faboideae	<i>Robinia pseudoacacia</i>	Black Locust	*		x
Brassicaceae	<i>Rorippa nasturtium-aquaticum</i>	Watercress	*	x	
Brassicaceae	<i>Rorippa sp.</i>	Rorippa	*	x	
Rosaceae	<i>Rosa sp hort</i>	Oranmental Rose	*		x



Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Rosaceae	<i>Rubus fruticosus agg sp</i>	Blackberry	** RR	x	
Rosaceae	<i>Rubus parvifolius</i>	Native Raspberry		x	x
Polygonaceae	<i>Rumex crispus</i>	Curled Dock	*	x	x
Polygonaceae	<i>Rumex sp.</i>	Rumex	*	x	
Salicaceae	<i>Salix babylonica</i>	Weeping Willow	*	x	x
Salicaceae	<i>Salix fragilis var fragilis</i>	Crack Willow	** R		x
Salicaceae	<i>Salix sp.</i>	Salix	*	x	
Goodeniaceae	<i>Scaevola ramosissima</i>	Hairy Fan-flower		x	
Uvulariaceae	<i>Schelhammera undulata</i>	Lilac Lily		x	
Cyperaceae	<i>Schoenoplectus validus</i>				x
Asteraceae	<i>Senecio diaschides</i>	Shingle Fireweed		x	
Asteraceae	<i>Senecio madagascariensis</i>	Fireweed		x	x
Poaceae	<i>Setaria gracilis</i>	Slender Pigeon Grass	*		x
Rubiaceae	<i>Sherardia arvensis</i>	Field Madder	*	x	
Malvaceae	<i>Sida rhombifolia</i>	Paddy's Lucerne	*	x	x
Asteraceae	<i>Sigesbeckia orientalis ssp. orientalis</i>	Indian Weed		x	x
Smilacaceae	<i>Smilax glycyphylla</i>	Sweet Sarsparilla		x	
Solanaceae	<i>Solanum linnaeanum</i>	Apple of Sodom	*	x	
Solanaceae	<i>Solanum mauritianum</i>		*		x
Solanaceae	<i>Solanum nigrum</i>	Black-berry Nightshade	*	x	
Solanaceae	<i>Solanum pseudocapsicum</i>	Madeira Winter Cherry	*	x	x
Solanaceae	<i>Solanum sp.</i>	Solanum	*	x	
Asteraceae	<i>Sonchus oleraceus</i>	Common Sowthistle	*	x	x
Lemnaceae	<i>Spirodela sp.</i>	Spirodela		x	
Poaceae	<i>Sporobolus indicus</i>	Parramatta Grass	*	x	
Ericaceae - Styphelioideae	<i>Sprengelia sp.</i>	Sprengelia		x	
Poaceae	<i>Stenotaphrum secundatum</i>	Buffalo Grass	*	x	x
Moraceae	<i>Streblus brunonianus</i>	Whalebone Tree		x	x
Strelitziaceae	<i>Strelitzia reginae</i>	Bird of Paradise	*		x
Stylidiaceae	<i>Stylidium productum</i>	Stylidium		x	x
Myrtaceae	<i>Syncarpia glomulifera ssp. glomulifera</i>	Syncarpia		x	x
Myrtaceae	<i>Synoum glandulosum ssp. glandulosum</i>	Synoum		x	
Myrtaceae	<i>Syzygium australe</i>	Brush Cherry			x

Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Asteraceae	<i>Tagetes minuta</i>	Stinking Roger	*		x
Asteraceae	<i>Taraxacum officinale</i>	Dandelion	*		x
Bignoniaceae	<i>Tecoma capensis</i>	Cape Honeysuckle	*		x
Phormiaceae	<i>Thelionema caespitosum</i>	Tufted Lily		x	
Poaceae	<i>Themeda australis</i>	Kangaroo Grass		x	x
Acanthaceae	<i>Thunbergia alata</i>	Black-eyed Susan	*		x
Anthericaceae	<i>Thysanotus tuberosus ssp. tuberosus</i>	Common Fringe-lily		x	
Melastomataceae	<i>Tibouchina sp</i>	Tibouchina	*		x
Meliaceae	<i>Toona ciliata</i>	Red Cedar		x	
Apocynaceae	<i>Trachelospermum jasminoides</i>	Star Jasmine	*		x
Commelinaceae	<i>Tradescantia fluminensis</i>	Trad	*	x	x
Ulmaceae	<i>Trema tomentosa var. viridis</i>	Native Peach		x	
Anthericaceae	<i>Tricoryne elatior</i>	Yellow Autumn-lily		x	
Anthericaceae	<i>Tricoryne simplex</i>	Tricoryne		x	x
Fabaceae - Faboideae	<i>Trifolium repens</i>	White Clover	*	x	x
Apocynaceae	<i>Tylophora barbata</i>	Bearded Tylophora		x	
Typhaceae	<i>Typha domingensis</i>	Narrow-leaved Cumbungi			x
Typhaceae	<i>Typha orientalis</i>	Broadleaf Cumbungi			x
Ulmaceae	<i>Ulmus parvifolia</i>	Chinese Elm	*		x
Urticaceae	<i>Urtica incisa</i>	Stinging Nettle		x	x
Lentibulariaceae	<i>Utricularia australis</i>	Yellow Bladderwort		x	
Scrophulariaceae	<i>Verbascum virgatum</i>	Green Mullein	*		x
Verbenaceae	<i>Verbena bonariensis</i>	Purpletop	*	x	x
Asteraceae	<i>Vernonia cinerea var. cinerea</i>	Vernonia		x	
Scrophulariaceae	<i>Veronica plebeia</i>	Trailing Speedwell		x	
Violaceae	<i>Viola hederacea</i>	Ivy-leaved Violet		x	
Violaceae	<i>Viola sieberiana</i>	Viola		x	
Asteraceae	<i>Vittadinia cuneata</i>	Fuzzweed			x
Campanulaceae	<i>Wahlenbergia gracilis</i>	Sprawling or Australian Bluebell		x	
Campanulaceae	<i>Wahlenbergia sp.</i>	Wahlenbergia		x	
Iridaceae	<i>Watsonia bulbifera</i>	Watsonia	*	x	
Lamiaceae	<i>Westringia longifolia</i>	Long-leaved Westringia			x
Monimiaceae	<i>Wilkiea huegeliana</i>	Veiny Wilkiea		x	



Family	Scientific name	Common name	Status	Previous surveys	Current surveys
Fabaceae - Faboideae	<i>Wisteria</i>	Wisteria	*		x
Xanthorrhoeaceae	<i>Xanthorrhoea sp.</i>	Xanthorrhoea		x	

Notes to tables:

**EPBC Act:**

EX - Extinct  
 CR - Critically endangered  
 EN - Endangered  
 VU - Vulnerable  
 CD - Conservation dependent  
 M - Migratory

**TSC Act:**

C1 – Critically endangered  
 E1 – Endangered (Part 1, Schedule 1)  
 E2 – Endangered (Part 2, Schedule 1)  
 E4 – Presumed extinct (Part 4, Schedule 1)  
 V1 – Vulnerable (Part 1, Schedule 2)

U - introduced species

Fauna species in these tables are listed in alphabetical order within their taxonomic group.

Observation type: W = heard, O = seen, T = trapped, P = scat, R = road kill, AD = Anabat recording (definite), AP = Anabat recording (probable).

**Table A1-2 Fauna species inventory combining 2007 to 2013 surveys**

Family	Scientific Name	Common Name	EPBC Act	Migratory EPBC Act	NSW TSC Act	Obs type previous	Obs type current
<b>Amphibians</b>							
Myobatrachidae	<i>Limnodynastes peronii</i>	Striped Marsh Frog				OW	W
Hylidae	<i>Litoria dentata</i>	Bleating Tree Frog				OW	
Hylidae	<i>Litoria fallax</i>	Eastern Dwarf Tree Frog				OW	O
Hylidae	<i>Litoria nudidigita</i>	Leaf Green Tree Frog (Southern Call Race)				W	
Hylidae	<i>Litoria peronii</i>	Peron's Tree Frog				W	
Hylidae	<i>Litoria verreauxii</i>	Verreaux's Frog				OW	
Myobatrachidae	<i>Pseudophryne bibronii</i>	Brown Toadlet				W	
<b>Birds</b>							
Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill					O
Pardalotidae	<i>Acanthiza nana</i>	Yellow Thornbill				OW	
Pardalotidae	<i>Acanthiza pusilla</i>	Brown Thornbill				O	
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill				OW	O



Family	Scientific Name	Common Name	EPBC Act	Migratory EPBC Act	NSW TSC Act	Obs type previous	Obs type current
Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk				O	
Accipitridae	<i>Accipiter novaehollandiae</i>	Grey Goshawk					A
Sturnidae	<i>Acridotheres tristis</i>	Common Myna			U	OW	
Alaudidae	<i>Alauda arvensis</i>	Skylark			U	W	
Psittacidae	<i>Alisterus scapularis</i>	Australian King-Parrot				OW	
Anatidae	<i>Anas castanea</i>	Chestnut Teal				O	O
Anatidae	<i>Anas gracilis</i>	Grey Teal				O	
Anatidae	<i>Anas platyrhynchos</i>	Mallard					O
Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck				O	O
Meliphagidae	<i>Anthochaera carunculata</i>	Red Wattlebird				OW	O
Meliphagidae	<i>Anthochaera chrysoptera</i>	Little Wattlebird				W	O
Motacillidae	<i>Anthus novaeseelandiae</i>	Richard's Pipit				O	
Ardeidae	<i>Ardea ibis</i>	Cattle Egret	M			O	
Ardeidae	<i>Ardea intermedia</i>	Intermediate Egret					O
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron				O	O
Artamidae	<i>Artamus cinereus</i>	Black-faced Woodswallow					O
Anatidae	<i>Aythya australis</i>	Hardhead				O	O
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo				O	
Cacatuidae	<i>Cacatua roseicapilla</i>	Galah				OW	O
Cacatuidae	<i>Cacatua sanguinea</i>	Little Corella				OW	
Cacatuidae	<i>Cacatua tenuirostris</i>	Long-billed Corella				O	
Cacatuidae	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black-Cockatoo				W	O
Cacatuidae	<i>Calyptorhynchus lathami</i>	Glossy Black-cockatoo			V	O	
Fringillidae	<i>Carduelis carduelis</i>	European Goldfinch			U	O	
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck				O	O
Accipitridae	<i>Circus approximans</i>	Swamp Harrier					O
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				W	O

Family	Scientific Name	Common Name	EPBC Act	Migratory EPBC Act	NSW TSC Act	Obs type previous	Obs type current
Climacteridae	<i>Cormobates leucophaeus</i>	White-throated Treecreeper				W	
Corvidae	<i>Corvus coronoides</i>	Australian Raven				W	OW
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird				O	
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird				W	
Myobatrachidae	<i>Crinia signifera</i>	Common Eastern Froglet				W	W
Cuculidae	<i>Cuculus pallidus</i>	Pallid Cuckoo				W	
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra				OW	O
Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird				W	
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron				OW	O
Accipitridae	<i>Elanus axillaris</i>	Black-shouldered Kite				O	
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin				W	OW
Cuculidae	<i>Eudynamys scolopacea</i>	Common Koel				W	
Falconidae	<i>Falco cenchroides</i>	Nankeen Kestrel				O	O
Falconidae	<i>Falco peregrinus</i>	Peregrine Falcon				O	
Rallidae	<i>Fulica atra australis</i>	Eurasian Coot					O
Columbidae	<i>Geopelia humeralis</i>	Bar-shouldered Dove				W	
Artamidae	<i>Grallina cyanoleuca</i>	Magpie-lark				OW	OW
Artamidae	<i>Gymnorhina tibicen</i>	Australian Magpie				OW	OW
Accipitridae	<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	M			O	
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow				O	O
Columbidae	<i>Leucosarcia melanoleuca</i>	Wonga Pigeon				W	
Columbidae	<i>Lopholaimus antarcticus</i>	Topknot Pigeon				O	
Columbidae	<i>Macropygia amboinensis</i>	Brown Cuckoo-Dove				OW	
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren				OW	
Maluridae	<i>Malurus lamberti</i>	Variiegated Fairy-wren					OW
Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner				OW	OW
Meliphagidae	<i>Meliphaga lewinii</i>	Lewin's Honeyeater				W	W



Family	Scientific Name	Common Name	EPBC Act	Migratory EPBC Act	NSW TSC Act	Obs type previous	Obs type current
Meliphagidae	<i>Meliphaga lewinii</i>	Lewin's Honeyeater				W	
Dicruridae	<i>Monarcha melanopsis</i>	Black-faced Monarch	M			OW	
Dicruridae	<i>Myiagra inquieta</i>	Restless Flycatcher				W	
Passeridae	<i>Neochmia temporalis</i>	Red-browed Finch				OW	
Strigidae	<i>Ninox novaeseelandiae</i>	Southern Boobook				W	
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon				OW	
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole				W	
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler				W	
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote				W	O
Passeridae	<i>Passer domesticus</i>	House Sparrow			U	O	
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican				O	O
Hirundinidae	<i>Petrochelidon ariel</i>	Fairy Martin					O
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant					O
Phalacrocoracidae	<i>Phalacrocorax varius</i>	Pied Cormorant				O	O
Psittacidae	<i>Platycercus elegans</i>	Crimson Rosella				OW	OW
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella				OW	OW
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth				O	
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphen				O	O
Cinclosomatidae	<i>Psophodes olivaceus</i>	Eastern Whipbird				W	W
Pteropodidae	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	VU		V	OW	
Ptilonorhynchidae	<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird				O	
Pycnonotidae	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul			U	O	
Dicruridae	<i>Rhipidura albiscapa</i>	Grey Fantail				W	OW
Dicruridae	<i>Rhipidura leucophrys</i>	Willie Wagtail				OW	OW
Dicruridae	<i>Rhipidura rufifrons</i>	Rufous Fantail	M			W	O

Family	Scientific Name	Common Name	EPBC Act	Migratory EPBC Act	NSW TSC Act	Obs type previous	Obs type current
Cuculidae	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo				O/W	
Artamidae	<i>Strepera graculina</i>	Pied Currawong				W	
Columbidae	<i>Streptopelia chinensis</i>	Spotted Turtle-Dove			U	W	
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe				O	O
Threskiornithidae	<i>Threskiornis molucca</i>	Australian White Ibis				O	O
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis				O	O
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher				O/W	
Psittacidae	<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet				O	
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet				O/W	O
Turdidae	<i>Turdus merula</i>	Eurasian Blackbird			U	O	O
Zosteropidae	<i>Zosterops lateralis</i>	Silvereye				O/W	
<b>Mammals</b>							
Dasyuridae	<i>Antechinus sp.</i>	Unidentified Antechinus					A
Cervidae	<i>Cervus timorensis</i>	Rusa Deer			U	O	
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	VU		V	AD	
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat				AD	
Vespertilionidae	<i>Chalinolobus morio</i>	Chocolate Wattled Bat				AD	
Leporidae	<i>Lepus capensis</i>	Brown Hare			U	O	O
Macropodidae	<i>Macropus giganteus</i>	Eastern Grey Kangaroo				O	
Vespertilionidae	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	CD		V	AD	
Molossidae	<i>Mormopterus norfolkensis</i>	Eastern Freetail Bat			V	AD/AP	
Vespertilionidae	<i>Myotis macropus</i>	Large-footed Myotis			V	AD/AP	
Vespertilionidae	<i>Nyctophilus sp.</i>	Long-eared bat				AD/AP	
Leporidae	<i>Oryctolagus cuniculus</i>	Rabbit			U	O	



Family	Scientific Name	Common Name	EPBC Act	Migratory EPBC Act	NSW TSC Act	Obs type previous	Obs type current
Petauridae	<i>Petaurus breviceps</i>	Sugar Glider				W	SC
Rhinolophidae	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat				AD	
Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat			V	AD/AP	
Vespertilionidae	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat			V	AP	
Vespertilionidae	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat				AP	
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna				O	A
Molossidae	<i>Tadarida australis</i>	White-striped Freetail Bat				W	
Phalangeridae	<i>Trichosurus vulpecula</i>	Common Brushtail Possum				R	
Vespertilionidae	<i>Vespadelus darlingtoni</i>	Large Forest Bat				AD/AP	
Vespertilionidae	<i>Vespadelus regulus</i>	Southern Forest Bat				AP	
Vespertilionidae	<i>Vespadelus vulturnus</i>	Little Forest Bat				AD/T	
Vombatidae	<i>Vombatus ursinus</i>	Common Wombat				O/P	Burrow
Canidae	<i>Vulpes vulpes</i>	Fox			U	O	
Macropodidae	<i>Wallabia bicolor</i>	Swamp Wallaby					A
<b>Reptiles</b>							
Elapidae	<i>Acanthophis antarcticus</i>	Common Death Adder					A
Chelidae	<i>Chelodina longicollis</i>	Eastern Long-necked Tortoise				R	O
Scincidae	<i>Ctenotus robustus</i>	Striped Skink				O	
Scincidae	<i>Eulamprus quoyii</i>	Eastern Water Skink				O	O
Scincidae	<i>Lampropholis delicata</i>	Grass Skink				O	O
Agamidae	<i>Physignathus lesueurii</i>	Eastern Water Dragon				O	O
Elapidae	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake				O	O
Elapidae	<i>Pseudonaja textilis</i>	Eastern Brown Snake					A
Scincidae	<i>Tiliqua scincoides</i>	Eastern Blue-tongued Lizard				O	A

# Appendix B

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Threatened species and populations  
likelihood of occurrence



## Appendix B – Threatened species and populations likelihood of occurrence

Table A2-1 Threatened flora species and populations recorded from the Atlas of NSW Wildlife and EPBC Act PMST 10 kilometre search area.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Acacia pubescens</i>	Downy Wattle	VU	V	<p><i>Acacia pubescens</i> is found in Sydney Metropolitan, and Hawkesbury/Nepean Catchment Management Region, with concentrated populations around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon.</p> <p>It occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravelly soils, often with ironstone. The species occurs in open woodland and forest, in a variety of plant communities, including Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland. Flowers from August to October. The pods mature in October to December.</p>	1 (Atlas of NSW Wildlife)	2003	Low. The study area does not provide preferred habitat for the species. The single record of the species at South Nowra dates for ten years.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Asterolasia elegans</i>		EN	E1	Occurs in the north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby local government areas. Also likely to occur in the western part of Gosford LGA. Known from only six populations in the catchments of the Colo and Hawkesbury Rivers, only one of which is wholly within a conservation reserve. Found in sheltered forests on mid- to lower slopes and valleys which support sheltered forest on Hawkesbury Sandstone. The canopy at known sites includes <i>Syncarpia glomulifera</i> , <i>Angophora costata</i> , <i>Eucalyptus piperita</i> , <i>Allocasuarina torulosa</i> and <i>Ceratopetalum gummiferum</i> . The species is considered to be fire sensitive and reliant on seed germination after disturbance to maintain populations. A soil seedbank appears to be established by this species, so for a number of years following fire or other disturbance the species may not be apparent, but be present only as seed in the soil. The size of the seedbank depends not only on the amount of seed contributed by mature plants each season, but on the level of dormancy of the seed which can vary from year to year. The longevity of each crop of seed in the soil is perhaps five - 10 years.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area does not provide preferred habitat for the species. The study area is outside the species known natural distribution.



Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Boronia deanei</i>	Deane's Boronia	VU	V	Occurs in Hawkesbury/Nepean and Southern Rivers Catchments. There are scattered populations of Deane's Boronia between the far south-east of NSW and the Blue Mountains. The species grows on the margins of high altitude swamps, in wet heath and in drier open forest on low nutrient, poorly drained peaty soils on sandstone or granite.	1 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1965	Low. The study area does not provide preferred habitat for the species. The single record of the species near Budderoo is on the plateau beyond the Illawarra Escarpment.
<i>Chamaesyce psammogeton</i>	Sand Spurge		E1	Sand Spurge is a herb that forms mats to one metre across. The species grows on fore-dunes, pebbly strandlines and exposed headlands, often with <i>Spinifex sericeus</i> and <i>Zoysia micrantha</i> . Flowering occurs in spring and summer and the floating seeds dispersed on the ocean and other coastal waterways. Sand Spurge is found sparsely along the coast from south of Jervis Bay (at Currarong, Culburra and Seven Mile Beach National Park) to Queensland (and Lord Howe Island). Populations have been recorded in Wamberal Lagoon Nature Reserve, Myall Lakes National Park, Moonee Beach Nature Reserve and Bundjalung National Park.	1 (Atlas of NSW Wildlife)	1987	Low. The study area does not provide preferred habitat for the species. The single record of the species in Seven Mile Beach National Park occurs in coastal dunes.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	VU	V	<p>This species does not have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.</p> <p>The larger populations typically occur in woodland dominated by <i>Eucalyptus sclerophylla</i> Scribbly Gum, <i>E. sieberi</i> Silvertop Ash, <i>Corymbia gummifera</i> Red Bloodwood and <i>Allocasuarina littoralis</i> Black Sheoak. The species appears to prefer open areas in the understorey of this community and is often found in association with the <i>Cryptostylis subulata</i> Large Tongue Orchid and <i>Cryptostylis erecta</i> Tartan Tongue Orchid.</p> <p>The Leafless Tongue Orchid has been recorded from Gibraltar Range National Park in the north and south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites).</p>	5 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2005	Medium. The study area supports potential habitat for the species and it has a cryptic habit.



Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Cynanchum elegans</i>	White-flowered Wax Plant	EN	E1	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. Catchment Management Regions include Hawkesbury/Nepean, Hunter/Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan. <i>Cynanchum elegans</i> usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; <i>Leptospermum laevigatum</i> , <i>Banksia integrifolia</i> ssp. <i>integrifolia</i> ; <i>Eucalyptus tereticornis</i> open forest and woodland; <i>Corymbia maculata</i> open forest and woodland; and <i>Melaleuca armillaris</i> scrub to open scrub. Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific.	None (predicted habitat from EPBC Act PMST)	None	Low. Although some habitat in the form of <i>Corymbia maculata</i> open forest is present, the nearest record of the species which is outside the search area at Rose Valley represents the southern extent of the species known distribution.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Daphnandra johnsonii</i>	Illawarra Socketwood	EN		Occupies the rocky hillsides and gully slopes of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes. Associated soils are loams and clay loams derived from volcanic or fertile sedimentary rocks. Vegetation types the species is associated with include Illawarra Escarpment Subtropical Rainforest, Lowland Dry Subtropical Rainforest, Moist Coastal White Box Forest and Moist Box - Red Gum Foothills Forest. The species is occasionally found in moist Eucalypt forest in association with <i>Eucalyptus tereticornis</i> , <i>Eucalyptus pilularis</i> , <i>Eucalyptus quadrangulata</i> or <i>Casuarina cunninghamiana</i> . The species is endemic to the Illawarra region of NSW where it has been recorded from 41 sites within the local government areas (LGAs) of Wollongong, Shellharbour, Kiama and Shoalhaven. The main distribution extends from Avondale in Wollongong LGA to Toolijooa in Kiama LGA, a distance of 27 kilometres. An outlying site at Scarborough (northern Wollongong LGA) is located approximately 35 kilometres north of this main distribution. The species western distributional limit follows the upper slopes of the Illawarra escarpment.	34 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2006	Low. Although marginal habitat in the form of open forest is present. The nearest record of the species at Broughton Vale, north of the study area, represents the southern extent of the species known distribution.



Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Eucalyptus langleyi</i>	Albatross Mallee	VU	V/E2	<p>The Albatross Mallee occurs inland west and south-west of Nowra on the south coast of NSW. The main occurrence of the species is to the south-west of Nowra as far as Yarramunmun Creek and on rocky outcrops near the Tomerong-Yerriyong area. A series of fragmented stands across approximately 1.3 square kilometres on both sides of the boundary between Bomaderry Creek Regional Park and land owned by Shoalhaven City Council and some other scattered records found north of the Shoalhaven River form the endangered population of the species. The main occurrences of the species are on shallow, poorly drained sandy soils over sandstone or associated with laterite. It also occurs on plateaux in highly dissected areas, often in heath patches surrounded by woodland of <i>Corymbia gummifera</i>, <i>Eucalyptus consideriana</i> and a 'Scribbly Gum'.</p> <p>The endangered northern population occurs on skeletal soils on rocky sloping Nowra Sandstone outcrops along Bomaderry Creek, in woodland dominated by <i>Eucalyptus punctata</i>, but sometimes with <i>Corymbia maculata</i> present. The woodland habitat has a shrubby midstorey comprising species such as <i>Pittosporum undulatum</i>, <i>Kunzea ambigua</i>, <i>Melaleuca armillaris</i>, <i>Allocasuarina littoralis</i>, <i>Leptospermum</i> spp. and <i>Ficus coronata</i>.</p>	14 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2007	Low. Although marginal habitat in the form of Currumbene Batemans Lowlands Forest is present the species is conspicuous and was not recorded in areas of marginal habitat likely to be disturbed.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Genoplesium baueri</i>	Bauer's Midge Orchid		V	<i>Genoplesium baueri</i> grows in dry sclerophyll forest and moss gardens over sandstone on well drained sandy and gravelly soil. The species has been recorded from locations between Ulladulla and Port Stephens with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. The species is highly localised and is currently known from just over 200 plants across 13 sites.	9 (Atlas of NSW Wildlife)	2006	Medium. The study area supports potential habitat for the species and it has a cryptic habit.
<i>Lastreopsis hispida</i>	Bristly Shield Fern		E1	The species is rare in NSW with the only recent confirmed records from Mt Wilson in the Blue Mountains. Also occurs in southern Victoria and Tasmania. <i>Lastreopsis hispida</i> grows in moist humus-rich soils in wet forest and rainforest gullies. At Mt Wilson, associated species include <i>Ceratopetalum apetalum</i> , <i>Elaeocarpus holopetalus</i> , <i>Fieldia australis</i> and a range of ferns such as <i>Cyathea australis</i> , <i>Blechnum nudum</i> , <i>Blechnum patersonii</i> and <i>Leptopteris fraseri</i> .	1 (Atlas of NSW Wildlife)	1905	Low. The study area does not provide preferred habitat for the species. The single record of the species near Flying Fox Creek dates over 100 years.



Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	VU	V	<i>Melaleuca biconvexa</i> is only found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Catchment regions include: Hunter/Central Rivers, Hawkesbury/Nepean, Southern Rivers, and Northern River Catchments. The species generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. The species can occur in dense stands forming a narrow strip adjacent to watercourses, in association with other <i>Melaleuca</i> species or as an understorey species in wet forest types.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area provides some broad habitat in the form of coastal floodplain. However the species is conspicuous and was not recorded in the current surveys. The nearest most recent record is outside the search area to the south at Woollamia.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Melaleuca deanei</i>	Deane's Paperbark	VU	V	<i>Melaleuca deanei</i> is endemic to the Sydney Basin Bioregion with its main occurrence in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas. <i>Melaleuca deanei</i> mostly occupies broad flat ridgetops, dry ridges and slopes. The species is strongly associated with sandy loam soils that are low in nutrients, sometimes with ironstone present. <i>Melaleuca deanei</i> occurs in a wide range of vegetation communities including forest, open forest, woodland and open woodland, heathland and shrubland.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area provides some preferred habitat in the form of vegetation association and soil type. However the species is conspicuous and was not recorded in the current surveys. The nearest most recent record is outside the search area to the south west at Colymea State Area.
<i>Pelargonium</i> sp. Striatellum (G.W.Carr 10345)	Omeo Stork's-bill	EN		<i>Pelargonium</i> sp. Striatellum (G.W.Carr 10345) occurs in NSW and Victoria within the South Eastern Highlands and South East Corner IBRA Bioregions In NSW the species is known from the Hawkesbury-Nepean, Murrumbidgee, Southern Rivers and North East Natural Resource Management Regions. The species is usually located just above the high water level of irregularly inundated or ephemeral lakes. During dry periods, the species is known to colonise exposed lake beds.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area does not provide preferred habitat for the species. The nearest most recent record is outside the search area to the south west near Canberra.



Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Pimelea spicata</i>	Spiked Rice-flower	EN	E1	<i>Pimelea spicata</i> occurs in two disjunct areas, the Cumberland Plain and the Illawarra. Catchment areas are Hawkesbury/Nepean, Southern Rivers, and Sydney Metropolitan Catchment. In western Sydney, the species occurs on an undulating topography of substrates derived from Wianamatta Shale in areas supporting, or that previously supported Cumberland Plain Woodland. Associated species include: <i>Eucalyptus moluccana</i> , <i>Eucalyptus tereticornis</i> , <i>Eucalyptus crebra</i> , <i>Bursaria spinosa</i> , and <i>Themeda australis</i> . In the Illawarra region, <i>Pimelea spicata</i> is found in open woodland and also in coastal grassland communities with emergent shrubs. Dominant species within the woodland habitat include <i>Eucalyptus tereticornis</i> , <i>Eucalyptus eugenioides</i> , <i>Themeda australis</i> , and <i>Lomandra longifolia</i> . In the coastal Illawarra it occurs commonly in Coast Banksia open woodland with a more well developed shrub and grass understorey.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area provides some preferred habitat in the form of vegetation association. The nearest most recent record is outside the search area to the north east at Gerroa. The species is highly restricted in coastal habitats of the south coast.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	EN	E1	Known from a small number of populations in the Hunter region, the Illawarra region and the Shoalhaven region and is likely to be extinct in western Sydney. All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by <i>Eucalyptus tereticornis</i> , <i>Eucalyptus longifolia</i> and <i>Melaleuca decora</i> . Near Nowra, the species grows in an open forest of <i>Corymbia maculata</i> , <i>Eucalyptus tereticornis</i> and <i>Eucalyptus paniculata</i> . In the Hunter region, the species grows in open woodland dominated by <i>Eucalyptus crebra</i> , Forest Red Gum and <i>Callitris endlicherii</i> . The Illawarra Greenhood 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.	76 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2007	Medium. The study area supports potential habitat for the species and it has a cryptic habit.
<i>Pterostylis pulchella</i>	Waterfall Greenhood	VU	V	<i>Pterostylis pulchella</i> has a limited distribution and has been recorded at Fitzroy Falls, Belmore Falls, upper Bundanoon Creek (Meryla) and Minnamurra Falls. The species is found on cliff faces close to waterfalls and creek banks and mossy rocks alongside running water.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area does not provide preferred habitat for the species. The nearest most recent record is outside the search area to the northwest Barrengarry.



Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Pterostylis vernalis</i>	Spring Tiny Greenhood	CE	CE	<i>Pterostylis vernalis</i> is only known from five populations located to the west and south-west of Nowra. Four are within a few kilometres of each other, and one is located approximately 18 kilometres to the south-west. The total population is approximately 450-500 known individuals. This species of orchid grows in heath and heathy forests. It is most commonly found in open sites in shallow sandy soil and moss gardens around the margins of sandstone sheets with associated dwarf heaths and sedges. It is also found in moss beneath taller shrubs, particularly <i>Kunzea ambigua</i> and <i>Leptospermum sejunctum</i> . The species is associated with soil of a specific moisture regime, where the flow of water through the profile is inhibited by the underlying rock strata.	16 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2011	Low. The study area does not provide preferred habitat for the species. The species is highly restricted due to its highly specific habitat requirements. The nearest most recent record is six kilometres south of the study area.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Rhizanthella slateri</i>	Eastern Australian Underground Orchid	EN	V/E2	Occurs from south-east Queensland to south-east NSW. In NSW, currently known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Jervis Bay. Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest. Highly cryptic given that it grows almost completely below the soil surface, with flowers being the only part of the plant that can occur above ground. Therefore usually located only when the soil is disturbed. Flowers October to November.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area provides some preferred habitat in the form of vegetation association. The nearest most recent record is outside the search area to the south at Falls Creek.
<i>Solanum celatum</i>			E1	Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing. Grows in rainforest clearings, or in wet sclerophyll forest	7 (Atlas of NSW Wildlife)	1978	Low. The study area provides some preferred habitat in the form of vegetation association. However the species is conspicuous and was not recorded in the current surveys.



Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	VU	E1	Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea. Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities. The species occurs in the following Catchment Authority Regions - Hunter/Central Rivers, Hawkesbury/Nepean, Sydney Metropolitan, and Southern Rivers.	1 (Atlas of NSW Wildlife)	2004	Low. The study area provides some marginal habitat in the form of vegetation association. However the species is conspicuous and was not recorded in the current surveys.
<i>Thelymitra</i> sp. Kangaloon	Kangaloon Sun-orchid	CE	E4	<i>Thelymitra</i> sp. Kangaloon is only known to occur on the southern tablelands of NSW in the Moss Vale to Kangaloon to Fitzroy Falls area at 550-700 metres above sea level. It is known to occur at three swamps that are above the Kangaloon Aquifer. These swamps are a part of the ecological community Coastal Upland Swamp. It is likely that the number of mature individuals of <i>Thelymitra</i> sp. Kangaloon is very low, with less than 250 plants known. The species occurs in swamps in sedgeland over grey silty grey loam soils.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area does not provide preferred habitat for the species. The species is highly restricted in geographic range and due to highly specific habitat requirements.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Thesium australe</i>	Austral Toadflax	VU	V	Found in very small to large populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. <i>Thesium australe</i> is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass. It is often found in damp sites in association with <i>Themeda australis</i> , but also found on other grass species at inland sites. Occurs on clay soils in grassy woodlands or coastal headlands.	None (predicted habitat from EPBC Act PMST)	None	Medium. The study area provides some marginal habitat in the form of vegetation association and the species has a cryptic habit.
<i>Triplarina nowraensis</i>	Nowra Heath Myrtle	EN	E1	There are five known populations of Nowra Heath Myrtle. Three of these form a cluster to the immediate west of Nowra. A fourth, much smaller population is found 18kilometres south-west of Nowra in the Boolijong Creek Valley. The fifth population is located north of the Shoalhaven River on the plateau above Bundanon. Nowra Heath Myrtle occurs on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone. The sites are often either treeless or have a very open tree canopy due to the impeded drainage.	16 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2012	Low. The study area does not provide preferred habitat for the species. The species is highly restricted in geographic range and due to highly specific habitat requirements.



Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Zieria baeuerlenii</i>	Bomaderry Zieria	EN	E1	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 by one kilometre area of the bushland, and are found on both sides of Bomaderry Creek. Bomaderry Zieria occurs on skeletal sandy loam overlaying sandstone, on a rocky plateau amongst sandstone boulders in either shrubby open forest, shrubby woodland or closed scrub.	298 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2004	Low. The distribution of the species is well studied and documented. The species is highly restricted in geographic range. The species highly specific habitat is not present in the study area.
<i>Zieria granulata</i>	Illawarra Zieria	EN	E1	Occurs in the Kiama district where it grows on dry rocky ridges in sclerophyll forest to rainforest margins. The species primarily occupies the coastal lowlands between Oak Flats and Toolijooa, in the local government areas of Shellharbour and Kiama. The typical habitat is dry ridge tops and rocky outcrops on shallow volcanic soils. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying areas on Quaternary sediments. Associated vegetation includes <i>Melaleuca armillaris</i> scrub, <i>Eucalyptus tereticornis</i> woodland and rainforest margins, although the species has been recorded from a number of other vegetation types	14 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2006	Low. The study area provides some marginal habitat in the form of vegetation association. However the species is conspicuous and was not recorded in the current surveys.

Scientific Name	Common Name	EPBC Act	TSC Act	Habitat requirements	Number of records in search area (source)	Most recent record in search area	Likelihood of occurrence
<i>Zieria tuberculata</i>	Warty Zieria	VU	V	Warty Zieria grows in the Mt Dromedary and Tilba Tilba area. The population in the Cambewarra Mountain area near Nowra is now referable to a separate taxon. The Warty Zieria grows in heath amongst rocky outcrops on rain forest edges and in tall forest and shrubland. Now known only from Little Dromedary Mt and the lower eastern slopes of Mt Dromedary in the Central Tilba area on the South Coast of NSW, the species has a geographic range of six kilometre. In 1931, it was collected from Good Dog Mountain in the Cambewarra Range, north of Nowra but more recent searches have failed to find the species there. Although this site is now heavily revegetated, the species may have been eliminated from the area as a result of earlier clearing and grazing. The total known population of about 900 plants grows at eight sites. Four populations are on private property. Three of the smaller populations totalling about 60 plants occur within Gulaga National Park and the Little Dromedary Mt population is on crown land.	1 (Atlas of NSW Wildlife)	1931	Low. The distribution of the species is well studied and documented. The species is highly restricted in geographic range.



Table A2-2 Threatened fauna species and populations recorded from the Atlas of NSW Wildlife and EPBC Act PMST 10 kilometre search area.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
Birds							
<i>Anthochaera phrygia</i>	Regent Honeyeater	E4A	EN	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>E. 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. Regent Honeyeaters 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.	3 (Atlas of NSW Wildlife)	1993	Low. Potential foraging habitat present within the Currumbene lowlands forest with the presence of preferred feed tree species ( <i>Corymbia maculata</i> ). Previously recorded at one location within 10 kilometre of the study area; approximately 4.5 kilometre to the south. 0.83 hectares of disturbed roadside Currumbene lowlands forest would be removed by the proposal, which equates to only 0.02per cent of the occurrence of the plant community within the locality. Given that the Regent Honeyeater is a rare visitor east of the divide and that no breeding resources would be impacted, no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E1	EN	The Australasian Bittern is 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 this bird 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.	8 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2008	Medium. Uncommon species in the Shoalhaven, however recent sightings have been recorded in the Illawarra. Limited potential habitat occurs within the study area in the form of dams and wetlands with dense fringing and emergent vegetation. Given the proximity and connectivity to suitable habitats of Coomonderry Swamp, a seven part test has been prepared for this species.
<i>Burhinus grallarius</i>	Bush Stone-curlew	E1		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.	4 (Atlas of NSW Wildlife)	2007	Medium. Previously recorded west, south and south east of the study area adjacent to the Shoalhaven River and associated with areas of floodplain and/or intact woodland. Potential habitat occurs within the forests and surrounding farmland of the study area, therefore a seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Calidris alba</i>	Sanderling	V		Occurs on the coast mostly on open sand beaches exposed to open sea-swells.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<i>Calidris ferruginea</i>	Curlew Sandpiper	E1		Inhabits sheltered intertidal mudflats. Also non-tidal swamps, lagoons and lakes near the coast. Infrequently recorded inland.	6 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1987	Low. The study area does not provide preferred habitat for the species. No breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<i>Calidris tenuirostris</i>	Great Knot	V		Mainly found on intertidal mudflats, sand flats and sandy beaches.	4 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2000	Low. The study area does not provide preferred habitat for the species. No breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	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 typically in high forests during summer for nesting.	23 (Atlas of NSW Wildlife)	2012	High. The study area supports potential foraging habitat for the species within the Forest of the study area. The Gang-gang Cockatoo has been recorded previously to the north, south, east and west of the study area. A total of 17 hollow-bearing trees would be directly impacted by the proposal and an additional nine may be indirectly impacts. Although the species typically nests in high forest, a precautionary approach has been adopted given the number of records of the species in the locality. A seven part test has been prepared for this species.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	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. Breeds in hollows stumps or limbs, either living or dead.	281 (Atlas of NSW Wildlife)	2012	High. The study area supports potential and known foraging and nesting habitat for the species within the study area. The Glossy Black-Cockatoo has been recorded previously within the study area in Bomaderry and to the south west and south east within the locality. Given the presence of the species within the study area and the potential loss of potentially limiting breeding resources (ie tree hollows), and foraging (ie Allocasuarina littoralis) resources, a seven part test has been prepared for this species.
<i>Charadrius leschenaultii</i>	Greater Sand-plover	V		Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries and roosting during high tide on sandy beaches or rocky shores. Individuals have been recorded on inshore reefs, rock platforms, small rocky islands and sand cays on coral reefs, within Australia. Occasional sightings have also occurred on near-coast saltlakes, brackish swamps, shallow freshwater wetlands and grassed paddocks.	1 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1981	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Charadrius mongolus</i>	Lesser Sand-plover	V		In Australia, the species is known to favour coastal environments including beaches, mudflats and mangroves. Within NSW, individuals have been observed on intertidal sand and mudflats in estuaries or roosting on sandy beaches or rocky shores at high tide.	6 (Atlas of NSW Wildlife)	1987	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<i>Circus assimilis</i>	Spotted Harrier	V		The Spotted Harrier is 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. The Spotted Harrier is 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 and unlike other harriers, the Spotted Harrier nests in trees.	4 (Atlas of NSW Wildlife)	1987	Low. The study area does provide habitat suitable for the Spotted Harrier and the species has previously recorded to the south of the study area within Bomaderry, east within Berry and south of the Shoalhaven River in the 1980's. However, given the high mobility of the species and the lack of recent records following surveys, no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V		The Varied Sittella is 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. The Varied Sittella 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.	20 (Atlas of NSW Wildlife)	2011	Medium. The study area provides a small portion of habitat suitable for the Varied Sittella in the woodland to the south of the study area. The species has also been previously recorded to the south west, north east and south east of the study area. Being a sedentary species, the closest record of the species is along Bomaderry Creek 700 metres from the study area. It may be likely that the species utilises the woodland habitat of the study area on occasion, therefore a seven part test has been prepared.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E1	EN	Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands.	11 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2009	Low. The study area does contain potential sub-optimal foraging and dispersal habitat for the species, however the species is contained to four distinct populations within the broader locality. Closest records for the species are located to the west of the study area in Budderoo National Park, and the north-west in Barren Grounds Nature Reserve. No limiting breeding or foraging resources for the species would be impacted by the proposed development and therefore no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E1		Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water.	2 (Atlas of NSW Wildlife)	1974	Low. The study area does provide sub-optimal habitat suitable for the Black-necked Stork, however the species has only be recorded within the locality once (duplicate record over 30 years old). Within the study area, the species may forage within farmland, including farm dams. No limiting breeding or foraging resources would be impacted by the proposal. The loss of non-limiting farmland habitat and approximately 0.34 ha non-limiting riparian habitats is not likely to impact this species. No seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Epthianura albifrons</i>	White-fronted Chat	V		Sydney Metropolitan CMA: The White-fronted Chat occupies foothills and lowlands below 1000 metre above sea level. In NSW it occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state. The White-fronted Chat is 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 one 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, saltlakes and salt pans that are along the margins of rivers and waterways. In the Sydney region nests have been observed in low isolated mangroves. An Endangered Population occurs in the Sydney Metropolitan CMA area, at Newington Nature Reserve near Homebush and at Towra Point Nature Reserve.	12 (Atlas of NSW Wildlife)	2004	Low. The study area does contain potential sub-optimal foraging and dispersal habitat for the species. No limiting breeding or foraging resources for the species would be impacted by the proposal. No seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Erythrotriorchis radiatus</i>	Red Goshawk	E4A	VU	Occur in forest and woodland habitat near permanent water. In NSW prefer Melaleuca swamp forest and open eucalypt woodland. Require greater than 20 metre tall trees for nesting.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area contains potential suitable nesting and foraging habitat for the Red Goshawk. However it has never been recorded within the locality. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<i>Esacus magnirostris</i>	Beach Stone-curlew	E4A		Occurs on open, undisturbed beaches, islands, reefs and estuarine intertidal sand and mudflats.	1 (Atlas of NSW Wildlife)	2002	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Glossopsitta pusilla</i>	Little Lorikeet	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 two metres and 15 metres, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.	6 (Atlas of NSW Wildlife)	2004	Medium. Potential foraging and nesting habitat within the study area. Previously recorded south west and east of the study area. Within the study area the species may forage on nectar and pollen within the forest patches and nest in tree hollows (although none of the preferred tree species occur in the study area). Given the loss of potential limiting breeding resources (ie tree hollows), a seven part test has been prepared for this species.
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V		The Sooty Oystercatcher is found on undisturbed tidal rocks on ocean shores and islands. Occasionally it is observed on sand spits and mudflats. It forages on exposed rock or coral at low tide for limpets and mussels. The Sooty Oystercatcher breeds in spring and summer almost exclusively offshore or on isolated promontories	3 (Atlas of NSW Wildlife)	1985	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Haematopus longirostris</i>	Pied Oystercatcher	E1		An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Its food supply (beach macroinvertebrate) have been negatively affected by human impacts. The Pied Oystercatcher is restricted to the littoral zone of beaches and estuaries, nesting on the ground above the tideline. A pair will re-nest in the same spot each year, rarely shifting their territory. Occasionally the Pied Oystercatcher is found in paddocks near the coast.	32 (Atlas of NSW Wildlife)	2011	Low. The study area does not provide preferred habitat for the species. Previously recorded south east of the study area at Seven Mile Beach National Park and Coomonderry Swamp. No breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Hieraaetus morphnoides</i>	Little Eagle	V		The Little Eagle is 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. The Little Eagle nests in tall living trees within farmland, woodland and forests.	5 (Atlas of NSW Wildlife)	2008	Medium. Potential foraging habitat within the study area within agricultural land containing scattered trees and forest remnants. Suitable breeding habitat is also present within the study area, although limited. The species has previously been recorded in the locality with the closest record ~500 metres from the study area. Given the high mobility of this species; suitable habitat and, the species' fairly non-specialised breeding requirements (builds a stick nest in a tall, living tree within a remnant patch; (NSW Scientific Committee 2009b), a seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Ixobrychus flavicollis</i>	Black Bittern	V		The Black Bittern is found along the coastal plains within NSW, although individuals have rarely been recorded south of Sydney or inland. It inhabits terrestrial and estuarine wetlands such as flooded grasslands, forests, woodlands, rainforests and mangroves with permanent water and dense waterside vegetation. The Black Bittern typically roosts on the ground or in trees during the day and forages at night on frogs, reptiles, fish and invertebrates. The breeding season extends from December to March. Nests are constructed of reeds and sticks in branches overhanging the water.	5 (Atlas of NSW Wildlife)	2009	Medium. Limited potential habitat occurs within the study area in the form of creeklines and dams/wetlands where dense fringing and emergent vegetation occurs. Not all sections of creekline within the study area are considered potential habitat. Previously recorded south of the study area along the Shoalhaven River and to the north near Broughton Mill Creek. Given the proposal will result in the loss of up to 0.34 hectares of riparian vegetation and loss and/or disturbance of a small number of waterbodies a seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Lathamus discolor</i>	Swift Parrot	E1	EN	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. Favoured feed trees include winter flowering species such as Swamp Mahogany <i>Eucalyptus robusta</i> , Spotted Gum <i>Corymbia maculata</i> , Red Bloodwood <i>C. gummifera</i> , Mugga Ironbark <i>E. sideroxylon</i> , and White Box <i>E. albens</i> . Commonly used lerp infested trees include Grey Box <i>E. microcarpa</i> , Grey Box <i>E. moluccana</i> and Blackbutt <i>E. pilularis</i> . This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability.	2 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1984	Medium. Potential habitat occurs within the study area within the eucalypt forest patches particularly where preferred feed trees species such as <i>Corymbia maculata</i> , <i>C. gummifera</i> and <i>Eucalyptus pilularis</i> are present. Previously recorded once, approximately nine kilometre to the south east. Although no breeding habitat occurs, given the proposed removal of three preferred feed tree species, a seven part test has been prepared for this species.
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	V		Occurs in sheltered parts of coasts, such as estuaries, harbours, embayments and lagoons, which have shell or sandbanks nearby.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Limosa limosa</i>	Black-tailed Godwit	V		Mainly coastal, usually in sheltered bays, estuaries and lagoons with large intertidal mudflats or sand flats.	7 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1989	Low. The study area does not provide preferred habitat for the species. Previously recorded south east of the study area on the Shoalhaven River. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<i>Lophoictinia isura</i>	Square-tailed Kite	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 (Atlas of NSW Wildlife)	2011	High. The study area does provide habitat for the species. Previously recorded just south and south west of the study area within and around Bomaderry. Also previously recorded south east of the study area. Given the high mobility of this species including a hunting range greater than 100 kilometre square (DEC 2005), and the presence of suitable habitat in the form of agricultural land containing scattered trees and riparian vegetation, a seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Neophema chrysogaster</i>	Orange-bellied Parrot	E4A	CE	A single breeding population of fewer than 200 individuals occurs in a narrow coastal strip of south-west Tasmania. Adult birds depart Tasmania for the mainland in February. The first adults begin leaving the mainland for Tasmania in September with the last birds having departed by November. It is a coastal species inhabiting saltmarshes, sedgeplains, coastal dunes, pastures, shrublands and moorlands, generally within 10 kilometres of the coast. Critical winter habitat for the species includes natural saltmarshes dominated by <i>Sarcocornia quinqueflora</i> (Beaded Glasswort) and <i>Sclerostegia arbuscula</i> (Shrubby Glasswort), as well as the associated grassy or weedy pastures. Historical records indicate that the Orange-bellied Parrot was formerly more abundant and widespread in NSW than it is now, however the species' distribution continues to extend into south-eastern NSW where suitable habitat is still available.	1 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1986	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Neophema pulchella</i>	Turquoise Parrot	V		Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs. Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies. Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist.	1 (Atlas of NSW Wildlife)	1975	Medium. Potential limiting breeding resources present within the study area (ie tree hollows). The species has previously been recorded north and south of the study area. Within the study area the Turquoise Parrot may forage within the forests and surrounding farmland, and nest in tree hollows. Given the loss of potential limiting breeding resources (ie tree hollows), a seven part test has been prepared for this species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Ninox connivens</i>	Barking Owl	V		Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country. Territories are typically 2000 hectares in NSW habitats.	1 (Atlas of NSW Wildlife)	1992	Medium. The study area supports foraging and limited breeding habitat for the Barking Owl. The species has been recorded once to the west of the study area near Bengalee Creek. It is likely to be highly associated with the intact habitats to the west, although has been observed foraging and nesting in lower lying farmland in the past. It is unlikely that preferred nest sites would be lost, however potentially suitable tree hollows for prey species may be removed. Therefore, a seven part test has been prepared for these species.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Ninox strenua</i>	Powerful Owl	V		The Powerful Owl 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 for the Powerful Owl 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 cm. It has a large home range of between 450 and 1450 hectares.	27 (Atlas of NSW Wildlife)	2009	High. Suitable foraging and breeding habitat present within the study area and the locality, however the foraging habitat within the study area is not considered to be limiting for these mobile species. It is unlikely that preferred nest sites would be lost, however potentially suitable tree hollows for prey species may be removed. Therefore, a seven part test has been prepared for this species.
<i>Oxyura australis</i>	Blue-billed Duck	V		Almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora.	2 (Atlas of NSW Wildlife)	1985	Low. The study area does provide some small scaled, sub-optimal habitat for the species, however the locality lacks the presence of any large scale wetlands or water bodies. No limiting breeding or foraging resources would be impacted by the proposed development and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Pachycephala olivacea</i>	Olive Whistler	V		Found in a range of habitats including alpine thickets, wetter rainforest/woodlands, riparian vegetation and heaths.	7 (Atlas of NSW Wildlife)	1993	Low. Considered to be a rare visitor in the Shoalhaven. Previously recorded in the 1980's and 1990's to north, west and south west of the study area. Within the study area the species could forage within the forest patches (including riparian forest) and nest in forks of low shrubs. However, no limiting foraging or breeding resources would be impacted. Therefore, no seven part test has been completed.
<i>Pandion cristatus</i>	Osprey	V		Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 kilometres inland along larger rivers. It is water-dependent, hunting for fish in clear, open water. The Osprey 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.	5 (Atlas of NSW Wildlife)	2010	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Petroica boodang</i>	Scarlet Robin	V		During the breeding season the Scarlet Robin 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. The Scarlet Robin 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 two metres above the ground. It is conspicuous in open and suburban habitats.	12 (Atlas of NSW Wildlife)	2010	Medium. The study area provides potential foraging and dispersal habitat for the species within the woodland, forest and riparian areas. The species is known to be a winter visitor to the Shoalhaven and may utilise habitats of farmland areas during the cooler months. Previously recorded north, south, east and west of the study area. The proposal may remove up to 0.02 per cent (2.56 hectares) of potential forest and riparian habitats, therefore a seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Petroica phoenicea</i>	Flame Robin	V		Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. The preferred habitat in summer includes moist eucalyptus forests and open woodlands, whilst in winter it prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January.	1 (Atlas of NSW Wildlife)	1989	Low. The study area provides potential foraging and dispersal habitat for the species within the woodland, forest and riparian areas. The species is known to be a winter visitor to the Shoalhaven and may utilise habitats of farmland areas during the cooler months. The species is known to be a rare winter visitor to the Shoalhaven, with only one previous record of the species from the 1980's recorded in the locality, six kilometres north of the study area. Given the rarity of the species in the locality and that the proposal may remove up to 0.02 per cent of non-limiting habitat, no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Petroica rodinogaster</i>	Pink Robin	V		The Pink Robin is found in dense, dank forests and treefern gullies. During the winter months the Pink Robin disperses north (as far up as the central coast of NSW) and west (as far as the ACT area) into more open forests, woodlands and scrublands.	1 (Atlas of NSW Wildlife)	1989	Low. The study area may provide potential wintering habitat for the Pink Robin, however no limiting breeding or foraging resources would be impacted. The loss of approximately 0.02 per cent (2.56 hectares) non-limiting forest habitat and non-limiting farmland is not likely to impact this species. No seven part test has been completed.
<i>Pezoporus wallicus wallicus</i>	Eastern Ground Parrot	V		Mainly found in heathland, sedgeland or buttongrass plains providing medium to dense cover.	2 (Atlas of NSW Wildlife)	2011	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Rostratula australis</i>	Australian Painted Snipe	E1	VU	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters.	None (predicted habitat from EPBC Act PMST)	None	Low. Not previously recorded within 10 kilometre of the study area. Potential habitat occurs within the study area in the form of farm dams and wetlands with emergent vegetation. Some farm dams surrounded by a grassy seepage area may also provide potential habitat for this species. Given the poor quality of potential habitat in the study area, the absence of records of the species within 10 kilometres and the presence of higher quality potential habitat in the locality (eg Coomonderry Swamp), it is considered unlikely that the loss and/or disturbance of a small number of farm dams/wetlands would impact this species. No seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Sterna albifrons</i>	Little Tern	E1		The Little Tern favours sheltered coasts, harbours, bays, lakes, inlets, estuaries, coastal lagoons and ocean beaches especially with sand-spits and sand islets. It forages over shallow waters close inshore or over sandbars and reefs.	69 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2004	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<i>Sternula nereis nereis</i>	Fairy Tern		VU	The Fairy Tern nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The species roosts on beaches at night	None (predicted habitat from EPBC Act PMST)	None	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<i>Stictonetta naevosa</i>	Freckled Duck	V		The Freckled Duck 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.	1 (Atlas of NSW Wildlife)	1981	Low. Limited potential habitat occurs within the study area at farm dams with dense vegetation. No breeding habitat occurs in the study area. Previously recorded once, south of the study area (south of the Shoalhaven River). The loss and/or disturbance of a small number of farm dams/wetlands is not likely to impact this species. No seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Thalassarche cauta</i>	Shy Albatross	V	VU	The Shy Albatross is a marine pelagic species inhabiting sub-antarctic and subtropical waters, spending the majority of its time at sea. Occasionally it is observed in continental shelf waters in bays and harbours.	1 (Atlas of NSW Wildlife)	1990	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<i>Thinornis rubricollis</i>	Hooded Plover	E4A		Prefers sandy ocean beaches, especially those that are broad and flat.	1 (Atlas of NSW Wildlife)	1987	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Tyto novaehollandiae</i>	Masked Owl	V		The Masked Owl may be 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. It nests 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. Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet. It has a large home range of between 500 to 1000 hectares.	4 (Atlas of NSW Wildlife)	1996	Medium. The study area supports foraging and breeding habitat for the Masked Owl, however the foraging habitat is not considered to be limiting for these mobile species. The species has been recorded to the east of the study area within Seven Mile Beach National Park, and to the south west within the Shoalhaven River corridor. Although it is unlikely that preferred nest sites would be lost, potentially suitable tree hollows may be removed. Therefore, a seven part test has been prepared for these species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Tyto tenebricosa</i>	Sooty Owl	V		The Sooty Owl is often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW it is mostly found on escarpments with a mean altitude less than 500 metres. Nests in hollows of tall emergent trees, mainly eucalypts often located in gullies. Nests have been located in trees 125 to 161 cm in diameter.	17 (Atlas of NSW Wildlife)	2005	Medium. The study area supports sub-optimal foraging habitat for the Sooty Owl, however the foraging habitat is not considered to be limiting for these mobile species. This species has been recorded numerous times to the west of the Study Area, preferring the rainforest habitat found at the base of the escarpment. Although it is unlikely that preferred nest sites would be lost, potentially suitable tree hollows may be removed. Therefore, a seven part test has been prepared for these species.
<i>Xenus cinereus</i>	Terek Sandpiper	V		Mainly found on saline intertidal mudflats in sheltered estuaries, embayments, harbours and lagoons.	2 (Atlas of NSW Wildlife)	2001	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
Amphibians							
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	VU	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 of its 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 metres from breeding sites.	7 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2010	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Litoria aurea</i>	Green and Golden Bell Frog	E1	VU	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC. The species is 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. Breeding usually occurs in summer. Tadpoles, which take approximately 10-12 weeks to develop, feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species.	106 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2012	Medium. The Green and Golden Bell Frog has been recorded to the south and south east of the study area. No key populations have been identified within the study area or the immediate locality, however the species could potentially use the area in times of population growth for dispersal and new breeding sites. Farm dams with no fringing or emergent vegetation and creeklines within the study area are considered unlikely to provide potential habitat for this species. Given the recent population growth experiences in the South Nowra key population, a cautious approach is being taken for this species, and a seven part test has been provided as the proposed development may impact on its potential habitat.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	V	VU	The species is distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern VIC. It is not known from coastal habitats. Occurs in wet and dry sclerophyll forests and heath communities associated with sandstone outcrops between 280 and 1000 metres. Littlejohn's Tree Frog prefers permanent and semi-permanent rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation. Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. The species breeds in autumn but will also breed after heavy rainfall in spring and summer. The species has been recorded calling in all seasons with variously reported peak calling periods. Eggs are laid in loose gelatinous masses attached to submerged twigs; eggs and tadpoles are most often recorded in slow-flowing pools that receive extended exposure to sunlight.	2 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2003	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Mixophyes balbus</i>	Stuttering Frog	E1	VU	This species is usually associated with mountain streams, wet mountain forests and rainforests. It rarely moves very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains.	2 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1994	Low. The study area does not provide preferred habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.
<b>Reptiles</b>							
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	E1	VU	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer.	6 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2009	Low. The study area does not provide preferred habitat for the species. The escarpment to the west of the study area would be more likely to provide habitat for the species. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
Mammals							
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V		Patchily distributed from the coast to the Great Dividing Range, and as far as Pillaga, 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. Individuals will use a number of different hollows and an individual has been recorded using up to nine nest sites within a 0.5 hectares area over a five month period. It is mainly solitary, and each individual uses several nests. Home ranges of males are generally less than 0.75 hectares, and those of females are smaller.	5 (Atlas of NSW Wildlife)	2006	Low. The study area is considered unlikely to provide limiting breeding and foraging records for the species. The loss of approximately 0.01 per cent (1.98 hectares) non-limiting forest/woodland habitat is not likely to impact this species. No seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	VU	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. Likely that it hibernates during the cooler months. The only known existing maternity roost is in a sandstone cave near Coonabarabran.	3 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2010	Medium. Recorded within study area during 2009 Biosis field investigations. Non-maternity roost habitat and breeding habitat available within the study area, however foraging habitat occurs within riparian habitats and within woodlands. Therefore a seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	EN	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. Seventy per cent 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. Breeding occurs from May to August.	45 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2006	Medium. Disbursal, foraging and breeding habitat present within the Study Area, however the most recent record for the species within the locality is 108 years old. The species has previously been recorded in all directions from the study area. The closest record occurs approximately 2.3 kilometres to the south west. However, given the loss of a potential limiting breeding resource (ie tree hollows), a seven part test has been prepared for this species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	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. Apparently hibernates in winter. 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. Has a large foraging range, up to 136 hectares. Records show movements of up to 12 kilometres between roosting and foraging sites.	6 (Atlas of NSW Wildlife)	2008	High. Foraging habitat within the study area is not considered to be limiting for these mobile species. No records occur within the study area however Biosis has previously recorded the species to the north east. Given the presence of these species adjacent to the study area in the immediate locality, and the loss of a limiting breeding resource (ie tree hollows), a seven part test has been prepared for these species.
<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot (eastern)	E1	EN	This species prefers sandy soils with scrubby vegetation and/or areas with low ground cover that are burnt from time to time. A mosaic of post fire vegetation is important for this species.	1 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1989	Low. The study area provides limited sub-optimal foraging and nesting habitat. The vegetation communities lack the dense ground cover layer, and the most recent record for the species within the locality is 24 years old. No limiting breeding or foraging resources would be impacted and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Macropus parma</i>	Parma Wallaby	V		Occurs in wet and dry sclerophyll forest with a thick, shrubby understorey associated with grassy patches. They may also occur in rainforest but prefer the wet sclerophyll forest (Strahan, 1995 134 /id). This species feeds on grasses and herbs (Strahan, 1995 134 /id).	1 (Atlas of NSW Wildlife)	1905	Low. The study area does not provide preferred habitat for the species. The vegetation communities lack the dense ground cover layer, and the most recent record for the species within the locality is 108 years old. No limiting breeding or foraging resources would be impacted and therefore No seven part test has been completed.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	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. They 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.	15 (Atlas of NSW Wildlife)	2011	High. Identified roosting habitat (ie culverts) and potential foraging habitat present within the study area. Species identified in previous 2009 Biosis field investigation and potentially identified in current 2013 survey roosting in culvert over Flying Fox Creek. Given that identified roosting habitat would be impacted within the study area, the proposed works is likely to impact on this species. A seven part test is provided.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	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.	10 (Atlas of NSW Wildlife)	2010	High. Potential foraging and roosting habitat located within the study area, however, the foraging habitat within the study area is not considered to be limiting for these mobile species. Recorded during the previous field surveys undertaken by Biosis in 2009. Given the presence of these species within the study area and locality, and the potential loss of a limiting breeding resource (ie tree hollows), a seven part test has been prepared for these species.
<i>Myotis macropus</i>	Southern Myotis	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.	12 (Atlas of NSW Wildlife)	2010	High. Recorded within the study area during the 2009 Biosis field surveys. Given the presence of these species within the study area and locality, and the potential loss of a limiting breeding resource (ie tree hollows), a seven part test has been prepared for these species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Petaurus australis</i>	Yellow-bellied Glider	V		Restricted to tall native forests in regions of high rainfall along the coast of NSW. Bago Plateau: 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 2-6 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 (more than 15,000 hectares) are required to conserve viable populations.	266 (Atlas of NSW Wildlife)	2010	High. Potential habitat occurs within the study area within the eucalypt forest patches particularly where preferred feed trees species such as <i>Corymbia maculata</i> , <i>C. gummifera</i> and <i>Eucalyptus pilularis</i> are present. Previously recorded multiple times south west of the study area (including as close as 200 metre within Bomaderry Creek Regional Park). Additional records occur to the north and north west within 10 kilometres. The proposal would also result in the loss of a limiting breeding resource (ie tree hollows). A seven part test has been prepared for this species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E1	VU	Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from two to 30 hectares.	5 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	1979	Low. The study area does not provide preferred habitat for the species. The escarpment to the south-west of the study area would be more likely to provide habitat for the species. No limiting breeding or foraging resources would be impacted and therefore No seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Phascolarctos cinereus</i>	Koala	V	VU	Pittwater LGA and Hawks nest: 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 one to two hectares and overlap, while in semi-arid country they are usually discrete and around 100 hectares.	5 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2005	Low. Although two preferred feed tree species were recorded during the field surveys (ie <i>Eucalyptus racemosa</i> and <i>E. tereticornis</i> ), they occur as either scattered roadside trees ( <i>E. tereticornis</i> ) or within a small roadside, forest patch ( <i>E. racemosa</i> ) completely surrounded by urban development. Koalas have been previously been recorded west, south and south east of the study area. It is considered unlikely that the study area supports (or could support) a population of Koala. No seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	VU	Occurs from Queensland to Victoria, normally within 50 kilometres of the coast. Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 millimetres. Requires relatively thick ground cover where the soil is light and sandy. Known to eat fungi, arthropods, fleshy fruit, seeds and plant tissue. It is solitary and sedentary, but tends to aggregate in small groups. It has two breeding seasons, one in late winter-early spring and the other in late summer. This species appears to benefit from a lack of recent disturbance.	19 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2010	Low. The study area provides limited sub-optimal foraging and nesting habitat. The vegetation communities lack the dense ground cover layer, however the species has been recorded to the west and east of the study area. No limiting breeding or foraging resources for the species would be impacted and therefore no seven part test has been completed.
<i>Pseudomys fumeus</i>	Smoky Mouse	E4A	EN	Appears to prefer heathy ridgetops and slopes within sclerophyll forests, heathland and open forest from the coast to sub-alpine regions of up to 1800 metres.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area does not provide preferred habitat for the species and it has not been recorded within the locality. The escarpment to the west and south-west of the study area would be more likely to provide habitat for the species. No limiting breeding or foraging resources would be impacted by the proposed development and therefore no seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Pseudomys novaehollandiae</i>	New Holland Mouse		VU	The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. The home range of the New Holland Mouse can range from 0.44 hectares to 1.4 hectares. The New Holland Mouse is a social animal, living predominantly in burrows shared with other individuals. The species is nocturnal and omnivorous, feeding on seeds, insects, leaves, flowers and fungi, and is therefore likely to play an important role in seed dispersal and fungal spore dispersal. It is likely that the species spends considerable time foraging above-ground for food, predisposing it to predation by native predators and introduced species. Breeding typically occurs between August and January, but can extend into autumn.	None (predicted habitat from EPBC Act PMST)	None	Low. The study area may provide limited sub-optimal foraging and nesting habitat, however the vegetation communities lack the dense ground cover layer and heath understorey that is optimal for the species. The New Holland Mouse has never been recorded within the locality. Therefore no limiting breeding or foraging resources for the species would be impacted and No seven part test has been completed.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	VU	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. Bats commute daily to foraging areas, usually within 15 kilometres of the day roost although some individuals may travel up to 70 kilometres.	48 (Atlas of NSW Wildlife. Also predicted habitat from EPBC Act PMST)	2012	High. Potential foraging habitat for the Grey-headed Flying-fox occurs throughout the study area. The species was recorded during the 2009 Biosis field surveys just outside the study area, and also previously recorded east and south west of the study area. There is a known camp site within Coomonderry Swamp approximately 5 kilometres east of the study area. Given the high mobility of this species, a seven part test has been completed.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V		Found throughout NSW. They have been reported from southern Australia between January and June. 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. They 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. It forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country.	9 (Atlas of NSW Wildlife)	2007	High. Potential foraging and roosting habitat located within the Study Area, however, the foraging habitat within the study area is not considered to be limiting for these mobile species. Recorded during the previous field surveys undertaken by Biosis in 2009. Given the presence of these species within the study area and locality, and the potential loss of a limiting breeding resource (ie tree hollows), a seven part test has been prepared for these species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V		Occurs along the Great Dividing Range, generally at 500 metres 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 metres 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.	13 (Atlas of NSW Wildlife)	2010	High. Potential foraging and roosting habitat located within the Study Area, however, the foraging habitat within the study area is not considered to be limiting for these mobile species. Recorded during the previous field surveys undertaken by Biosis in 2009. Given the presence of these species within the study area and locality, and the potential loss of a limiting breeding resource (ie tree hollows), a seven part test has been prepared for these species.



Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Most recent record	Likelihood of occurrence
<i>Sminthopsis leucopus</i>	White-footed Dunnart	V		The White-footed Dunnart is found in a range of different habitats across its distribution, including coastal dune vegetation, coastal forest, tussock grassland and sedgeland, heathland, woodland and forest. They shelter in bark nests in hollows under standing or fallen timber, burrows in the ground, piles of logging debris, large grass clumps such as provided by Grass Trees <i>Xanthorrhoea</i> sp. and <i>Macrozamia</i> s and rock crevices.	1 (Atlas of NSW Wildlife)	1995	Low. Previously recorded once, 9.5 kilometres west of the study area. Within the study area, potential habitat is considered limited at best but may occur within the forest patches. No limiting breeding or foraging resources would be impacted by the proposed development. Given the above, it is considered unlikely that the loss of approximately 0.02 per cent (2.95 hectares) non-limiting disturbed roadside forest habitat would impact the White-footed Dunnart. No seven part test has been completed.

**Table A2-3 Migratory species recorded, or predicted to occur, within 10 kilometres of the study area.**

Scientific name	Common name	Most recent record	Likelihood of Occurrence
<i>Anthochaera phrygia</i>	Regent Honeyeater	1993	Low
<i>Apus pacificus</i>	Fork-tailed Swift	2007/#	Moderate - flyover
<i>Ardea ibis</i>	Cattle Egret	2009/#	High
<i>Ardea modesta</i>	Eastern Great Egret	2010	High
<i>Ardenna pacificus</i>	Wedge-tailed Shearwater	1985	Low
<i>Ardenna tenuirostris</i>	Short-tailed Shearwater	1984	Low
<i>Arenaria interpres</i>	Ruddy Turnstone	1986/#	Low
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	1987/#	Low
<i>Calidris alba</i>	Sanderling	#	Low
<i>Calidris canutus</i>	Red Knot	1995/#	Low
<i>Calidris ferruginea</i>	Curlew Sandpiper	1987/#	Low
<i>Calidris melanotos</i>	Pectoral Sandpiper	1981	Low
<i>Calidris ruficollis</i>	Red-necked Stint	2004/#	Low
<i>Calidris tenuirostris</i>	Great Knot	2000/#	Low
<i>Chalcophaps indica</i>	Emerald Dove	2009	Low
<i>Charadrius bicinctus</i>	Double-banded Plover	2004/#	Low
<i>Charadrius leschenaultii</i>	Greater Sand-plover	1981/#	Low
<i>Charadrius mongolus</i>	Lesser Sand-plover	1987/#	Low
<i>Charadrius veredus</i>	Oriental Plover	#	Low
<i>Gallinago hardwickii</i>	Latham's Snipe	1987/#	Low
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	2010/#	High - flyover
<i>Hirundapus caudacutus</i>	White-throated Needletail	1994/#	Moderate - flyover
<i>Hydroprogne caspia</i>	Caspian Tern	2010	Low
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	#	Low
<i>Limosa lapponica</i>	Bar-tailed Godwit	2010/#	Low
<i>Limosa limosa</i>	Black-tailed Godwit	1989/#	Low
<i>Merops ornatus</i>	Rainbow Bee-eater	1994/#	Low
<i>Monarcha melanopsis</i>	Black-faced Monarch	2011/#	High
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	2009/#	Low
<i>Neophema chrysogaster</i>	Orange-bellied Parrot	1986/#	Low
<i>Numenius madagascariensis</i>	Eastern Curlew	2010/#	Low

Scientific name	Common name	Most recent record	Likelihood of Occurrence
<i>Numenius phaeopus</i>	Whimbrel	2010/#	Low
<i>Pandion cristatus</i>	Osprey	2010	Low
<i>Plegadis falcinellus</i>	Glossy Ibis	2002	Mow
<i>Pluvialis fulva</i>	Pacific Golden Plover	1897/#	Low
<i>Pluvialis squatarola</i>	Grey Plover	1986	Low
<i>Rhipidura rufifrons</i>	Rufous Fantail	2010/#	Moderate
<i>Rostratula australis</i>	Australian Painted Snipe	#	Low
<i>Sterna hirundo</i>	Common Tern	1995	Low
<i>Sternula albifrons</i>	Little Tern	2004/#	Low
<i>Tringa brevipes</i>	Grey-tailed Tattler	1985/#	Low
<i>Tringa glareola</i>	Wood Sandpiper	#	Low
<i>Tringa nebularia</i>	Common Greenshank	1987	Low
<i>Tringa stagnatilis</i>	Marsh Sandpiper	1987/#	Low
<i>Xenus cinereus</i>	Terek Sandpiper	2001	Low

# PMST predicted habitat (ie no specific database record).



# Appendix C

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Hollowbearing tree and stag inventory

## Appendix C – Hollowbearing tree and stag inventory

**Table A3-1 Hollow-bearing trees and stag inventory**

Point Label	Location (impact)	Easting	Northing	Description
1	Beyond study area	280067	6141550	Stag with fissures. Potential roosting habitat for microchiropteran bats.
2	Subject site (indirect impacts)	280141	6142629	HBT - Medium sized hollow in main leader. Moderate potential for threatened species.
3	Subject site (indirect impacts)	280163	6142620	HBT - Medium sized hollow in main leader. Moderate potential for threatened species.
4	Subject site (indirect impacts)	280365	6142650	HBT - four pipe hollows with moderate roosting potential for microchiropteran bats; two x 20cm hollows in main leader trunk - potential for threatened species nesting eg parrots
5	Subject site (indirect impacts)	280375	6142700	Stag - Fissures with Microbat potential but might be a little small to be insulating.
6	Subject site (indirect impacts)	280380	6142700	HBT - Bees in large hollow in main leader. No threatened species potential at this stage.
7	Subject site (indirect impacts)	280339	6142960	HBT - Three small pipe hollows. No threatened species potential.
8	Study area (ancillary buffer)	280253	6143284	HBT - Spotted Gum with one moderate sized hollow in main leader. Potential for threatened species nesting eg parrots
9	Subject site (direct impacts)	280309	6143270	HBT - Spotted Gum with one moderate sized hollow in main leader. Potential for threatened species nesting eg parrots
10	Subject site (indirect impacts)	280360	6143358	HBT - Spotted Gum with two hollows in Crown and numerous small pipe hollows. One medium sized hollow, with moderate threatened species potential.
11	Study area (ancillary buffer)	280553	6143690	Stag - One large hollow in main leader. Threatened species potential. Potential for threatened species nesting eg parrots
12	Study area (ancillary buffer)	280713	6144040	HBT - Spotted Gum with two medium sized pipe hollows.
13	Study area (ancillary buffer)	281195	6144120	HBT & Stags - up to five Spotted Gums and/or Stags containing medium and large sized hollows and pipe hollows, with threatened species potential. Stags contain fissures suitable for threatened microchiropteran bats roosts.
14	Subject site (direct impacts)	281125	6144300	HBT & Stags - up to five Spotted Gums and/or Stags containing medium and large sized hollows and pipe hollows, with threatened species potential. Stags contain fissures suitable for threatened microchiropteran bats roosts.

Point Label	Location (impact)	Easting	Northing	Description
15	Subject site (direct impacts)	281135	6144410	HBT - Isolated Spotted Gum with two medium sized hollows. Potential for threatened species nesting eg parrots
16	Subject site (direct impacts)	281329	6144830	HBT & Stags - up to five Spotted Gums and/or Stags containing medium and large sized hollows and pipe hollows, with threatened species potential. Stags contain fissures suitable for threatened microchiropteran bats roosts.
17	Subject site (direct impacts)	281480	6145160	HBT & Stags - up to five Spotted Gums and/or Stags containing medium and large sized hollows and pipe hollows, with threatened species potential. Stags contain fissures suitable for threatened microchiropteran bats roosts.
18	Beyond study area	282594	6145700	Stag - Hollow trunk and fissures in bark. Potential for threatened microchiropteran bat roost.
19	Subject site (direct impacts)	282575	6145610	Stag - Hollow trunk and fissures in bark. Potential for threatened microchiropteran bat roost.
20	Study area (ancillary buffer)	282883	6145656	HBT - Spotted Gum with two large hollows with threatened species potential.
21	Subject site (direct impacts)	282877	6145452	HBT - Spotted Gum with medium sized hollow in main leader. Moderate potential for threatened species.
22	Subject site (direct impacts)	282879	6145427	HBT - Spotted Gum with medium sized pipe hollows. Moderate potential for threatened species.
23	Study area (ancillary buffer)	282907	6145518	HBT & Stags - up to ten Spotted Gums and/or Stags containing medium and large sized hollows and pipe hollows within the woodland, with threatened species potential. Stags contain fissures suitable for threatened microchiropteran bats roosts.
24	Subject site (indirect impacts)	282909	6145505	HBT - Spotted Gum with medium and large hollows in the main leader. Potential for threatened species.
25	Subject site (indirect impacts)	282910	6145497	HBT - Spotted Gum with medium and large hollows in the main leader. Potential for threatened species.
26	Subject site (direct impacts)	282902	6145426	HBT - Spotted Gum with two medium hollows in the main leader. Potential for threatened species.
27	Subject site (indirect impacts)	282950	6145481	HBT - Spotted Gum with two medium hollows in the main leader. Potential for threatened species.
28	Subject site (direct impacts)	282980	6145431	Stag - Fissures in bark. Potential for threatened microchiropteran bat roost.
29	Subject site (direct)	284489	6145660	Stag - Isolated paddock tree with two medium size hollows in the main leader. Moderate potential for



Point Label	Location (impact)	Easting	Northing	Description
	impacts)			threatened species.
30	Study area (ancillary buffer)	284512	6145610	Stag - Isolated paddock tree with one medium size hollows in the main leader. Moderate potential for threatened species.
31	Subject site (direct impacts)	284507	6145770	Stag - One medium size hollows in the main leader. Fissures may be suitable for microchiropteran bats. Moderate potential for threatened species.
32	Subject site (direct impacts)	284650	6145810	Stag - Two medium size hollows in the main leader. Fissures may be suitable for microchiropteran bats. Moderate potential for threatened species.
33	Study area (ancillary buffer)	285032	6145880	Stag - Isolated paddock tree with one medium size hollows in the main leader. Moderate potential for threatened species.
34	Study area (ancillary buffer)	285195	6145960	Stag - Isolated paddock tree with hollow trunk. Moderate potential for threatened species. Potential for threatened species nesting eg parrots
35	Subject site (direct impacts)	286049	6146315	HBT - Eucalyptus sp. With medium sized pipe hollows. Moderate potential for threatened species.
36	Subject site (direct impacts)	286054	6146311	HBT - Eucalyptus sp. With medium sized pipe hollows. Moderate potential for threatened species.
37	Subject site (indirect impacts)	286169	6146505	Stag - Fissures in bark. Potential for threatened microchiropteran bat roost.
38	Study area (ancillary buffer)	286224	6146475	Stag - Fissures in bark. Potential for threatened microchiropteran bat roost.
39	Study area (ancillary buffer)	286235	6146473	Stag - Fissures in bark. Potential for threatened microchiropteran bat roost.
40	Study area (ancillary buffer)	286239	6146478	Stag - Fissures in bark. Potential for threatened microchiropteran bat roost.
41	Study area (ancillary buffer)	286241	6146477	HBT - Medium sized hollows in main leader. Moderate potential for threatened species.
42	Subject site (direct impacts)	286158	6146544	HBT - Medium sized hollows and fishers. Moderate potential for threatened species.
43	Subject site (direct impacts)	286158	6146545	Stag - Fissures in bark. Potential for threatened microchiropteran bat roost.
44	Subject site (direct impacts)	286160	6146541	Stag - Fissures in bark. Potential for threatened microchiropteran bat roost.

Point Label	Location (impact)	Easting	Northing	Description
45	Study area (ancillary buffer)	286357	6146524	HBT - Spotted Gum with medium pipe hollows. Moderate potential for threatened species.
46	Study area (ancillary buffer)	286357	6146524	HBT - Spotted Gum with medium pipe hollows. Moderate potential for threatened species.
47	Study area (ancillary buffer)	286358	6146524	HBT - Spotted Gum with medium pipe hollows. Moderate potential for threatened species.
48	Study area (ancillary buffer)	286728	6147430	Stags - Two Turpentine stags containing medium sized hollows and fissures suitable for microchiropteran bat roosts.
49	Subject site (direct impacts)	287405	6148340	HBT - Medium sized hollow in main leader. Moderate potential for threatened species.

# Appendix D

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TSC Act assessments of significance



## Threatened ecological communities

### **River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions**

RFEFCF is listed as a TEC in Part 3 of Schedule 1 of the TSC Act. It is equivalent to Riverbank forest which was identified along the riparian corridors of freshwater creeks including Jaspers Brush Creek, Wileys Creek and Flying Fox Creek.

The Riverbank forest in the study area was characterised by a tall native canopy of *Casuarina cunninghamiana* and an understorey completely dominated by high densities of weeds. Natural structural layers were no longer intact and in most areas the mid storey and ground layers were completely dominated by weed species including *Ligustrum sinense*, *Lantana camara*, *Solanum mauritianum*, *Ageratina riparia* and *Tradescantia fluminensis*. These weed-infested areas were considered to have little capacity for the regeneration of natural vegetation without significant resources allocated to weed control and revegetation. Obvious disturbances to the Riverbank forest included heavy grazing and erosion.

Approximately 48.54 hectares of Riverbank forest occurs in the locality. Approximately 0.53 hectares would be directly impacted by the proposal and 0.74 hectares would be indirectly impacted. It should be noted that part of the 48.54 hectares mapped in the locality includes areas on Bundewallah Creek that would be impacted by the associated Foxground and Berry Bypass, Princes Highway upgrade. The cumulative impacts on this community are discussed in **Chapter 4** of this report and were addressed in the Biosis 2009 report in accordance with legislative requirements in relation to improving or maintaining biodiversity values.

**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.

**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.

**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.**

Based on the vegetation mapping (adapted from DEC), approximately 48.54 hectares of RFEFCF exists within the locality. The community has been reduced to narrow, fragmented strips adjoining creeklines. In the locality, RFEFCF is mapped on Jaspers Brush Creek, Bundewallah Creek to the north east and Bomaderry Creek to the south. The proposal would directly impact approximately 0.53 hectares of RFEF in the subject site and a further 0.74 of RFEFCF would be indirectly impacted by the proposal through the creation of new edges and the resulting continuation or exacerbation of edge effects. The total potential direct and indirect impacts equates to 2.61 per cent of this community in the locality.

The main impact of the proposal on RFEFCF habitat would be the removal of the canopy of *Casuarina cunninghamiana* from the areas of RFEFCF within the subject site, and the subsequent alteration of plant community structure in the remaining areas beneath the proposed upgraded culverts at Jaspers Brush Creek, Wileys Creek and Flying Fox Creek. Given the existing weed dominance in the understorey of the riparian vegetation, the proposal is unlikely to significantly alter the composition of the RFEFCF in the study area by introducing or increasing the spread of weeds. There may be some positive impacts from weed reduction and bush regeneration strategies in these areas as part of mitigation measures (see Chapter 6). RFEFCF in the study area is currently grazed and highly altered by weed invasion, so further indirect impacts from edge effects are likely to be minimal.

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

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

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

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

RFEFCF in the study area occurs along Jaspers Brush Creek, Wileys Creek and Flying Fox Creek. The current condition of the riparian vegetation is highly degraded and impacted by fragmentation and edge effects. The proposal route follows the existing Princes Highway and is not likely to result in further fragmentation of the vegetation community in new locations. Edge effects are likely to occur to a small proportion of the TEC.

Given the existing weed dominance in the understorey of RFEFCF, the proposal is unlikely to significantly affect the movement of characteristic native plant species through this community. The main impact of the proposal on habitat connectivity would be the removal of the canopy of *Casuarina cunninghamiana* from the areas of RFEFCF within the subject site and the subsequent alteration of plant community structure in these areas through the removal of the key strata (canopy) and ongoing maintenance to manage regrowth of trees adjacent to roadway.

Given the historic and ongoing disturbances (eg grazing) to this community within the study area and the resultant poor condition, the small area of this TEC which would be removed is not considered to be vital for the long term survival of the TEC in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for RFEFCF.

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

A recovery plan for RFEFCF has not been prepared to date. The threatened species profile for RFEFCF refers to 10 priority actions to assist in recovery of the TEC. Those considered relevant to the proposal include (DEC 2005o):

- Install fencing and signage to exclude livestock and machinery, and prevent rubbish dumping.
- Implement weed control programs.
- Protect remnants from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.

The proposal and associated mitigation measures are not inconsistent with the priority actions that relate to the recovery of the EEC.

**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, as listed under the TSC Act, are relevant to the proposal and may impact on RFEFCF:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - the proposal would involve clearing of approximately 0.53 hectares of RFEFCF.
- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' (NSW Scientific Committee 2002b) – given that bridges would be built over the creeks adjacent to the existing bridges, the proposal is unlikely to increase the operation of this key threatening process.
- 'Invasion of native plant communities by exotic perennial grasses' (NSW Scientific Committee 2003a – exotic perennial grasses, such as *Pennisetum clandestinum* currently occur in the study area. These exotic grasses have the potential to spread further into the disturbed areas resulting from the proposal.
- 'Invasion, establishment and spread of Lantana camara' (NSW Scientific Committee 2006)– *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area, including RFEFCF. *Lantana camara* has the potential to spread further into disturbed areas as a result of the proposal.

The proposal has the potential to increase the operation of the above listed key threatening processes

### **Conclusion**

The proposal is not likely to impose a significant impact on the RFEFCF of the study area or locality as:

- The proposal would not adversely affect the extent or composition of the ecological community to the point where its current ecological function is compromised to cause it to become locally extinct.
- The proposal would not further fragment or isolate the community or affect its long term survival in the study area 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 RFEFCF in the locality.
- The proposal does not and would not significantly contribute to any key threatening process that is either currently in operation in the study area or that will operate as a result of the proposal.

Consequently, an SIS is not required for this community.

### ***Illawarra lowlands grassy woodland in the Sydney Basin Bioregion (ILGW)***

Illawarra lowlands grassy woodland in the Sydney Basin Bioregion (ILGW) is listed as an Endangered Ecological Community in Part 3 of Schedule 1 of the TSC Act. This community has been mapped as South Coast grassy woodland which was identified along the existing Princes Highway.

The extent of this community in the study area is represented by scattered roadside trees within and adjacent to the road reserve and by an isolated linear patch of highly modified scrubby regrowth growing on a roadside cutting. Attributing this linear patch of vegetation to the EEC is precautionary and based on the assumption that it is a 'derived vegetation community' where the normal structural components are considerably altered and have developed as a result of management practices associated with the road maintenance.



Approximately 0.3 hectares of ILGW would be impacted directly and 0.01 hectares potentially indirectly impacted by the proposal. Approximately 245.34 hectares of this community has been mapped in the locality (DEC 2005).

**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.

**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.

**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.**

Based on the vegetation mapping (adapted from DEC), approximately 245.34 hectares of the EEC, ILGW exists within the locality. In the study area the community occurs as remnants often subject to ongoing impacts including grazing, weed invasion and clearing. The proposal would directly impact approximately 0.30 hectares of ILGW and potentially indirectly impact 0.01 hectares in the study area. This equates to a total of 0.13 per cent of this community in the locality which is considered unlikely to place the local occurrence at risk of extinction.

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

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

The ILGW in the study area occurs in a linear patch of derived native vegetation growing in the road reserve along the Princes Highway. The current condition of the vegetation is highly modified and degraded, and already impacted by fragmentation and edge effects. The proposal route would result in the removal of approximately 0.3 hectares of ILGW and potentially result in indirect impacts including a range of edge effects to 0.01 hectares in the study area. The proposal would not result in any areas of ILGW becoming fragmented or isolated from other areas of ILGW.

The importance of the patch to be impacted by the proposal is considered to be of low importance to the survival of the community in the locality for the following reasons:

- The total potential impact to ILGW is estimated at 1.72 hectares equating to 0.13 per cent of the community in the locality.
- The ILGW is highly modified, dominated by weeds and in poor condition.
- The ILGW is subject to ongoing disturbance regimes and edge effects which are likely to result in further degradation over time unless significant resources are allocated to rehabilitation.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for ILGW.

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

A recovery plan for ILGW has not been prepared to date. The threatened species profile for ILGW refers to 10 priority actions to assist in recovery of the TEC (DECC 2005), none of which are considered relevant to the proposal.

**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, as listed under the TSC Act 1995, are relevant to the proposal and may impact on ILGW:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - the proposal would involve clearing of approximately 0.3 hectares of ILGW.
- 'Invasion of native plant communities by exotic perennial grasses' (NSW Scientific Committee 2003) – exotic perennial grasses, such as *Pennisetum clandestinum* currently occur in the study area. These exotic grasses have the potential to spread further into the disturbed areas resulting from the proposal.
- 'Invasion, establishment and spread of *Lantana camara*' (NSW Scientific Committee 2006) – *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area, including RFEFCF. *Lantana camara* has some potential to spread into disturbed areas as a result of the proposal.
- The proposal has the potential to increase the operation of the above listed key threatening processes.

**Conclusion**

The proposal is not likely to impose a significant impact on the ILGW of the study area or locality as:

- The proposal would not adversely affect the extent or composition of the ecological community to the point where its current ecological function is compromised to cause it to become locally extinct.
- The proposal would not further fragment or isolate the community or affect its long term survival in the study area 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 ILGW in the locality.
- The proposal does not and would not significantly contribute to any key threatening process that is either currently in operation in the study area or that will operate as a result of the proposal.

Consequently, an SIS is not required for this community.

## Flora

### *Pterostylis gibbosa*

*Pterostylis gibbosa* is listed as Endangered under the TSC Act 1995 and Endangered under the EPBC Act 1999.

It is known from a small number of populations in the Hunter region, the Illawarra region and the Shoalhaven region near Nowra. Potential habitat for this species within the study area is considered to include Currumbene lowlands forest and derived South Coast grassy woodland. Approximately 1.74 hectares of potential habitat for *Pterostylis gibbosa* would be cleared as part of the proposal with further potential indirect impacts to an additional 2.38 hectares of potential habitat.

*Pterostylis gibbosa* has not been recorded in the study area; Surveys were undertaken in February 2007, May 2009 and March 2013 when this species can be visible above the ground, and in November 2008, during its known flowering season.

Potential habitat for the species occurs in Currumbene lowlands forest and derived South Coast grassy woodlands in the study area.

**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 (DEC 2005). Flowering occurs between August and November. Pollination is by small male gnats attempting to mate with the insect-like labellum (Jones 2006).

In the southern populations, individuals grow among grass and low shrubs in forests on poorly drained soils (Jones 2006). In the Illawarra region the species grows in woodland dominated by *Eucalyptus tereticornis*, *E. longifolia* and *Melaleuca decora*. Near Nowra, the species grows in an open forest of *Corymbia maculata*, *E. tereticornis* and *E. paniculata* (DEC 2005).

The proposal is not likely to impact movement of the male gnats that pollinate the species. Since no individuals have been recorded in the study area, and only a small area of potential habitat would be impacted, it is unlikely that the proposal would have an adverse effect on the lifecycle of the species such that a viable population of the species would 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.**

Not applicable.

**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.



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

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

Potential habitat for the species occurs in Currumbene lowlands forest and derived South Coast grassy woodlands in the study area. Approximately 1.74 hectares of potential habitat for *Pterostylis gibbosa* would be cleared as part of the proposal with further potential indirect impacts to an additional 2.38 hectares of potential habitat. Habitat to be directly impacted by the proposal equates to 0.22 per cent of Currumbene lowlands forest and South coast grassy woodland within the locality.

Potential habitat for *Pterostylis gibbosa* that would be impacted by the proposal is part of an already fragmented and cleared landscape. The proposal would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation. Since no individuals have been recorded in the study area, the study area is not considered important to the long-term survival of the species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for *Pterostylis gibbosa*.

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

A recovery plan has been prepared for *Pterostylis gibbosa*. The overall objective of the recovery plan is to protect known populations of *P. gibbosa* from decline and to develop a management regime, based on current knowledge, designed to promote the plant's conservation and evolutionary potential in situ (NSW NPWS 2002). Relevant objectives of the recovery plan include (NSW NPWS 2002):

- To ensure that all known *P. gibbosa* populations occurring on public and private lands are protected and managed for conservation.
- To establish the full extent of the distribution of *Pterostylis gibbosa*.

Given that no populations are known to be present in the study area the proposal and associated mitigation measures are consistent with the objectives of the recovery plan.

The threatened species profile for *Pterostylis gibbosa* refers to 20 priority actions to assist in recovery of the species. One Priority Action relevant to the proposal is (DEC 2005):

- Ensure that developments and activities are assessed with reference to the recovery plan, EIA guidelines and any future advice from the NPWS regarding the species.

The proposal and associated mitigation measures are consistent with the above listed Priority Action.

**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, as listed under the TSC Act 1995, are relevant to the proposal and may impact on *Pterostylis gibbosa*:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - The proposal would result in the clearing of approximately 1.74 hectares of potential habitat for *Pterostylis gibbosa*.
- 'Invasion of native plant communities by exotic perennial grasses' (NSW Scientific Committee 2003a) – exotic perennial grasses such as *Pennisetum clandestinum* currently occur in proximity of the study area. These exotic grasses have the potential to spread further into the adjoining bushland after disturbance associated with the proposal.
- 'Invasion, establishment and spread of *Lantana camara*' (NSW Scientific Committee 2006) – *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposal would involve vegetation disturbance which could lead to further spread of *Lantana camara*.

**Conclusion**

The proposal would have the following impacts on *Pterostylis gibbosa*:

- Approximately 1.74 hectares of potential habitat would be cleared.
- Approximately 2.38 hectares of potential habitat would be indirectly impacted.
- The proposal would include the operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of *Pterostylis gibbosa*, as:

- Potential habitat would not be fragmented or isolated.
- The proposal would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of this species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

## *Cryptostylis hunteriana*

*Cryptostylis hunteriana* is listed as Vulnerable under the TSC Act 1995 and Vulnerable under the EPBC Act 1999.

*Cryptostylis hunteriana* is a leafless saprophytic orchid which produces an upright flower-stem to 45 cm tall, bearing five to 10 flowers between November and February. It has small narrow green sepals and petals to 22 mm long, but is dominated by an erect, narrow, very hairy 'tongue' (the labellum) (DEC 2005d).

*Cryptostylis hunteriana* does not appear to have well-defined habitat preferences and has been recorded from a range of communities, including swamp-heath and woodland (DEC 2005d). Clark et al. (2004) found that *C. hunteriana* occurred in six vegetation types in the Shoalhaven LGA, using the Forest Ecosystems classification of Thomas et al. (2000). Three vegetation types accounted for 84 per cent of occurrences of *C. hunteriana*: lowland dry shrub forest, northern coastal hinterland heath shrub dry forest and northern coastal tall wet heath. Another three accounted for the remaining 16 per cent of occurrences: Jervis Bay lowland shrub/grass dry forest, coastal sands shrub/fern forest and northern foothills moist shrub forest.

*Cryptostylis hunteriana* was not recorded in the study area; however potential habitat is considered to exist within Currumbene lowlands forest and Shoalhaven sandstone forest both of which correspond or are similar to the preferred habitats as described by Clarke et al. (2004).

Approximately 1.68 hectares of potential habitat for *Cryptostylis hunteriana* would be cleared as part of the proposal with further potential indirect impacts to an additional 3.92 hectares of potential habitat.

**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 following is known about the lifecycle of *Cryptostylis hunteriana* (DEWHA 2008a):

- Flowering in NSW occurs between November and February.
- Pollination is via pseudocopulation by the male Ichneumon Wasp (*Lissopimpla excelsa*), which is believed to pollinate all *Cryptostylis* species in Australia.
- Seed is spread either by wind transportation or by being dropped in the immediate vicinity once the flower head has fallen over.
- The likelihood of spreading by vegetative reproduction is suggested to be low due to the poorly developed root system.
- Mychorrizal fungi are considered important partners in orchid germination.
- Flowering intensity may be stimulated by previous fire events, however, fire during the flowering season has been identified as a potential threat to the species.

The following disturbances are thought to impact on the lifecycle of *Cryptostylis hunteriana* (NPWS 2002; DEC 2005d):

- Development pressure on sites where it occurs – the proposal is not likely to result in the loss of any individuals of *Cryptostylis hunteriana*.

*Cryptostylis hunteriana* was not recorded in the study area, however the species has previously been recorded approximately four kilometres to the west of the study area. Surveys were undertaken in February 2007 and November 2008, within the known flowering period for this species; however it is acknowledged that this species is hard to detect outside its flowering period; has inconsistent flowering, with individuals not always flowering each season; and it is sometimes difficult to find known populations even with considerable search effort (DEWHA 2008a).



Potential habitat for the species occurs in Currumbene lowland forest and Shoalhaven sandstone forest in the study area. Since no individuals have been recorded in the study area, it is unlikely that the proposal would have an adverse effect on the lifecycle of the species such that a viable population of the species would 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.**

Not applicable.

**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.

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

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

*Cryptostylis hunteriana* was not recorded in the study area; however potential habitat is considered to exist within Currumbene lowlands forest and Shoalhaven sandstone forest in the study area. Approximately 1.68 hectares of potential habitat for *Cryptostylis hunteriana* would be cleared as part of the proposal with further potential indirect impacts, such as those associated with edge effects, to an additional 3.92 hectares of potential habitat. The removal of 1.68 hectares of potential habitat in the study area constitutes approximately 0.15 per cent of similar potential habitat mapped in the locality. Since no individuals have been recorded during surveys, the study area is not considered important to the long-term survival of the species in the locality. Potential habitat for *Cryptostylis hunteriana* that would be impacted by the proposal is part of an already fragmented and cleared landscape. The proposal would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation. The proposal is not likely to impact movement of the male Ichneumon Wasp that pollinates the species.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for *Cryptostylis hunteriana*.

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

To date, no recovery plans have been prepared for *Cryptostylis hunteriana*. The threatened species profile for *Cryptostylis hunteriana* refers to four Priority Actions to assist in recovery of the species, all of which relate to known or priority populations, none of which occur in the study area (DEC 2005).

The proposal and associated mitigation measures are not inconsistent with the Priority Actions.

**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, as listed under the TSC Act 1995, are relevant to the proposal and may impact on *Cryptostylis hunteriana*:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - The proposal would result in the clearing of approximately 1.68 hectares of potential habitat for *Cryptostylis hunteriana*.
- 'Invasion of native plant communities by exotic perennial grasses' (NSW Scientific Committee 2003a) – exotic perennial grasses, such as *Pennisetum clandestinum* currently occur in the study area. These exotic grasses have the potential to spread further into the disturbed areas resulting from the proposal.
- 'Invasion, establishment and spread of *Lantana camara*' (NSW Scientific Committee 2006) – *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. *Lantana camara* has the potential to spread further into disturbed areas as a result of the proposal.

**Conclusion**

The proposal would have the following impacts on *Cryptostylis hunteriana*:

- Approximately 1.68 hectares of potential habitat would be cleared.
- Approximately 3.92 hectares of potential habitat would be indirectly impacted.
- The proposal would include the operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of *Cryptostylis hunteriana*, as:

- Potential habitat would not be fragmented or isolated.
- The proposal would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of this species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

### *Genoplesium baueri*

*Genoplesium baueri* is listed as Vulnerable under the TSC Act.

The species has been recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years (DEC 2005).

Potential habitat for this species within the study area is considered to include Shoalhaven sandstone forest. Approximately 0.24 hectares of potential habitat for *Genoplesium baueri* would be cleared as part of the proposal with further potential indirect impacts to an additional 1.56 hectares of potential habitat.

**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.**

*Genoplesium baueri* is a terrestrial orchid species that grows in open sclerophyll forest (including shrubby and heathy open forest) or moss gardens on sandstone. Typically the habitat is a drier heathy forest (Harden 1993; Bishop 1996; Jones 2006). The species is self-pollinating, flowers from December to April, and flowering is enhanced by summer fires (DEC 2005k; Jones 2006).

*Genoplesium baueri* is threatened by urban and infrastructure development, and is likely to be affected by inappropriate fire regimes (DEC 2005k).

*Genoplesium baueri* was not recorded in the study area, however, the species has previously been recorded within four kilometres to the west and south of the study area. Surveys were undertaken in February 2007 and March 2013 within the known flowering period for this species.

Potential habitat for the species occurs in Shoalhaven sandstone forest in the study area. Habitat to be impacted equates to only 0.06 per cent of Shoalhaven sandstone forest habitat mapped within the locality. Since no individuals have been recorded in the study area, and a relatively small per cent of the potential habitat within the locality would be impacted, it is unlikely that the proposal would have an adverse effect on the lifecycle of the species such that a viable population of the species would 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.**

Not applicable.

**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.



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

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

Potential habitat for the species occurs in Shoalhaven sandstone forest in the study area. Approximately 0.24 hectares of potential habitat for *Genoplesium baueri* would be cleared as part of the proposal with further potential indirect impacts such as those associated with edge effects to an additional 1.56 hectares of potential habitat.

Potential habitat for *Genoplesium baueri* that would be impacted by the proposal is part of an already fragmented and cleared landscape. The proposal would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Since no individuals have been recorded in the study area, the study area is unlikely to be important to the long-term survival of the species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for *Genoplesium baueri*.

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

To date, no recovery plans have been prepared for *Genoplesium baueri*. The threatened species profile for *Genoplesium baueri* refers to 12 priority actions to assist in recovery of the species. None of these are considered relevant to the proposal.

**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, as listed under the TSC Act 1995, are relevant to the proposal and may impact on *Genoplesium baueri*:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - The proposal would result in the clearing of approximately 0.24 hectares of potential habitat for *Genoplesium baueri*.
- 'Invasion of native plant communities by exotic perennial grasses' (NSW Scientific Committee 2003) – exotic perennial grasses such as *Pennisetum clandestinum* currently occur in proximity of the study area. These exotic grasses have the potential to spread further into the adjoining bushland after disturbance associated with the proposal.
- 'Invasion, establishment and spread of *Lantana camara*' (NSW Scientific Committee 2006) – *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposal would involve vegetation disturbance which could lead to further spread of *Lantana camara*.

## Conclusion

The proposal would have the following impacts on *Genoplesium baueri*:

- Approximately 0.24 hectares of potential habitat would be cleared.
- Approximately 1.56 hectares of potential habitat would be indirectly impacted.
- The proposal would include the operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of *Genoplesium baueri*, as:

- Potential habitat would not be fragmented or isolated.
- The proposal would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of this species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

### *Thesium australe*

*Thesium australe* is listed as Vulnerable under the TSC Act 1995 and Vulnerable under the EPBC Act 1999.

*Thesium australe* is found in very small to large populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands (DEC 2005). No known records of this species occur in the locality. This species is known to occur on damp sites in association with the native grass, *Themeda australis*.

Marginal potential habitat for this species occurs in the study area, where *Themeda australis* and other native grasses such *Poa* spp. were recorded. On this basis, potential habitat is considered to include Illawarra gully wet forest, Currumbene batemans lowlands forest, Shoalhaven sandstone forest and derived South coast grassy woodland. Approximately 2.95 hectares of potential habitat for *Thesium australe* would be cleared as part of the proposal with further potential indirect impacts to an additional 4.67 hectares of potential habitat.

**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.**

*Thesium australe* is a small, straggling herb often hidden amongst grasses and herbs. It is a root parasite that takes water and some nutrient from other plants, especially *Themeda australis* (DEC 2005). It is often found in damp sites in association with *Themeda australis*, but also found on other grass species at inland sites (G. Leonard pers. obs.). It also occurs on clay soils in grassy woodlands or coastal headlands (James et al. 1999). Flowering occurs in spring (DEC 2005).

*Thesium australe* is threatened by habitat loss, fragmentation and degradation of habitat as a result of infrastructure (eg road works) and invasion of weeds (DEC 2005).

*Thesium australe* was not recorded in the study area, and has not been recorded in the locality. The closest records for this species are from near Bundanoon (25 kilometres to the west) and Ulladulla (40 kilometre to the south). Surveys were undertaken in February 2007, November 2008 (during the known flowering season), May 2009, and March 2013.

Marginal potential habitat for the species occurs in Illawarra gully wet forest, Currumbene lowlands forest, Shoalhaven sandstone forest and derived South coast grassy woodland in the study area. While there is potential for the study area to provide habitat for this species, given that no records have been made within the study area or locality, it is unlikely that the proposal would have an adverse effect on the lifecycle of the species such that a viable population of the species would 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.**

Not applicable.

**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.



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

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

Marginal potential habitat for the species occurs in Illawarra gully wet forest, Currumbene lowlands forest, Shoalhaven sandstone forest and derived South coast grassy woodland in the study area. Approximately 2.95 hectares of potential habitat for *Thesium australe* would be cleared as part of the proposal with further potential indirect impacts to an additional 4.67 hectares of potential habitat. This would equate to 0.42 per cent of the extent of communities Illawarra gully wet forest, Currumbene lowlands forest, Shoalhaven sandstone forest and derived South coast grassy woodland within the locality.

Potential habitat for *Thesium australe* that would be impacted by the proposal is part of an already fragmented and cleared landscape. The proposal would impact upon the edge of existing patches of potential habitat and would not increase fragmentation or isolation.

Since no individuals have been recorded in the study area or locality, and the potential habitat for this species within the study area is largely in moderate to poor condition (due to the dominance of exotic species in the understorey, altered community structure and existing fragmentation), the study area is not considered important to the long-term survival of the species in the locality.

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

Critical habitats are land that is crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for *Thesium australe*.

**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 for *Thesium australe*. The threatened species profile for *Thesium australe* refers to 15 priority actions to assist in recovery of the species, which relate either to known populations (DEC 2005), none of which occur in the study area, or to tasks that need to be undertaken by DECCW (eg preparation of a recovery plan).

The proposal and associated mitigation measures are not inconsistent with the Priority Actions for this species.

**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, as listed under the TSC Act 1995, are relevant to the proposal and may impact on *Thesium australe*:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - The proposal would result in the clearing of approximately 2.95 hectares of potential habitat for *Thesium austral*.
- 'Invasion of native plant communities by exotic perennial grasses' (NSW Scientific Committee 2003) – exotic perennial grasses such as *Pennisetum clandestinum* currently occur in proximity of the study area. These exotic grasses have the potential to spread further into the adjoining bushland after disturbance associated with the proposal.

- 'Invasion, establishment and spread of *Lantana camara*' (NSW Scientific Committee 2006) – *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposal would involve vegetation disturbance which could lead to further spread of *Lantana camara*.

## Conclusion

The proposal would have the following impacts on *Thesium australe*:

- Approximately 2.95 hectares of potential habitat would be cleared.
- Approximately 4.67 hectares of potential habitat would be indirectly impacted.
- The proposal would include the operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of *Thesium australe*, as:

- Potential habitat would not be fragmented or isolated.
- The proposal would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of this species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

## Threatened fauna

*Australasian Bittern* *Botaurus poiciloptilus*

*Black Bittern* *Ixobrychus flavicollis*

The Australasian Bittern is listed as endangered under Schedule 1 of the TSC Act. The Black Bittern is listed as vulnerable under Schedule 2 of the TSC Act.

The study area contains potential habitat for these two species. They have been assessed together on the basis that they have the same basic ecological requirements.

The Australasian Bittern favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.) where it can hide during the day. The species feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains. The Australasian Bittern breeds in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds (OEH 2012c).

The Black Bittern inhabits terrestrial and estuarine wetlands, predominantly within areas containing permanent water and dense vegetation (OEH 2012b). Potential foraging and roosting habitat may include permanent water within flooded grassland, forest, woodland, rainforest and mangroves (Marchant and Higgins 1990). Within this habitat, the Black Bittern would roost in trees or amongst dense reeds. The diet of the Black Bittern includes frogs, reptiles, fish and invertebrates, both terrestrial and aquatic. Foraging mostly occurs at dusk or nocturnally and the day is spent roosting in trees or amongst dense vegetation on the ground. Nests are built in leafy trees overhanging water in densely vegetated wetlands. During the breeding season from December to March, these otherwise solitary birds are found in pairs (Marchant and Higgins 1990).

**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.**

Neither of these species have been recorded within the study area either during the field surveys or as historical records. The Australasian Bittern is uncommon within the Shoalhaven with all records being associated with Coomonderry Swamp and Brundee Swamp Nature Reserve. The species has recently been sighted north, in the Illawarra. The Black Bittern is considered to be rare in the locality and has been recorded on five occasions to the south and east of the study area with the most recent record dating from 2009. Potential habitat for these species occurs within the study area in the form of creeks, dams and wetlands with dense fringing and emergent vegetation.

The dams and small wetlands may provide limited foraging and breeding resources for the Australasian Bittern and the Black Bittern on occasion, and although the study area is not likely to host a local population of either species, a network of permanent and ephemeral waterways provide connective habitat to Coomonderry Swamp, over five kilometres to the east, and south to Bomaderry Creek.

The waterbodies present within the study area provide marginal habitat for both species, being heavily disturbed through the alteration of water regimes, and impacts from farming practices and invasive flora and fauna. They are unlikely to be important for the lifecycle of a local population of Australasian Bittern or Black Bittern given that breeding has not been recorded at these locations historically and given the proximity of more extensive higher quality habitats present within Coomonderry Swamp Nature Reserve. It is unlikely that the proposal would disrupt the life cycle of these species to the extent that a viable local population would 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.**

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of Australasian Bittern or Black Bittern listed under the Act.

**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 threatened species.

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

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

Following habitat assessments, at least eight water bodies and a number of creeklines are considered to support suitable potential habitat for these species, including some, if not all, of the following:

- Presence of emergent aquatic vegetation such as *Phragmites australis* Common Reed and *Typha domingensis* Narrow-leaved Cumbungi with some portions suitable for Australasian Bittern nesting; and/or,
- Presence of permanent water bodies including creeklines with potential foraging habitats and some portions suitable for Black Bittern nesting.

The proposed works would result in the removal of four water bodies in the form of farm dams and sections of pooling creeks. This would occur on both sides of Abernethys Creek, west of Meroo Road and Fletchers Lane and east of the corner of Princes Highway and Morschels Lane.

There is also the potential to indirectly impact an additional three, which are located within the indirect subject site. The remaining one is located in the study area. No breeding or signs of breeding (platform nests in reeds or trees lining creeklines), have been located within water bodies of the study area following field surveys.

Each of these species may be resident at permanent wetlands where breeding occurs annually however they will move in response to changing environmental conditions. Given the mobility of these species and the suboptimal quality of habitats present, the proposal is unlikely to fragment habitats present for these species.

The current state of breeding habitat throughout the study area is considered to be of poor condition for the Australasian Bittern and Black Bittern. Water bodies containing dense emergent vegetation are small and isolated and have no historical records of use of these habitats by either of these species in the past. More suitable breeding ponds for these species in the locality occur five kilometres east of the study area within Coomonderry Swamp and to the south along Bomaderry, Flat Rock and Nowra Creeks. The habitat to be removed, or modified within the study area is unlikely to affect the long-term survival of the species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Australasian Bittern or Black Bittern.

**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 for the Australasian Bittern or the Black Bittern. However, the OEH has developed activities to help assist these species in NSW. Those actions relevant to the proposal include:

- Protect wetlands and water-courses from pollution.
- Protect wetlands, ponds and associated marshy areas from clearing or disturbance.
- In areas of suitable breeding habitat, seek to retain and manage riparian vegetation.

Potential habitat exists within the study area. As part of the proposal, some of this potential habitat would be cleared, however the majority of the potential habitat in the study area would not be impacted. As such, the proposal is not considered to be inconsistent with the recovery actions outlined by the DECC.

The threat abatement plans for the European Fox and Feral Cat are relevant to this species. The overall objective of these plans is to focus fox and cat control on areas where the impacts of predation on threatened fauna are greatest. The study area is not listed a priority area for control.

**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 Australasian Bittern and the Black Bittern are threatened by habitat loss through clearing and draining for flood mitigation, agriculture, and residential development, degradation of wetland habitats through pollution and salinisation, and modification of natural water flow regimes.

Key Threatening Processes are listed on Schedule 3 of the TSC Act. Those related to the Australasian Bittern and the Black Bittern are:

- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' (NSW Scientific Committee 2002) – few of the water bodies within the study area are natural waterways, having been dammed and channelled in the past. The proposal would remove four water bodies, in the form of farm dams and sections of pooling creeks, from the direct subject site and have the potential to indirectly impact an additional three.
- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve the removal and/or modification of native vegetation that provides sheltering and roosting habitat within the study area.
- 'Predation and hybridisation of feral dogs (*Canis lupus familiaris*)' (NSW Scientific Committee 2009) – Australasian Bittern and Black Bittern are prey for feral dogs or even domestic dogs in off leash areas or on private property. This is unlikely to be exacerbated by the proposal.
- 'Predation by the feral cat (*Felis catus*)' (NSW Scientific Committee 2011a) – feral cats may also inhabit the study area. The proposal is unlikely to increase cat numbers or lead to increases in the predation pressure exerted by this species on the Australasian Bittern and the Black Bittern.
- 'Predation by the European red fox (*Vulpes vulpes*)' (NSW Scientific Committee 2011b) – it is known that foxes inhabit the study area. The proposal is unlikely to increase fox numbers or lead to increases in the predation pressure exerted by this species on the Australasian Bittern and Black Bittern.

**Conclusion:**

The proposal would have the following impacts on the Australasian Bittern and the Black Bittern:

- Direct removal of four small water bodies providing potential habitat.
- Indirect modification of three small water bodies providing potential breeding and foraging habitat.

The proposal is considered unlikely to result in a significant impact on a local population of Australasian Bittern or Black Bittern, as:

- Only a relatively small area (four small water bodies) of low quality potential breeding and foraging habitat would be removed.
- Potential habitat would not be fragmented or isolated.
- Higher quality breeding and foraging habitats (eg Coomonderry Swamp) would remain within the locality.
- The habitat to be impacted by the proposal is of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.



### *Bush Stone-curlew *Burhinus grallarius**

The Bush Stone-curlew is listed as endangered under Schedule 1 of the TSC Act 1995.

The Bush Stone-curlew has a broad distribution, having been recorded from almost all but the most arid areas of mainland Australia and on many offshore islands (DEC 2006). The current NSW distribution is patchy and scattered with coastal populations occurring sporadically from Sydney to the Queensland border, with fewer records south of Sydney. Bush Stone-curlews have been reported around Nowra, Narooma and Bermagui (DEC 2006).

Bush Stone-curlew generally occurs in open woodlands with few shrubs (if any), and short, sparse grasses of less than 15 centimetres in height, with scattered fallen timber, leaf litter and bare ground present. In coastal areas, structurally similar elements of tidal and estuarine communities provide suitable habitat (DEC 2006). In the northern part of its range (and in Pittwater Local Government Area), the Bush Stone-curlew can be found in semi-urban and urban areas.

**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.**

During the day, Bush Stone-curlews roost on the ground under large trees or within woodland remnants with fallen timber and leaf litter. At night, Bush Stone-curlews travel as far as three kilometres from the roost site to feeding grounds (NPWS 2000). Bush Stone-curlews will nocturnally forage in a variety of areas, including irrigated and pasture-improved paddocks, playing fields, waste disposal facilities, mangroves, saltmarsh, mudflats, swamps and woodland remnants as these areas are likely to support an abundance of insects and other food resources (DEC 2006).

Approximately 3.48 hectares of potential foraging and roosting habitat would be cleared. These impacts equate to only 0.02 per cent of similar plant communities occurring in the locality (19,473.83 hectares). An additional 5.41 hectares of potential foraging and roosting habitat may be indirectly impacted. Given the extent of suitable foraging and roosting habitat that would remain within the study area and the wider locality, particularly along the Shoalhaven River, its tributaries and within Seven Mile Beach National Park, it is unlikely that the proposal 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.**

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of Bush Stone-curlew listed under the Act.

Based on the above assessment, an SIS is not considered necessary for this species.

**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 threatened species.

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

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

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

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

The proposal would remove approximately 3.48 hectares of potential foraging and roosting habitat for the Bush Stone-curlew. These impacts equate to only 0.02 per cent of similar plant communities occurring in the locality (19,473.83 hectares).

Being a relatively mobile species, the Bush Stone-curlew is capable of negotiating the existing highway, surrounding farmland and rural environments. Habitats removed as a result of the proposal are not likely to effect the current dispersal of the species in the locality such that it becomes fragmented or isolated from other areas of habitat.

DEC (2006) highlights the important structural elements of Bush Stone-curlew habitat appear to be:

- A low sparse ground cover.
- Some fallen timber and leaf litter.
- A general lack of a shrubby understory.
- Open woodlands.

The habitats of the study area are highly disturbed, being located next to the existing highway and with several key threatening processes already in place (including predation by feral dogs, European red fox and the feral cat), however some of the above structural elements including low sparse ground cover, fallen timber and leaf litter and open woodland are present.

With the existing threats to the species in place, the habitat to be removed or modified as part of the proposal is not considered important to the long-term survival of the species community in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Bush Stone-curlew (DECC Threatened Species Unit).

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

The OEH has developed a recovery plan for the species with the overall objective to manage at least five populations of the Bush Stone-curlew across NSW to ensure they are secure and consistently increasing in both extent of occurrence and area of occupancy over the five years of the plan (note that the plan was developed in 2006 and is due to be reviewed) (DEC 2006). Eleven actions have been developed to assist the recovery of the Bush Stone-curlew in NSW:

- Expand existing Bush Stone-curlew community conservation programs.
- Raise community recognition of the Bush Stone-curlew and interest in the recovery program.
- Increase the total area of Bush Stone-curlew habitat protected and managed for conservation in public and private lands by 25 per cent in each CMA.
- Supplement declining wild populations with a robust and well-funded captive-breeding and translocation program.

- Ensure the conservation status of the Bush Stone-curlew is adequately recognised under NSW and Commonwealth legislation.
- Ensure that impacts on Bush Stone-curlews and their habitat are accurately assessed during planning and environmental assessment processes.
- Increase understanding of the ecology of the Bush Stone-curlew.
- Increase understanding of threatening processes affecting Bush Stone-curlews.
- Increase understanding of the significance of the Bush Stone-curlew to indigenous Australians.
- Integrate the recovery plan with other conservation plans and programs to maximise the efficient use of resources and benefits to biodiversity.
- Implement a well-funded and coordinated recovery program across NSW.

Given that the habitat within the study area is not considered limiting within the locality, the proposal is considered to be consistent with the activities recommend by OEHL to assist the Bush Stone-curlew.

**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.**

Key Threatening Processes are listed on Schedule 3 of the TSC Act. Those related to the Bush Stone-curlew are:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - the proposal would involve clearing native vegetation that is potential foraging and roosting habitat for the Bush Stone-curlew.
- 'Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)' (NSW Scientific Committee 2002b) – As rabbits may support fox populations, rabbit are also considered to be a key threatened process to the Bush Stone-curlew. This is unlikely to be exacerbated by the proposal.
- 'Predation and hybridisation of feral dogs (*Canis lupus familiaris*)' (NSW Scientific Committee 2009) – Bush Stone-curlew are prey for feral dogs or even domestic dogs in off leash areas, although predation by feral dogs is unlikely to be exacerbated by the proposal.
- 'Predation by the European red fox (*Vulpes vulpes*)' (NSW Scientific Committee 2011a) – Bush Stone-curlew are prey for European red fox, although predation by European red fox is unlikely to be exacerbated by the proposal,
- 'Predation by the feral cat (*Felis catus*)' (NSW Scientific Committee 2011b) – Bush Stone-curlew are prey for feral cat or even domestic cats when let roam free, although predation by feral cats is unlikely to be exacerbated by the proposal.
- 'Removal of Dead Wood and Dead Trees' (NSW Scientific Committee 2003b) – limited dead wood and dead trees would be removed. These may provide shelter and roosting habitat for the Bush Stone-curlew.

**Conclusion**

The proposal would have the following impacts on the Bush Stone-curlew:

- Approximately 3.48 hectares of potential foraging and roosting habitat would be cleared.
- The operation of two key threatening processes.



The proposal is considered unlikely to result in a significant impact on a local population of Bush Stone-curlew, as:

- No limiting foraging resources would be removed.
- Only a relatively small area of disturbed potential roosting habitat would be removed.
- Potential habitat would not be fragmented or isolated.
- Only approximately 0.02 per cent of suitable habitats would be removed within the locality.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of this species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

*Powerful Owl Ninox strenua*

*Barking Owl Ninox connivens*

*Sooty Owl Tyto tenebricosa*

*Masked Owl Tyto novaehollandiae*

The Powerful Owl, Barking Owl, Sooty Owl and Masked Owl are listed as vulnerable under Schedule 2 of the TSC Act 1995. These four species have been grouped for the impact assessment due to their similar habitat requirements.

**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.**

Tree hollows are particularly important for all four species of owl. Firstly, they provide habitat for hollow-dwelling arboreal marsupials (eg possums and gliders – typical prey for the powerful owl), which comprise a large proportion of their diet, and secondly, they provide nesting sites (Higgins 1999). Large mature trees with hollows at least 0.4 metre deep (usually located over 20 metre above the ground) are required for nesting (Gibbons and Lindenmayer 1997). The barking owl prefers hollows within *Eucalyptus camaldulensis*, *E. albens*, *E. polyanthemos* and *E. blakelyi*; the powerful owl prefers large hollows in large trees at least 150 years old; the masked owl prefers large tree hollows in moist eucalypt forested gullies; and, the sooty owl prefers large tree hollows in rainforest (DEC 2005a; DEC 2005w; DEC 2005r; DEC 2005j).

The Masked, Sooty and Barking owls have an estimated home-range of between 100 and 500 hectares whereas the larger powerful owl has a home-range of 600-1450 hectares (Gibbons and Lindenmayer 1997), depending upon surrounding forest condition, fragmentation and the abundance of prey species.

The study area provides marginal potential breeding habitat for these four owls in the form of hollow-bearing trees. Up to 15 habitat trees containing hollows large enough for forest owl occur within the subject site and would be removed as part of the proposal. None of these trees however occur in moist eucalypt forested gullies or rainforest habitats. These owls are likely to forage for ground-dwelling and/or arboreal mammals within the study area, however, the study area is not considered to provide limiting foraging resources.

Three of the four owl species have been previously recorded within the locality. The closest record is of the powerful owl and occurs approximately 200 metre from the study area, recorded in 2007 during Bosis field surveys. All but the barking owl have been previously recorded in the locality (the barking owl has been recorded twice within 10 kilometre to the north and west of the study area). The powerful owl has been recorded during field surveys to the north east of the study area and has also previously been recorded to the north west, south west and east of the study area. The masked owl has been previously recorded to the south west and east of the study area while the sooty owl has been previously recorded to the north east, north west, west and south west of the study area (Birds Australia 2009).

The proposal is unlikely to impact the foraging behaviour of the four owls as no limiting foraging resources occur on site. Potential breeding habitat (tree hollows) would be removed by the proposal. Up to 2.94 hectares of eucalypt and Riverbank (riparian) forest containing tree hollows would be removed. This equates to only 0.01 per cent of similar plant communities (assumed to contain tree hollows) occurring in the locality (19473.83ha).

Given that up to 15 habitat trees containing hollows would be removed, and that other tree hollows within the study area and in the estimated 6084 hectares of surrounding conservation reserves in the locality would be retained, the low condition of the potential habitat to be removed (ie isolated roadside trees), and the high mobility of these species, it is considered unlikely that the proposal would have an adverse effect on the life cycle of the powerful owl, barking owl, sooty owl or masked owl, such that a viable local population of these 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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the NSW Scientific Committee, is facing a very high risk of extinction in NSW in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Powerful, Barking, Sooty and Masked owls in NSW.

**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 threatened species.

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

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

The proposal would result in the removal of approximately 2.41 hectares of eucalypt forest and 0.53 hectares of Riverbank (riparian) forest. A further 3.1 hectares and 0.74 hectares of eucalypt forest and riverbank forest would be indirectly impacted, respectively. These impacts equate to only 0.03 per cent of similar plant communities occurring in the locality (19,473.83 hectares). These owls are likely to forage for ground-dwelling and/or hollow-dependant arboreal mammals within the study area and although up to 30 hollows suitable for forest owl prey would be removed, the study area is not considered to provide limiting foraging resources.

Up to 15 habitat trees containing hollows large enough for forest owl occur within the subject site and would be removed as part of the proposal. None of these trees however occur in moist eucalypt forested gullies or rainforest habitats and are considered to be important breeding habitat for any forest owls.

No new edges would be created by the proposal as only roadside vegetation would be removed. Given this and the high mobility of the owls, the proposal would not result in habitat fragmentation or isolation for these species.

The area of potential habitat to be removed by the proposal is small and disturbed (eg edge-affected) and is considered to be of low importance to the long-term survival of the Powerful, Barking, Masked and Sooty owls in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the powerful, barking, sooty and masked owls.



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

There is currently a draft recovery plan for the Barking owl (NPWS 2003d) and a final recovery plan for large forest owls (including Sooty owl, Powerful owl and Masked owl) (DEC 2006).

The overall objective of the draft Barking owl Recovery Plan (NPWS 2003b) is “to simply ensure the long-term persistence of the Barking owl in NSW. This would be achieved by implementing actions under five specific objectives which increase understanding and awareness of the species, undertake threat abatement and mitigation, and which allow for efficiencies and coordination of the plan”. Actions under threat abatement and mitigation include:

- Protect known Barking owl nests sites and surrounding habitat.
- Assist with the protection of Barking owl habitat from disturbance due to developments and activities.
- Assess forestry prescriptions and threatened species licences for their effectiveness in conserving Barking owl habitat in State Forests.
- Incorporate the consideration of Barking owl habitat and potential habitat as a high priority in the assessment of property for reserve establishment.
- Support studies into the effects of agricultural poisons on the species.

Eight specific recovery objectives for the powerful, masked and sooty owls are identified in the recovery plan for large forest owls (NSW Department of Environment and Conservation 2005), two of which aim to:

- Minimise further loss and fragmentation of habitat outside conservation reserves and State forests by protection and management of significant owl habitat (including protection of individual nest sites).
- Minimise the impacts of development activities on large forest owls and their habitats outside conservation reserves and State forests.

No known nest sites would be removed for the proposal, although a small number of roadside hollow-bearing trees (potential roosting/breeding habitat) would be removed. The proposal would involve clearing of native vegetation which constitutes foraging habitat for the four owls. As such, the proposal is not entirely consistent with the objectives outlined by the recovery plans for these species.

**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 Powerful, Sooty, Masked and Barking owls are threatened by the following key threatening processes as listed under Schedule 3 of the TSC Act 1995:

- ‘Clearing of native vegetation’ (NSW Scientific Committee 2001) – the proposal would involve clearing of 2.94 hectares of native vegetation that provides general foraging habitat for the four owl species.
- ‘Loss of hollow-bearing trees’ (NSW Scientific Committee 2007a) – the proposal would involve the removal of approximately fifteen hollow-bearing trees, which could provide roosting and limited breeding opportunities for the four owls.
- ‘Removal of Dead Wood and Dead Trees’ (NSW Scientific Committee 2003b) – some dead wood and dead trees may be removed by the proposal.

## Conclusion

The proposal would have the following impacts on the powerful, sooty, masked and barking owls:

- Approximately 2.94 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be cleared.
- Approximately 3.84 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be indirectly impacted.
- The operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Powerful, Sooty, Masked or Barking Owls, as:

- No limiting foraging resources would be removed.
- Only a relatively small area of disturbed potential roosting/breeding habitat would be removed.
- Potential habitat would not be fragmented or isolated.
- Only approximately 0.03 per cent of eucalypt and riverbank forest would be removed within the locality.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

### *Gang-gang Cockatoo Callocephalon fimbriatum*

The Gang-gang Cockatoo is listed as Vulnerable under Schedule 1 of the TSC Act.

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

The Gang-gang Cockatoo occurs in a variety of forest and woodland habitats dominated by eucalypts. It forages in the canopy on seeds of native and introduced trees, especially eucalypts. Gang-gang cockatoos are dependent on tree hollows for breeding purposes, nesting in large trunks or large limbs (Gibbons and Lindenmayer 1997). The species prefers live trees near water. Although not much is known about the movements of this species, it is considered to be mobile and known to migrate in response to food availability and seasonal changes.

The Gang-gang Cockatoo has not been recorded within the study area previously but has been recorded approximately 1 kilometre east of the study area during field surveys undertaken by Biosis. Over 50 previous records for the Gang-gang Cockatoo exist to the north, south, east and west of the study area (DECC 2009; Birds Australia 2009).

The study area provides potential foraging habitat for the Gang-gang Cockatoo in the form of seed and fruit-bearing trees. The study area also provides limited breeding resources in the form of hollow-bearing trees. However, the study area is unlikely to provide prime or core habitat for this species as the potential habitat occurs as roadside trees over a disturbed understorey (or lacking) and as small patches of woodland surrounded by agricultural land.

Potential breeding and foraging habitat for the Gang-gang Cockatoo occurs in the woodland and forest habitats of the study area. The proposal is likely to remove approximately 3.48 hectares of this habitat with a further 5.41 hectares likely to be indirectly impacted. Up to ten isolated, roadside habitat trees containing medium sized hollows and an additional 15 habitat trees containing medium and large sized hollows located in clusters along the existing alignment would be removed. A further nine habitat trees may be indirectly impacted by the proposal. Given the mobility of this species and extent of habitat within the locality (17789.45 hectares of which 6084 hectares in conservation reserves), it is unlikely that the loss/modification of 0.05 per cent of the available habitat within the locality would disrupt the life cycle of the Gang-gang Cockatoo within the study area.

**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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act 1995 and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There is one listed Endangered Population of Gang-gang Cockatoos in the Ku-ring-gai and Hornsby LGAs (DEC 2005j). This Endangered Population occurs over 130 kilometres north of the study area. The proposal (which occurs in the Shoalhaven LGA) is therefore unlikely to place the Endangered Population at risk of extinction.

**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 threatened species.



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

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

The proposal would remove and/or disturb approximately 3.48 hectares of potential habitat (eucalypt forests and woodland) for the Gang-gang Cockatoo. This potential habitat to be removed/disturbed exists as roadside vegetation, representing less than 0.02 per cent within the locality (17789.45 hectares). Given this species high mobility, it is unlikely that the proposal would further fragment or isolate areas of potential habitat.

Up to ten isolated, roadside habitat trees containing medium sized hollows and an additional 15 habitat trees containing medium and large sized hollows located in clusters along the existing alignment would be removed. A further nine habitat trees may be indirectly impacted by the proposal. The species breeds in October to January and typically migrates to forests of higher altitude than those of the study area and often returns to the same hollow.

The potential habitat to be removed by the proposal is not considered to be important habitat for the long-term survival of the Gang-gang Cockatoo within the locality given the availability of breeding habitats in conservation reserves higher in the escarpment (eg Barren Grounds Nature Reserve and Cambewarra Range Nature Reserve) and extensive foraging habitat located along the Shoalhaven River. Therefore the loss of 0.04 per cent of potential habitat from the locality is unlikely to have long-term negative consequences for the species' local occurrence.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Gang-gang Cockatoo.

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

To date, there is no recovery plan or threat abatement plan for the Gang-gang Cockatoo. However, the DECCW has identified 11 Priority Actions to assist in the recovery of the Gang-gang Cockatoo. One relevant to the proposal is:

- Habitat management: Ongoing environmental impact assessment - advice to consent and planning authorities.

The proposal is consistent with the above Priority Action.

**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 Gang-gang Cockatoo is threatened by the following key threatening processes as listed under Schedule 3 of the TSC Act 1995:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve clearing of 3.48 hectares of native vegetation that provides general foraging habitat for the Gang-gang Cockatoo.
- 'Loss of hollow-bearing trees' (NSW Scientific Committee 2007a) – the proposal would involve the removal of a small number of hollow-bearing trees, which could provide roosting and limited

breeding opportunities for the Gang-gang Cockatoo.

- 'Removal of Dead Wood and Dead Trees' (NSW Scientific Committee 2003b) – some dead wood and dead trees may be removed by the proposal.

## **Conclusion**

The proposal would have the following impacts on the Gang-gang Cockatoo:

- Approximately 3.48 hectares of potential habitat for the Gang-gang Cockatoo would be cleared by the proposal.
- Up to ten isolated, roadside habitat trees containing medium sized hollows and an additional 15 habitat trees containing medium and large sized hollows located in clusters along the existing alignment would be removed. A further nine habitat trees may be indirectly impacted by the proposal.
- The operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Gang-gang Cockatoo, as:

- Individual death and/or injury is highly unlikely.
- Potential habitat would not be fragmented or isolated.
- Foraging habitat removed is not considered limiting in the locality.
- Although suitably sized hollows are present within the study area, the species typically migrates to higher altitudes during the breeding months.
- Indirect impacts (to an area of 4.67 hectares) would be minor and not exacerbate existing edge effects.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of the species in the locality.

Based on the above assessment, an SIS is not considered necessary.

*Glossy Black-cockatoo*      *Calyptorhynchus lathami*

The Glossy Black-cockatoo is listed as Vulnerable under Schedule 2 of the TSC Act 1995.

**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 Glossy Black-cockatoo relies almost entirely on the seeds of a few species of *Allocasuarina* for food, these being *A. littoralis*, *A. torulosa* and *A. verticillata*. They also forage on angophora fruit, sunflower seeds, pine cones and grubs in acacia and *Allocasuarina*. They are dependent on large hollows in mature eucalypts for nesting (Higgins 1999).

The study area provides potential foraging and breeding habitat for the Glossy Black-cockatoo in the form of *Allocasuarina littoralis* and suitably-sized hollow-bearing trees. Preferred *Allocasuarina* species are likely to occur within the Currumbene lowland, Shoalhaven sandstone and Riverbank forests which occur within the study area. Eucalypt forests are likely to provide the mature hollow bearing trees which the Glossy Black-cockatoo requires for nesting.

The Glossy Black-cockatoo was recorded within the study site during field surveys undertaken by Biosis in 2007. The majority of records for the Glossy Black-cockatoo have been to the south west of the study area (over 60 records) (Birds Australia 2009; DECCW 2009) with six records occurring to the south east of the study area (DECCW 2009).

The proposal would remove up to 2.2 hectares of potential foraging habitat (vegetation communities containing *Allocasuarina* feed trees) and 3.48 hectares of potential breeding habitat (eucalypt forests). A further 5.41 hectares of breeding habitat (including 4.66 hectares of foraging habitat) may be indirectly impacted by disturbances such as run-off. The area under direct impact equates to 0.03 per cent of the potential foraging habitat occurring in the locality (7072.49 hectares) and 0.02 per cent of the potential breeding habitat occurring in the locality (17795.50 hectares).

Large hollow bearing trees are needed for breeding, emphasising the need to retain remnant vegetation in these areas just as much as food trees. Glossy Black-Cockatoo are known to have a life span that can exceed 30 years.

Up to 25 suitably-sized hollow-bearing trees do occur within the study area, they occur along roadsides, either over a disturbed understorey or lacking an understorey, or within small patches of woodland surrounded by agricultural land. Given that other tree hollows within and surrounding the study area and those located in the surrounding 6084 hectares of conservation reserve would be retained; the relatively low condition of the potential habitat to be removed (ie isolated roadside trees); and, the high mobility of these species, it is considered unlikely that the proposal would have an adverse effect on the life cycle of the Glossy Black-cockatoo such that a viable local population of these 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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Glossy Black-cockatoo in New South Wales.



**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 threatened species.

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

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

The proposal would result in the removal of approximately 5.4 of eucalypt forests (potential breeding habitat). This equates less than 0.02 per cent of the occurrence of the eucalypt forests within the locality (17461.70ha).

The eucalypt forest occurring within the subject site currently exists as scattered roadside trees. Despite the removal of some woodland from the study area, the proposal would not result in further habitat fragmentation or isolation for the mobile Glossy Black-cockatoo.

The area of potential habitat to be removed by the proposal is predominantly fragmented roadside vegetation. Preferred *Allocasuarina* feed tree species occur within the study area, however, the Glossy Black-cockatoo would be unlikely to rely on the 2.2 hectares of foraging resources within the subject site for ongoing survival. The potential habitat to be removed is partially disturbed (eg cleared, edge-effected) due to its location along the existing roadside and is considered to be of low importance to the long-term survival of the Glossy Black-cockatoo in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Glossy Black-cockatoo.

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

No threat abatement plans have been prepared for the Glossy Black-cockatoo. The DECCW have listed seven recovery strategies including nine priority actions to aid the recovery of this species in New South Wales. The only priority action which is relevant to the proposal is:

- Encourage the restoration of foraging habitat that has been cleared or degraded by previous impacts (DEC 2005I).

Mitigation recommended for the proposal includes restoration of key foraging vegetation communities using local species including *Allocasuarina* species post-construction (Pers. comm. Angie Radford, RMS). As such, the proposal is consistent with the relevant recovery action outlined by the DECCW (in absence of a recovery 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.**

The Glossy Black-cockatoo is threatened by the following key threatening processes:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - the proposal would involve clearing of 2.2 hectares of native vegetation that is potential foraging habitat for the Glossy Black-cockatoo.
- 'Removal of Dead Wood and Dead Trees' (NSW Scientific Committee 2003b) – limited dead wood and dead trees would be removed. These may provide nesting opportunities for the Glossy Black-cockatoo.
- 'Competition and grazing by the feral European rabbit' (NSW Scientific Committee 2002b) – through the removal of 2.2 hectares of potential foraging habitat in the form of native bushland, the proposal may serve to encourage the further spread of feral European rabbits in disturbed habitats, which may suppress the regeneration of *Allocasuarina* and put pressure on the Glossy Black-cockatoo.
- 'Loss of hollow-bearing trees' (NSW Scientific Committee 2007a)- the proposal would involve the removal of some hollow-bearing trees, which could provide nesting opportunities for the Glossy Black-cockatoo.

**Conclusion**

The proposal would have the following impacts on the Glossy Black-cockatoo:

- Approximately 2.2 hectares of potential foraging habitat would be cleared.
- Approximately 4.66 hectares of potential foraging habitat would be indirectly impacted.
- Up to 25 suitably-sized hollow-bearing trees would be removed and up to another nine would be indirectly impacted.
- The operation of four key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Glossy Black-cockatoo, as:

- Suitably sized hollows within the study area occur as roadside and paddock trees either over a disturbed understorey or lacking an understorey or within small patches of woodland surrounded by agricultural land, rather than in large tracts of remnant bushland. Potential habitat would not be fragmented or isolated.
- Only 0.03 per cent of potential foraging habitat containing *Allocasuarina* species and 0.02 per cent of potential breeding habitat (assumed to contain suitable hollow-bearing trees) would be removed.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an SIS is not considered necessary.

*Little Eagle Hieraaetus morphnoides*

*Square-tailed Kite Lophoictinia isura*

The Little Eagle and the Square-tailed Kite are both listed as vulnerable under Schedule 2 of the TSC Act.

These two species of threatened raptors have potential habitat in the study area. They have been assessed together on the basis that they have the same basic requirements.

The distribution of the Square-tailed Kite and the Little Eagle is sparse but widespread throughout Australia,. The Little Eagle is found in most habitat types and it occurs as a single population throughout NSW. Square-tailed Kites occur in coastal and sub-coastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, northeast and along the major west-flowing river systems (DEC, 2005g). It is a summer breeding migrant to the southeast, including the NSW South Coast, arriving in September and leaving by March (DEC, 2005g).

Little Eagles nest in mature living trees in open woodland or tree-lined watercourses. They rarely nest in isolated trees. The nest is an open bowl of twigs and branches, lined with green leaves. The female mainly broods the young and feeds the young small pieces of food bill to bill. The male hunts for food for the young. The male will incubate while the female eats the food he has brought for her. Square-tailed Kites are found in a variety of timbered habitats including dry woodlands and open forests, timbered watercourses, rocky hills and gorges (Marchant and Higgins 1993). They show a particular preference for timbered watercourses.

**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.**

Both species require large living trees for breeding, particularly near water with surrounding woodland or forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993). No raptor nests were located within the study area during field investigations, although riparian vegetation along the larger watercourses is considered to provide potential nesting habitat, however surrounding woodland or forest vegetation is highly disturbed when present at all.

Timbered habitats and riparian vegetation of the study area provide foraging resources for both the Square-tailed Kite and the Little Eagle as prey species including rabbits, other live mammals, small birds and insects have been recorded within the study area or are considered likely to occur. The Little Eagle and Square-tailed Kite however have very large territories, typically greater than 100 square kilometres, and the items of prey occurring within the study area are not limited within the locality.

The proposal would remove approximately 2.94 hectares of potential foraging and nesting habitat. These impacts equate to only 0.01 per cent of similar habitats occurring in the locality (19,473.83 hectares). Given the extent of suitable foraging and nesting habitat within the locality, particularly along the Shoalhaven River and its tributaries, and the typical size of territories for these species, it is unlikely that foraging or nesting resources in the locality would be significantly impacted such that a viable local population of either 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.**

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of Little Eagle or Square-tailed Kite listed under the Act.



**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.**

There are currently no endangered populations of the Little Eagle or Square-tailed Kite listed in NSW.

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

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

The proposal would remove approximately 2.94 hectares of potential foraging and nesting habitat for the Little Eagle or Square-tailed Kite. These impacts equate to only 0.01 per cent of similar habitats occurring in the locality (19,473.83 hectares).

Both species are highly mobile with extremely large territories and are highly capable of negotiating the existing highway, surrounding farmland and rural environments. Habitats removed as a result of the proposal are not likely to effect the current dispersal of either species in the locality such that they become fragmented or isolated from other areas of habitat.

Prey species of the Little Eagle, including rabbits, other live mammals and insects have been recorded within the study area or are considered likely to occur. The Square-tailed Kite feeds mostly on small birds and the contents of their nests, taken from the canopy. The species' diet also includes large insects, reptiles and occasionally small mammals. Habitats of the study area do contain prey species for both raptors. These habitats however are already highly disturbed, and surrounding bushland within the locality including the Shoalhaven River and its tributaries, provide much more suitable and extensive foraging opportunities for Little Eagle and Square-tailed Kite. Therefore, foraging habitat of the study area is not considered to be of importance to either species.

Both species require large living trees for breeding, particularly near water with surrounding woodland or forest close by for foraging habitat. Riparian vegetation along the larger watercourses of the study area is considered to provide potential nesting habitat, however surrounding woodland or forest vegetation is highly disturbed when present at all. As such, nesting habitat of the study area is not considered to be of importance to either species.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Little Eagle or Square-tailed Kite (DECC Threatened Species Unit).

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

There has been no recovery plan prepared for either species, however OEH recommends the following activities to assist the Little Eagle:

- Buffer habitat areas from the impacts of other activities.

- Protect known populations and areas of potential habitat from clearing, fragmentation or disturbance.
- Rehabilitate known and potential habitat.
- Retain and protect nesting and foraging habitat

While the following activities have been recommended to assist the Square-tailed Kite:

- 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.

Given that the habitat within the study area is not considered limiting within the locality and that no raptor nests have been observed within the study area, the proposal is considered to be consistent with the activities recommend by OEH to assist the Little Eagle or Square-tailed Kite.

**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.**

Key Threatening Processes are listed on Schedule 3 of the TSC Act. Those related to the Little Eagle and Square-tailed Kite are:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - the proposal would involve clearing native vegetation that is potential foraging and nesting habitat for threatened raptors.
- 'Removal of Dead Wood and Dead Trees' (NSW Scientific Committee 2003b) – limited dead wood and dead trees will be removed. These may provide shelter for prey items for the Little Eagle and Square-tailed Kite.

**Conclusion**

The proposal would have the following impacts on the Little Eagle and Square-tailed Kite:

- Approximately 2.94 hectares of potential foraging and nesting habitat would be cleared.
- Approximately 5.41 hectares of potential foraging and nesting habitat would be indirectly impacted.
- The operation of two key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Little Eagles or Square-tailed Kites, as:

- No limiting foraging resources would be removed.
- Only a relatively small area of disturbed potential nesting habitat would be removed.
- Potential habitat would not be fragmented or isolated.
- Only approximately 0.03 per cent of suitable habitats would be removed within the locality.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an SIS is not considered necessary for these species.

### *Little Lorikeet Glossopsitta pusilla*

The Little Lorikeet is listed as Vulnerable under Schedule 2 of the TSC Act 1995.

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

The Little Lorikeet prefers open eucalypt forests and woodlands including both old-growth and logged forests in the eastern part of their range, and remnant woodland patches and roadside vegetation on the western slopes (NSW Scientific Committee 2008c). They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and the fruit of mistletoes (NSW Scientific Committee 2008c).

The Little Lorikeet requires tree hollows ideally in smooth-barked eucalypts, such as *Eucalyptus viminalis*, *E. blakelyi* and *E. dealbata* in which to breed (NSW Scientific Committee 2008c). Nest hollows are located at heights of between 2 metre and 15 metre. These hollow openings are very small, approximately 3 cm in diameter (Courtney and Debus 2006). Nest hollows are occasionally located in dead trees, but the Little Lorikeet would generally desert hollows within two years of tree death.

The Little Lorikeet has been previously recorded within the study area on eight occasions since 1986 to 2004 (DECCW 2009). The closest record occurs approximately 0.6 kilometre to the south west in North Nowra, recorded in 1999 (Birds Australia 2009).

Although most breeding records for the species come from the western slopes, the study area contains suitably-sized tree hollows for breeding as well as foraging habitat within the eucalypt forests for the Little Lorikeet. Within the study area the species may forage on nectar and pollen within forest patches and nest in tree hollows (although none of the preferred nesting tree species occur in the study area, despite the species being known to be an uncommon resident of the Shoalhaven).

The proposal would impact potential habitat for the Little Lorikeet through the removal of roadside eucalypt forest. Approximately 3.48 hectares of eucalypt forest (potential foraging and breeding habitat) would be removed from the study area with a further 4.67 hectares affected by indirect impacts (eg edge effects). This combine, equates to only 0.04 per cent of eucalypt forest within the locality (17457.50 hectares). Given the availability of potential habitat within the locality and the high mobility of this species, it is considered unlikely that the proposal would have an adverse effect on the life cycle of the Little Lorikeet 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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Little Lorikeet in New South Wales.

**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 threatened species.

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

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

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

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

The proposal would result in the removal of approximately 3.48 hectares of eucalypt forests (potential foraging and breeding habitat). This equates to less than 0.02 per cent of the occurrence of the eucalypt forests within the locality.

The eucalypt forest occurring within the subject site exists as scattered roadside trees. Despite the removal of some woodland from the study area, the proposal would not result in further habitat fragmentation or isolation for the highly mobile Little Lorikeet.

No preferred nesting tree species occur within the study area, and the Little Lorikeet would be unlikely to rely on the foraging resources provided within the study area for ongoing survival. The potential habitat to be removed is partially disturbed (eg cleared, edge-effected) due to its location along the existing roadside and is considered to be of low importance to the long-term survival of the Little Lorikeet in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat.

To date, no critical habitat has been declared for the Little Lorikeet.

**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 or threat abatement plan for the Little Lorikeet. OEH is yet to identify Priority Actions or Recovery Strategies for this species.

**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 Little Lorikeet is threatened by the following key threatening processes as listed under Schedule 3 of the TSC Act:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve clearing of 3.48 hectares of native vegetation that is potential habitat for the Little Lorikeet.
- 'Infection by *Psittacine circoviral* (beak and feather) disease affecting endangered psittacine species' (NSW Scientific Committee 2008b) – the proposal is unlikely to increase susceptibility of Little Lorikeets to *Psittacine circoviral* disease.
- 'Forest eucalypt dieback associated with over-abundant bell miners and psyllids' (NSW Scientific Committee 2008a) – the proposal is unlikely to increase the incidence of bell miners or psyllids.

## Conclusion

The proposal would have the following impacts on the Little Lorikeet:

- Approximately 3.48 hectares of potential foraging habitat for the Little Lorikeet would be cleared by the proposal.
- Removal of up to 25 hollow-bearing trees and indirect impacts to up to an additional nine.
- The operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Little Lorikeet, as:

- Individual death and/or injury is highly unlikely.
- Potential habitat would not be fragmented or isolated.
- Only approximately 0.02 per cent of potential foraging and breeding habitat would be removed from the locality.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of the species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

### *Scarlet Robin Petroica boodang*

The Scarlet Robin is listed as vulnerable under Schedule 2 of the TSC Act 1995.

**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 Scarlet Robin occurs in open shrubby or grassy undergrowth in forests and woodlands with abundant logs and woody debris. The Scarlet Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. Most prey is collected from ground or air (70 per cent) but the rest is collected from plants including: *Eucalyptus caliginosa*, *E. blakelyi*, *E. melliodora*, acacias and mistletoe.

The species builds an open cup nest 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 two metres above the ground (Higgins and Peter 2002; Debus 2006). In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees.

The Scarlet Robin has previously been north, south, east and west of the study area. The species has been previously recorded on twelve occasions within a ten kilometre radius of the study with the most recent record dating from 2010. These most recent records occur to the north of the study area west of Berry within properties surrounded by well connected forest vegetation. The closest record occurs at the Shoalhaven River, Bombaderry dating from 1986. The Scarlet Robin may use the study area on occasion during the nonbreeding season when it moves into open habitats.

The study area provides potential foraging and some nesting habitat for the species within the forests and farmland areas. The proposal would impact 2.41 hectares of this potential habitat through the removal of trees and branches, and disturbance of groundcover during construction.

Given the mobility of the Scarlet Robin migrating to open habitats during the non-breeding season, and the availability of potential habitat in the locality (including protected habitat within surrounding intact woodland habitats of Seven Mile Beach National Park, Barren Grounds Nature Reserve ), the loss of approximately 0.01 per cent (of the 18,644.75 hectares) of non-limiting eucalypt forest and farmland habitat is unlikely to disrupt the feeding behaviour and life cycle of a viable local population of the Scarlet Robin to place it at risk of extinction within the study area or locality.

**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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the NSW Scientific Committee, is facing a very high risk of extinction in NSW in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Scarlet Robin in NSW.

**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 threatened species.



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

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

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

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

The proposal would impact potential foraging habitat for the Scarlet Robin through the removal of approximately 0.02 per cent (2.41 hectares) of non-limiting eucalyptus forest habitat. Approximately 2.41 hectares of eucalypt forest (potential foraging habitat) would be removed from the study area. This equates to only 0.02 per cent of the potential habitat (e.g. eucalypt forest and farmland) available within the locality (18,644.75 hectares). A further 5.41 hectares may be affected by indirect impacts (eg edge effects), totalling 0.04 per cent of the potential habitats present within the locality. Given the availability of known and potential habitat within the locality (including protected habitat within Seven Mile Beach National Park and Barren Grounds Nature Reserve), that no known breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that the proposal would have a significant impact on the Scarlet Robin habitat within the locality.

Populations of the Scarlet Robin are found within throughout most of mainland Australia with the distribution in NSW being nearly continuous from the coast to the far west of the state. The study area is not at, or near, the limit of distribution for this species.

The majority of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation. Wildlife corridors in the study area, therefore, are limited. Potential corridors in the study area are confined to degraded native and exotic riparian vegetation, which generally provide a discontinuous strip of vegetative cover through an otherwise cleared landscape.

The proposal is likely to remove and/or modify approximately 7.82 hectares (2.41 hectares from direct impacts with a further 5.41 hectares indirectly impacted) of known and potential foraging habitat from the study area. The areas to be removed (predominantly roadside) are edge affected and of lower habitat quality than surrounding intact vegetation. Given the availability of surrounding eucalypt forests and farmland, the small areas of proposed vegetation removal (the 2.41 hectares to be removed is made up of smaller areas spread along the 11.25 kilometre route) and the mobility of the Scarlet Robin, it is considered unlikely that the proposal would create or exacerbate barriers for this species.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Scarlet Robin (DECC 2008).

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

There are currently no recovery plan or threat abatement plan prepared for this species. A list of recovery actions identified for the Scarlet Robin by OEH include;

- Retain existing vegetation and remnant stands along roadsides and in paddocks.
- Increase the size of existing remnants by planting trees and establishing buffer zones.
- Where remnants have lost connective links, re-establish links by revegetating corridors or stepping stones.
- Limit firewood collection and retain dead timber in open forest and woodland areas.

- Encourage regeneration of habitat by fencing remnant stands and managing the intensity and duration of grazing.
- Control weeds in areas of known habitat.

The proposal would involve clearing of native vegetation which constitutes potential foraging habitat for this species. As such, the proposal is not entirely consistent with the objectives outlined by the recovery activities for the Scarlet Robin.

**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 Scarlet Robin is threatened by the following key threatening processes as listed under Schedule 3 of the TSC Act 1995:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve clearing of 2.41 hectares of native vegetation that provide potential habitat for the Scarlet Robin.
- Removal of Dead Wood and Dead Trees (NSW Scientific Committee 2003) - fallen timber provides temporary shelter and predator protection for the Scarlet Robin. Fallen timber within the study area may be removed by the proposal.

**Conclusion**

The proposal would have the following impacts on the Scarlet Robin:

- Approximately 2.41 hectares of potential foraging and breeding would be cleared.
- Approximately 5.41 hectares of potential foraging and breeding habitat would be indirectly impacted.
- The operation of two key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Scarlet Robin, as:

- No limiting foraging resources would be removed.
- Only a relatively small area of disturbed potential habitat would be removed.
- Only approximately 0.02 per cent of eucalypt forest and farmland would be removed within the locality.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

*Swift Parrot*    *Lathamus discolor*

The Swift Parrot is listed as Endangered under Schedule 1 of the TSC Act 1995. The species is also listed as Endangered under the EPBC Act 1999.

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

The Swift Parrot prefers open eucalypt forests where it feeds on nectar and lerps. Breeding only occurs in Tasmania. During the non-breeding season large flocks congregate at suitable feeding resources throughout eastern New South Wales. Preferred feed trees include winter-flowering species such as *Eucalyptus robusta*, *E. sideroxylon*, *E. albens*, *Corymbia maculata* and *C. gummifera* (Higgins 1999; DEC 2005). Commonly used lerp infested trees include *E. macrocarpa*, *E. moluccana* and *E. pilularis* (DEC 2005). The Swift Parrot moves between foraging sites on a cyclic basis depending on food availability.

The study area does not contain potential breeding habitat for the Swift Parrot as this species breeds only in Tasmania (Higgins 1999). The study area does provide potential foraging habitat for the Swift Parrot within the eucalypt forests. Three favoured feed tree species (*Corymbia maculata*, *C. gummifera* and *Eucalyptus pilularis*) occur within the study area. *Corymbia maculata* is dominant within Currumbene lowlands forest, *C. gummifera* is a dominant species within Shoalhaven sandstone forest and *Eucalyptus pilularis* is dominant within Illawarra gully wet forest.

The Swift Parrot has not been previously recorded within the study area. The closest record occurs approximately 9 kilometre to the south east at Shoalhaven Heads, recorded in 1984 (DECCW 2009). No other records of the species occur within 10 kilometre of the study area.

The proposal is unlikely to impact the breeding cycle of the Swift Parrot as no potential breeding habitat occurs on site. The proposal would impact potential foraging habitat for the Swift Parrot through the removal of roadside eucalypt forest. Approximately 1.98 hectares of eucalypt forest (potential foraging habitat) would be removed from the study area with a further 4.68 hectares affected by indirect impacts (eg edge effects). This equates to only 0.03 per cent of eucalypt forest within the locality (17457.50 hectares). Given the availability of potential foraging habitat within the locality, the fact that no breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that the proposal would have an adverse effect on the life cycle of the Swift Parrot 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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act 1995 and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species). Populations of the Swift Parrot are not eligible for listing as Endangered Populations as the species is already listed as Endangered.

**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 threatened species.



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

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

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

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

The proposal would result in the removal of approximately 1.98 hectares of eucalypt forests (potential foraging habitat). This equates to less than 0.01 per cent of the occurrence of the eucalypt forests within the locality.

The eucalypt forest occurring within the subject site is currently scattered roadside trees. Despite the removal of some woodland from the study area, the proposal would not result in further habitat fragmentation or isolation for the highly mobile Swift Parrot.

The area of potential habitat to be removed by the proposal is small and does not provide potential breeding habitat. Three preferred feed tree species occur within the study area, however, the Swift Parrot would be unlikely to rely on the foraging resources within the study area for ongoing survival. The potential habitat to be removed is partially disturbed (eg cleared, edge-effected) due to its location along the existing roadside and is considered to be of low importance to the long-term survival of the Swift Parrot in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Swift Parrot.

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

A national recovery plan has been prepared for the Swift Parrot (Swift Parrot Recovery Team 2001). The objectives of the plan include:

- To identify priority habitats and sites across the range of the Swift Parrot.
- To implement management strategies at the landscape scale to protect and improve priority habitats and sites resulting in a sustained improvement in carrying capacity.
- To reduce the incidence of collisions with man-made structures.
- To determine population trends within the breeding range.
- To quantify improvements in carrying capacity by monitoring changes in extent and quality of habitat.
- To increase public awareness about the recovery program and to involve the community in the recovery.

The proposal is considered to be consistent with the recovery plan.

A Threat Abatement Plan (TAP) relevant to the Swift Parrot is the national TAP for predation by feral cats (DEWHA 2008b). The overall objective of the plan is to focus cat control on areas where the impacts of predation on threatened fauna are greatest. The Swift Parrot is listed in the TAP as a threatened species that may be adversely affected by feral cats (DEWHA 2008b). Habitat management, including reduction of fragmentation and increase of vegetation density is identified as a critical factor in feral cat control (DEWHA 2008b; Biodiversity Group Environment Australia 1999a; Biodiversity Group Environment Australia 1999b). The proposal would not involve further fragmentation or a notable increase in edge effects in the study area. As such, the proposal is consistent with the objectives of the TAP for predation by feral cats.

**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 Swift Parrot is threatened by the following key threatening processes as listed under Schedule 3 of the TSC Act 1995:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve clearing of 1.98 hectares of native vegetation that is potential habitat for the Swift Parrot.
- 'Infection by *Psittacine circoviral* (beak and feather) disease affecting endangered psittacine species' (NSW Scientific Committee 2008b) – the proposal is unlikely to increase susceptibility of Swift Parrots to *Psittacine circoviral* disease.
- 'Forest eucalypt dieback associated with over-abundant bell miners and psyllids' (NSW Scientific Committee 2008a) – the proposal is unlikely to increase the incidence of bell miners or psyllids.

**Conclusion**

The proposal would have the following impacts on the Swift Parrot:

- Approximately 1.98 hectares of potential foraging habitat for the Swift Parrot would be cleared by the proposal.
- The operation of two of three likely key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Swift Parrot, as:

- No breeding habitat would be removed.
- Individual death and/or injury is highly unlikely.
- Potential habitat would not be fragmented or isolated.
- Approximately 99.99 per cent of potential foraging habitat would remain within the locality.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of the species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

### *Turquoise Parrot Neophema pulchella*

The Turquoise Parrot is listed as Vulnerable under Schedule 2 of the TSC Act 1995.

**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.**

Turquoise Parrots occur in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). The species is found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). They nest in hollow-bearing trees or hollows in tree stumps and they prefer to breed in open grassy forests and woodlands, and gullies which are moist (Higgins 1999).

The Turquoise Parrot is an uncommon visitor to the Shoalhaven and has been previously recorded within the study area once to the south near Shoalhaven River in 1975 (DECCW 2009). It has also been recorded to the north just outside of Budderoo National Park, in 1999 (Birds Australia 2009). No other records of the species occur within 10 kilometre of the study area.

The study area contains potential breeding habitat for the Turquoise Parrot in the form of hollow-bearing trees within eucalypt forests, however only one of these habitat trees, Tree 19, containing a vertical or near-vertical hollow suitable for nesting will be removed. (Higgins 1999). The Turquoise Parrot requires a diverse layer of shrubs and grasses in which to forage.

The proposal would impact potential breeding and foraging habitat for the Turquoise Parrot through the removal of roadside eucalypt forest. The vegetation to be removed as part of the proposal currently exists as scattered roadside trees, some of which contain hollows. Approximately 3.48 hectares of eucalypt forest (potential habitat) would be removed from the study area with a further 4.67 hectares affected by indirect impacts (eg edge effects). This equates to only 0.04 per cent of eucalypt forest within the locality (17789.46 hectares). Given the availability of potential habitat within the locality (including habitat protected within Cambewarra Range Nature Reserve and Barren Grounds Nature Reserve), and the high mobility of this species, it is considered unlikely that the proposal would have an adverse effect on the life cycle of the Turquoise Parrot 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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act 1995 and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Turquoise Parrot in New South Wales.

**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 threatened species.



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

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

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

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

The proposal would result in the removal of approximately 3.48 hectares of eucalypt forests (potential foraging habitat). This equates to less than 0.01 per cent of the occurrence of the eucalypt forests within the locality.

The eucalypt forest occurring within the subject site exists as scattered roadside trees. Despite the removal of some woodland from the study area, the proposal would not result in further habitat fragmentation or isolation for the highly mobile Turquoise Parrot. The potential habitat to be removed is partially disturbed (eg cleared, edge-effected) due to its location along the existing roadside and is considered to be of low importance to the long-term survival of the Turquoise Parrot in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat.

To date, no critical habitat has been declared for the Turquoise Parrot.

**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 or threat abatement plan for the Turquoise Parrot. OEH, however, has listed 10 Priority Actions and seven Recovery Strategies to help recover the Turquoise Parrot (DEC 2005). Those relevant to the proposal include:

- Retain hollow-bearing trees and provide for hollow tree recruitment.
- Retain foraging habitat.
- Conduct searches for the species in suitable habitat in proposal areas.

As the Turquoise Parrot has not been identified in the study area from current surveys, it is unlikely that the study area contains a high density population. The study area has not been identified as an important population by OEH. As such, the proposal is considered to be consistent with the relevant recovery actions outlined by OEH (in absence of a recovery plan).

One suitable roadside hollow-bearing trees (potential breeding habitat) would be removed. The proposal would involve clearing of native vegetation which constitutes foraging habitat for the Turquoise Parrot. As such, the proposal is not entirely consistent with the objectives outlined by OEH (in the absence of a recovery plan).

A TAP relevant to the Turquoise Parrot is the national TAP for predation by feral cats (DEWHA 2008b). The overall objective of the plan is to focus cat control on areas where the impacts of predation on threatened fauna are greatest. The Turquoise Parrot is listed in the TAP as a threatened species that may be adversely affected by feral cats (DEWHA 2008b). Habitat management, including reduction of fragmentation and increase of vegetation density is identified as a critical factor in feral cat control (DEWHA 2008b; Biodiversity Group Environment Australia 1999a; Biodiversity Group Environment Australia 1999b). The proposal would not involve further fragmentation or a notable increase in edge effects in the study area. As such, the proposal is consistent with the objectives of the TAP for predation by feral cats.

**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 Turquoise Parrot is threatened by the following Key Threatening Processes as listed under Schedule 3 of the TSC Act:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve clearing of 3.48 hectares of native vegetation that is potential habitat for the Turquoise Parrot.
- 'Infection by *Psittacine circoviral* (beak and feather) disease affecting endangered psittacine species' (NSW Scientific Committee 2008b) – the proposal is unlikely to increase susceptibility of Turquoise Parrots to *Psittacine circoviral* disease.

**Conclusion**

The proposal would have the following impacts on the Turquoise Parrot:

- Approximately 3.48 hectares of potential breeding and foraging habitat for the Turquoise Parrot would be cleared by the proposal.
- The loss of one suitable isolated, roadside habitat tree containing hollows.
- The operation of two key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Turquoise Parrot, as:

- Individual death and/or injury is highly unlikely.
- Potential habitat would not be fragmented or isolated.
- Approximately 0.01 per cent of potential foraging habitat would be removed from the locality.
- The proposal would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of the species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

*Varied Sittella Daphoenositta chrysoptera*

The Varied Sittella is listed as vulnerable under Schedule 2 of the TSC Act 1995.

**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 is sedentary and inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland (OEH 2012e). The Varied Sittella forages on arthropods gleaned from crevices in rough or decorticated bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. Cup-shaped nest of plant fibres and cobwebs are built in upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (Higgins and Peter 2002; Barrett et al. 2007).

The study area provides a small portion of habitat suitable for the Varied Sittella in the woodland to the south. The species has also been previously recorded to the south west, north east and south east of the study area. Being a sedentary species, the closest record of the species is along Bomaderry Creek 700 metres from the study area. It may be likely that the species utilises the woodland habitat of the study area on occasion. The proposal would impact 1.98 hectares of this potential habitat through the removal of trees and branches, and disturbance of groundcover during construction.

The species has been previously recorded on twenty occasions within a ten kilometre radius of the study area with the most recent record dating from 2011. The majority of records occur within Seven Mile Beach National Park, Barren Grounds Nature Reserve and along intact woodland vegetation north of the Shoalhaven River and within Sharpe Reserve.

Given the mobility of the Varied Sittella and the availability of potential habitat in the locality (including protected habitat within surrounding intact woodland habitats of Seven Mile Beach National Park), the loss of approximately 0.01 per cent (0.02 per cent (1.98 hectares)) of non-limiting eucalypt forest habitat is unlikely to disrupt the feeding behaviour and life cycle of a viable local population of the Varied Sittella to place it at risk of extinction within the study area or locality.

**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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the NSW Scientific Committee, is facing a very high risk of extinction in NSW in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Varied Sittella in NSW.

**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 threatened species.

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

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

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

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

The proposal would impact potential foraging habitat for the Varied Sittella through the removal of approximately 0.01 per cent of non-limiting eucalyptus forest habitat. Approximately 1.98 hectares of eucalypt forest (potential foraging habitat) would be removed from the study area with a further 4.68 hectares affected by indirect impacts (eg edge effects). This equates to only 0.03 per cent of the potential habitat (eg eucalypt forest) available within the locality (17,457.50 hectares). Given the availability of known and potential habitat within the locality (including protected habitat within Seven Mile Beach National Park and Barren Grounds Nature Reserve), that no known breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that the proposal would have a significant impact on the Varied Sittella habitat within the locality.

Populations of the Varied Sittella are found within throughout most of mainland Australia with the distribution in NSW being nearly continuous from the coast to the far west of the state. The study area is not at, or near, the limit of distribution for this species.

The majority of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation. Wildlife corridors in the study area, therefore, are limited; however the Princes Highway does cross the Seven Mile Beach National Park – Barren Grounds Nature Reserve corridor. Vegetation remnants at Toolijooa Ridge, Broughton Creek, Broughton Mill Creek and Bundewallah Creek are discontinuous parts of this corridor.

The proposal is likely to remove and/or modify approximately 6.66 hectares (1.98 hectares from direct impacts with a further 4.68 hectares indirectly impacted) of known and potential foraging habitat from the study area. The areas to be removed (predominantly roadside and riparian areas) are contiguous with intact forest that would remain. Given the availability of surrounding eucalypt forests, the small areas of proposed vegetation removal (the 1.98 hectares to be removed is made up of smaller areas spread along the 11.25 kilometre route) and the mobility of the Varied Sittella, it is considered unlikely that the proposal would create or exacerbate barriers for this species.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Varied Sittella (DECC 2008).

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

There are currently no recovery plan or threat abatement plan prepared for this species. A list of recovery actions identified for the Varied Sittella by OEH include;

- Retain existing vegetation and remnant stands along roadsides and in paddocks.
- Increase the size of existing remnants by planting trees and establishing buffer zones.
- Where remnants have lost connective links, re-establish links by revegetating corridors or stepping stones.
- Limit firewood collection and retain dead timber in open forest and woodland areas.
- Encourage regeneration of habitat by fencing remnant stands and managing the intensity and duration of grazing.



- Control weeds in areas of known habitat.

The proposal would involve clearing of native vegetation which constitutes potential habitat for this species. As such, the proposal is not entirely consistent with the objectives outlined by the recovery activities for the Varied Sittella.

**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 Varied Sittella is threatened by the following key threatening processes as listed under Schedule 3 of the TSC Act 1995:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve clearing of 1.98 hectares of native vegetation that provide potential habitat for the Varied Sittella.
- Removal of Dead Wood and Dead Trees (NSW Scientific Committee 2003) - fallen timber provides temporary shelter and predator protection for the Varied Sittella. Fallen timber within the study area may be removed by the proposal.

**Conclusion**

- The proposal would have the following impacts on the Varied Sittella:
- Approximately 1.98 hectares of potential foraging and breeding would be cleared.
- Approximately 4.68 hectares of potential foraging and breeding habitat would be indirectly impacted.
- The operation of two key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Varied Sittella, as:

- No limiting foraging resources would be removed.
- Only a relatively small area of disturbed potential habitat would be removed.
- Only approximately 0.01 per cent of eucalypt forest would be removed within the locality.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

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

The Green and Golden Bell Frog (GGBF) is listed as endangered under Schedule 1 of the TSC Act and vulnerable under the EPBC Act.

Literature detailing GGBF habitat in NSW suggests that suitable breeding habitat for the species consists of ponds or slowly moving water bodies that are shallow (ie less than one metre deep), sunny (ie exposed to direct sunlight for at least six hours a day during the spring/summer season), fish-free, contain open water and emergent vegetation, and experience certain kinds of disturbance regimes such as fluctuating water level or inflow of salty water (Pyke and White 1996; Pyke and White 2001; White and Pyke 2008; Pyke et al. 2002). The species also requires foraging and sheltering habitat in the form of low vegetation or solid objects such as rock, timber and other human artefacts as well as submerged and floating vegetation over the water body. The species is known to disperse over large distances between suitable water bodies. It is likely that the species disperses from core populations during seasons of high reproductive success.

The GGBF is known to breed during late winter to early autumn with a peak around January-February after heavy rain or storms (DSEWPaC 2011; Daly 1995; White 2001). *Gambusia* are capable of preying on hatchlings and tadpoles of the GGBF and, in 1999 the NSW Science Committee determined that predation by *Gambusia* poses a serious threat to the survival of threatened species. It is now listed as a key threatening process under Schedule 3 of the TSC Act 1995 (NPWS 2003a). GGBF populations in NSW have undergone a significant decline in numbers over the past few decades. Of the 31 populations known to exist in 1995, seven are considered to be extinct and four to be probably extinct leaving only 20 known populations comprised of 24 sub-populations (White and Pyke 2008).

The GGBF has been previously recorded 106 times in the locality with the most recent record from 2012. All of these records are associated with the Coomonderry Swamp Key Population.

Given the presence of potential breeding, foraging and dispersal habitat throughout the study area and the potential for the species to disperse through the subject site on occasion, a precautionary approach has been adopted. The following assessment of significance has been completed on the basis that additional targeted surveys for the GGBF would be undertaken during the appropriate season once a detailed design of the proposal is available.

**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.**

Despite suitable breeding habitat being present within the study area, the GGBF has not previously been recorded within the study area (although note that no targeted surveys were undertaken as part of the current survey). A network of permanent and ephemeral waterways provide connective habitat to the Coomonderry Swamp Key Population, over five kilometres to the east. This core habitat is considered to be critical to the life cycle for the local population of the species. It may be likely that in times of range expansion, as demonstrated in the Crookhaven River Floodplain population during the 2011/2012 seasons, the species may disperse and establish within the study area.

This assessment relies on the premise that the proposal would avoid and mitigate impacts, with the specific aim of ensuring works do not result in a significant impact according to both State and federal legislation to the GGBF if it is found following targeted surveys.

Provided that, if the species is located within the study area, a GGBF Management Plan would be developed to ensure works would be undertaken in a manner that would ensure as far as feasible and reasonable, the most suitable habitat is retained and that works associated with the decommissioning of water bodies considered to be breeding habitat are completed with a zoologist experienced in the identification and management of the GGBF present, a significant impact that places the local population placed at risk of extinction can be avoided.

**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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the GGBF in New South Wales.

**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 threatened species

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

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

Following habitat assessments, at least eight water bodies are considered to support suitable breeding habitat features for the species, including some if not all of the following:

- Presence of emergent aquatic vegetation such as *Phragmites australis* Common Reed and *Typha domingensis* Narrow-leaved Cumbungi.
- Presence of ground and shrub layers adjacent to the water body for foraging.
- Presence of ponding, shallow water (ie less than 1 metre deep) that is exposed to direct sunlight for at least six hours a day during the spring/summer season.
- Absence of predatory fish.
- Presence of a disturbance regime in the form of fluctuating water levels.
- Presence of areas that can be utilised by the species for access/egress to sheltering (over-wintering) sites such as rock, timber and other human artefacts as well as submerged and floating vegetation over the water body.

The proposed works would result in the removal of four water bodies in the form of farm dams and pooling creeks, from the direct subject site and have the potential to indirectly impact an additional three, which are located within the indirect subject site. The remaining one is located in the study area. An additional 120.15 hectares of potential dispersal or sheltering habitat has been mapped in an area surrounding 200 metres of each of the breeding habitats, resulting in the following:

- 20.97 hectares located within the direct subject site
- 29.90 hectares located within the indirect subject site.

The remaining 69.28 hectares is terrestrial habitat located in the study area.

The GGBF is a highly mobile species (Goldingay and Lewis 1999), capable of moving several kilometres between breeding sites (Pyke and White 2001). Suitable breeding ponds for the species in the locality occur west of the Coomonderry Swamp Key Population (Daly 1996). The study area is likely to form the most western extent in term of dispersal for the species being located at the limit of the coastal floodplain. While there is some connectivity from the eastern side of the study area to the west via the existing 17 temporary and permanent water bodies, it is unlikely that the species would disperse to habitats of higher altitude west beyond the study area. A total of eight crossings, including three (Wileys Creek, Jaspers Brush Creek and Flying Fox Creek) where the incorporation of fauna friendly design features would be considered, are proposed along existing creek crossings which would assist in the maintenance of connectivity east-west across the study area post-construction. Therefore, it is not considered that any area of habitat would become fragmented or isolated from other areas of habitat as a result of the proposal.

The current state of habitat throughout the study area is considered to be of moderate conservation value for the GGBF as the site provides dispersal and potential breeding habitat for an important (key) population of the species in times when ranges are extended. Under "normal" circumstances however, it is likely that this habitat would not be used. Nevertheless, the potential habitat to be directly impacted is considered to be of moderate importance to the long-term survival of the species in the locality.

Provided that targeted surveys for the species are completed in seasons of optimal detection and that if the species is located, a GGBF Management Plan is prepared to avoid and mitigate impacts to the species, no significant impact is likely to result on breeding, dispersal or sheltering habitat either directly or indirectly such as that caused by fragmentation.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the GGBF.

**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 GGBF (DEC 2005). This plan has recognised the Coomonderry Swamp Key Population which is located just over five kilometres from the study area. The main objectives of the plan are:

- Manage threats impacting on currently known populations so as to stabilise and prevent further decline.
- Return the species to its former distribution, abundance and role in the ecosystem wherever possible.
- Five specific objectives that aim to achieve the overall recovery objectives above are:
  - Increase the security of key GGBF populations by preventing the further loss of habitat of key populations and where possible secure opportunities for increasing protection of habitat areas.
  - Ensure extant populations are managed to eliminate threats.
  - Implement habitat management initiatives.
  - Establish captive populations.
  - Increase the level of awareness of the conservation status of the GGBF and provide greater opportunity for community involvement in the implementation of the recovery plan.



Given the proximity to this core population and recent examples of how the species can rapidly disperse through the landscape, it may be likely that the GGBF could utilise the habitats of the study area on occasion. The proposal, and associated habitat removal, would be undertaken in accordance with the guidelines set out in the recovery plan for this species (pers comm. Josie Stokes, RMS).

A threat abatement plan relevant to the GGBF is the Predation by Mosquito Fish Threat Abatement Plan (NPWS 2003c). Predation by Mosquito Fish has been identified as a serious threat to the GGBF. The proposal is consistent with the objectives of the TAP.

**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.**

Key Threatening Processes are listed on Schedule 3 of the TSC Act. Those related to the GGBF are:

- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' – few of the water bodies within the study area are natural waterways, having been dammed and channelled in the past. The proposal would remove four water bodies, in the form of farm dams and pooling creeks, from the direct subject site and have the potential to indirectly impact an additional three.
- 'Clearing of native vegetation' – the proposal would involve the removal and/or modification of native vegetation that provides movement corridors for the GGBF in the study area.
- 'Predation by the European red fox' – it is known that foxes inhabit the study area. The proposal is unlikely to increase fox numbers or lead to increases in the predation pressure exerted by this species on the GGBF.
- 'Predation by feral cats' – feral cats may also inhabit the study area. The proposal is unlikely to increase cat numbers or lead to increases in the predation pressure exerted by this species on the GGBF.
- 'Infection by amphibian chytridiomycosis disease' – it is currently unknown whether Chytrid fungus is present in amphibian populations occurring in the study area. The proposal is unlikely to exacerbate the infection or spread of Chytrid Fungus. Hygiene measures would be implemented to ensure works do not result in the spread of this disease.
- 'Predation by *Gambusia holbrooki* (Mosquito Fish)' – removal of submergent vegetation is thought to increase predation events as tadpoles cannot escape fish. Given that the study area provides little breeding opportunities, predation by Mosquito Fish is unlikely to increase in response to the proposal.

## Conclusion

The proposal would have the following impacts on the GGBF:

- Direct removal of four potential breeding water bodies considered to have low to moderate value in the locality.
- Indirect modification of three potential breeding water bodies considered to have low to moderate value in the locality.
- The operation of key threatening processes including the 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands', 'Clearing of Native Vegetation' and 'Predation by *Gambusia holbrooki* (Mosquito Fish)'.

This assessment of significance has been prepared on the basis of assuming that the recommended further targeted surveys would proceed closer to the detailed design phase. The outcomes of this assessment has also relied on the premise of avoiding and mitigating impacts to the GGBF to ensure the proposal would not result in a significant impact to this species (RTA, 2011).

With the above statement taken into account, the proposal is considered unlikely to result in a significant impact on a local population of the GGBF as:

- Works would be designed to ensure that a significant impact on a local population of the GGBF does not result, including targeted surveys to identify key microhabitats (if they occur) and that if the species is located, a GGBF Management Plan is prepared to avoid and mitigate impacts to the species.
- The proposal would be undertaken in accordance with the guidelines set out in the recovery plan for this species through the implementation of mitigation measures including; the enhancement and replacement of habitat within the study area and wider locality. This would ensure that the proposal would not interfere with the recovery of the species.

Based on a commitment to follow due diligence according to RMS policy and State and Commonwealth legislation and implement safeguards and management actions should the species be located in future surveys of the study area, an SIS is not considered necessary for this species.

*Eastern Bentwing-bat* *Miniopterus schreibersii oceanensis*

*Large-eared Pied Bat* *Chalinolobus dwyeri*

The Eastern Bentwing-bat and the Large-eared Pied Bat are listed as vulnerable under Schedule 2 of the TSC Act. The Large-eared Pied Bat is listed as vulnerable under the EPBC Act.

These two species of threatened microbats have potential habitat in the study area. They have been assessed together on the basis that they have the same basic ecological requirements.

The Eastern Bentwing-bat uses a broad range of habitats including rainforests, wet and dry sclerophyll forests, open woodlands and open grasslands (Churchill 2008). The Eastern Bentwing-bat is an obligate cave dwelling species; however it also utilises a number of man-made structures such as mine shafts and road culverts for roosting. Maternity caves used for birthing and rearing of young during spring and summer tend to have specific and stable temperature and humidity regimes. These caves can contain a large number of individuals and are used year after year (Churchill 2008). Bungonia Caves, located approximately 50 kilometres west and Wombeyan Caves, located approximately 65 kilometres northwest are the two closest maternity caves.

The Large-eared Pied Bat occurs in areas containing extensive cliff and caves, commonly in dry sclerophyll forests and woodlands (Churchill 2008). In the Sydney Basin the species is common in areas of high fertility soils in wet sclerophyll forests along the edges of sandstone escarpments. The Large-eared Pied Bat roosts in colonies of between three and 80 (but usually less than 10 individuals) in caves, Fairy Martin nests and mines, and beneath rock overhangs. It is likely that it hibernates during the cooler months. In NSW, four maternity roost sites have been recorded (DERM 2011), however, one was permanently flooded in 1976 and one was abandoned in 2009 (TSSC 2010az). The most reliable maternity roost is in a sandstone cave near Coonabarabran, 500 kilometres northwest of the study area.

Foraging habitat for both species occurs throughout the subject site and study area along vegetated corridors and waterbodies. Eastern Bentwing-bat has been previously detected 15 times in the locality with the most recent recorded in 2011. One record of the Eastern Bentwing-bat (recorded over four consecutive nights) is located just beyond the study area. Three previous records of the Large-eared Pied Bat occur within the locality, with the most recent record within study area made by Biosis during the 2009 field investigations (Biosis 2009).

The current field surveys of the subject site and study area located 13 microbats roosting within two vertical crevices of the bridge crossing Flying Fox Creek. Although not confirmed, it is very likely that this species is the Eastern Bentwing-bat. Several additional bridges and culverts within the subject site are also considered to provide habitat for the species, although not all have been inspected. Given the presence of non-maternal roosting and foraging habitat throughout the study area, the following assessment of significance has been completed on the basis that additional targeted surveys for the Eastern Bentwing-bat would be undertaken during the appropriate season to confirm the number of roost sites once a detailed design of the proposal is available.

**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 proposal is likely to directly remove and/or modify about 3.48 hectares of potential foraging habitat for the Eastern Bentwing-bat and Large-eared Pied Bat. The direct impacts during construction equate to only 0.02 per cent of similar habitat types occurring in the locality (18,644.75 hectares).

Given that the Eastern Bentwing-bat is highly mobile and known to forage in urban environs, the removal or modification of foraging habitat in the study area is not likely to effect on the life cycle of the species such that a viable local population is placed at risk of extinction. Little is known about the diet and foraging behaviour of the Large-eared Pied Bat, however Churchill (2008) has recorded them foraging along a creek bed and at mid-canopy level 6-10 metres above the ground. Almost all records are within several kilometres of cliff lines or rocky terrain and it is thought that critical foraging resources are also located in these areas (DERM 2011). Individuals of the Large-eared Pied Bat are likely to utilise resources within the study area on occasion for foraging purposes and are more likely to roost in caves and cliffs associated with the Illawarra Escarpment to the west. The proposal is unlikely to substantially alter the existing foraging habitat for this species to effect on the life cycle of the species such that a viable local population is placed at risk of extinction.

Thirteen microbats were located roosting in the bridge over Flying Fox Creek within the study area. It is very likely that this species was the Eastern Bentwing-bat and that there are other artificial structures such as culverts and bridges along the alignment that may provide suitable roosting habitat. Similarly, a number of culverts were noted to contain Fairy Martin nests which are known non-maternity roosts for the Large-eared Pied Bat however occupancy was not ascertained.

This assessment relies on the premise that the proposal would avoid, mitigate and minimise residual impacts with the specific aim of ensuring works do not result in a significant impact to threatened microbats according to state legislation.

Additional surveys are required to identify roost habitats within the subject site following the detailed design of the proposal. Provided a Microbat Plan of Management is developed to ensure works would be undertaken in a manner that would ensure that roosting habitat is either retained or supplemented through the establishment of bat roost boxes (species dependant), and that no individuals are harmed in the decommissioning of the existing roosts, a significant impact that places the local population placed at risk of extinction can be avoided.

**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.**

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of Eastern Bentwing-bat or Large-eared Pied Bat listed under the Act.

**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 threatened species.

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

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



The proposal is likely to directly remove and/or modify approximately 3.48 hectares of potential foraging habitat for the Eastern Bentwing-bat and Large-eared Pied Bat, with a further 5.41 hectares likely to be indirectly impacted.

One known microbat roost, likely to be Eastern Bentwing-bat, was recorded during the habitat assessment and up to an additional 16 waterway crossings (bridges and/or culverts) under the existing alignment have the potential to contain roost habitat for both the Eastern Bentwing-bat and Large-eared Pied Bat. The proposal may require the removal and/or modification of 17 potential roost habitats during the construction phase including the (replacement of eight bridges and a number of box culverts), although it has not yet been ascertained whether microbats are present in all of these habitats.

The majority of the study area consists of open grassland containing little native vegetation, wildlife corridors in the study area, therefore, are limited. The proposed alignment intersects vegetated corridors running east-west through the study area; however both species are capable of negotiating the proposal. Observations have been recorded of the Eastern Bentwing-bat flying at heights of up to 50 metres. Therefore, it is unlikely that either species would be impacted by the reduced connectivity resulting from the proposal within the locality.

An estimated total of 18644.75 hectares of potential foraging habitat occurs within the locality (based on a sum of all habitat types, excluding open grassland). This equates to the removal of 0.02 per cent of potential foraging habitat throughout the locality that would be directly impacted and an additional 0.03 per cent that may be indirectly impacted as a result of the proposal. The foraging habitat of the subject site is not considered limiting and is not important to the long-term survival of either species.

Given the landscape, the roosting habit located in cracks and crevices of culverts and bridges along the alignment is considered to be a limited habitat resource of the locality. Additional targeted surveys are required to identify roost habitats for the species within the subject site following the detailed design of the proposal. Provided a Microbat Plan of Management is developed to ensure works would be undertaken in a manner that would ensure that roosting habitat is either retained or supplemented through the establishment of artificial roost habitats, and that no individuals are harmed in the decommissioning of the existing roosts, a significant impact that places the long-term survival of the species at risk can be avoided.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Eastern Bentwing-bat (DECCW Threatened Species Unit).

Critical habitat is discussed in the *National Recovery Plan for the Large-eared Pied Bat* (DERM 2011), however the study area does not have any representative habitats such as cliffs, caves and foraging habitat along watercourse and in fertile woodlands is highly disturbed. Therefore the study area is not considered to contain critical habitat Large-eared Pied Bat.

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

To date, there are no recovery plans for the Eastern Bentwing-bat. There are also no threat abatement plans relevant to this species. OEH lists Priority Actions and recovery strategies to help recover the species. The following lists those relevant to the proposal:

- Compile register of all known roost sites in natural and artificial structures including current and historical data and identify significance of roost, eg maternity, hibernation, transient roost.
- For roost caves vulnerable to human disturbance, monitor their visitation by people, particularly during winter and spring/summer maternity season and in school holidays.

- Identify and protect significant roost habitat in artificial structures (eg culverts, old buildings and derelict mines).
- Prepare management plans for significant bat roosts especially all known maternity colonies and winter colonies.
- Search for significant roost sites and restrict access where possible. Significant sites include maternity, hibernation and transient sites including in artificial structures.

Queensland Department of Environment and Resource Management (DERM) have developed a *National Recovery Plan For The Large-eared Pied Bat* (DERM 2011). The overall objective of this recovery plan is to ensure the persistence of viable populations of the large-eared pied bat throughout its geographic range. The following specific actions have been identified to achieve the objective:

- Reviewing all available species information.
- Identifying, mapping and modelling bat colonies.
- Identifying priority colonies for conservation management.
- Surveying the species to clarify distribution and abundance to inform management.
- Protecting known roosts and associated foraging habitats.
- Managing threats through installation of bat gates,
- Establishing fire management plans and control of introduced species.
- Initiating public education and extension programs to encourage the public to be involved in the recovery process.
- Developing press releases to promote the recovery program.
- Conducting further research into the biology and ecology of the species.
- Analysing population genetics.

Additional targeted surveys would be required to identify artificial roost habitats for microbats within the subject site following the detailed design of the proposal. Although the proposal may require the removal or modification of up to 17 potential roost habitats along the alignment, all locations where microbats are identified would be supplemented using alternative roost habitat to ensure the proposal is consistent with the priority actions for the species.

It is unlikely however that either species is roosting in all potential habitats. Provided a Microbat Plan of Management is developed encompassing all located roost sites, ensuring works would be undertaken in a manner that would ensure that roosting habitat is either retained or supplemented, and that harm to roosting individuals in the decommissioning of the existing roosts is avoided, the proposal would then be consistent with the above priority actions for both species.

**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.**

Key Threatening Processes are listed on Schedule 3 of the TSC Act. Those related to the Eastern Bentwing-bat and the Large-eared Pied Bat are:

- 'Clearing of native vegetation' – the proposal would involve the removal and/or modification of native vegetation that may provide foraging habitat for the Eastern Bentwing-bat and Large-eared Pied Bat in the study area.

## Conclusion

The proposal would have the following impacts on the Eastern Bentwing-bat and the Large-eared Pied Bat:

- Direct removal of 0.02 per cent of potential foraging habitat considered to have low to moderate value in the locality.
- Direct removal of up to 17 potential non-maternity roost habitats, including one known roost in the bridge crossing Flying Fox Creek, considered to be of high value in the locality.
- Indirect modification of 0.03 per cent of potential foraging habitat considered to have low to moderate value in the locality.
- The operation of the key threatening process, 'Clearing of Native Vegetation'.

This assessment of significance has been prepared on the basis of assuming that the recommended further targeted surveys would proceed during the detailed design phase. The outcomes of this assessment have also relied on the premise of avoiding, mitigating and minimising residual impacts to biodiversity (RTA, 2011).

With the above statement taken into account, the proposal is considered unlikely to result in a significant impact on local populations of the Eastern Bentwing-bat and the Large-eared Pied Bat as:

- Targeted surveys to identify key roost habitats would occur prior to construction.
- Works would be designed in consultation with a suitably experienced and qualified ecologist to ensure that a significant impact on local populations of threatened microbats would be avoided.

A Microbat Management Plan including details on an appropriate exclusion methodology and additional mitigation measures such as habitat improvement would be prepared if the species were located in the targeted surveys.

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

The Grey-headed Flying-fox is listed as vulnerable under Schedule 2 of the TSC Act 1995. The species is also listed as Vulnerable under the EPBC Act.

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

The Grey-headed Flying-fox is found in a variety of habitats, including rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas (Churchill 1998). The species is a canopy-feeding frugivore and nectarivore. Their major food source is Myrtaceae blossom (mostly eucalypt) and fruits such as native figs (*Ficus* spp.) and cultivated fruit orchards (Churchill 1998). Bats commute daily to foraging areas, usually within 15 kilometres of the day roost (Strahan 1995), although some individuals may travel up to 70 kilometres.

The species was recorded during the 2009 Biosis field surveys just outside the study area. No evidence of a camp site (breeding habitat) was found within the study area. The closest known camp is located 1.5 kilometres to the south along Bomaderry Creek, which has records of between 80-7000 individuals (OEH 2013a). Given the distribution of records of the species within 10 kilometres, individuals from the Bomaderry Creek camp site are likely to utilise resources within the study area, particularly for foraging on fleshy fruited food trees including Lilly Pilly *Acmena smithi*.

Given the high mobility of the Grey-headed Flying-fox (able to travel up to 70 kilometres from a camp site) and the availability of known and potential habitat in the locality (including protected habitat within Seven Mile Beach National Park), the loss of approximately 0.04 per cent (7.75 hectares) of non-limiting woodland/forest and planted vegetation habitat is unlikely to disrupt the feeding behaviour and life cycle of a viable local population of the Grey-headed Flying-fox to place it at risk of extinction within the study area or locality.

**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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the NSW Scientific Committee, is facing a very high risk of extinction in NSW in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Grey-headed Flying-fox in NSW.

**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 threatened species.



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

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

The proposal would impact potential foraging habitat for the Grey-headed Flying-fox through the removal of approximately 0.04 per cent (7.75 hectares) non-limiting woodland/forest (3.48 hectares) and planted vegetation habitat (4.27 hectares).

Approximately 7.75 hectares of non-limiting woodland/forest and planted vegetation habitat would be removed from the study area as a result of the proposal. This equates to only 0.04 per cent of the potential habitat (eg eucalypt and riparian forest, rainforest, mangroves and paperbark swamps) available within the locality. Given the availability of known and potential habitat within the locality, including protected habitat within Seven Mile Beach National Park, that no breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that the proposal would have major negative impacts on the Grey-headed Flying-fox habitat within the locality.

The majority of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation. Wildlife corridors in the study area, therefore, are limited; however the Princes Highway does intersect waterways and limited riparian habitats connecting east-west vegetation. The Grey-headed Flying-fox is highly mobile and capable of negotiating disturbed habitats including the existing highway and surrounding farmland. The small areas of proposed vegetation removal (0.04 per cent within the locality) are not considered to fragment or isolate areas of habitat to the east or west of the study area.

As such, the habitat to be removed is not considered to be important to the long-term survival of the species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Grey-headed Flying-fox (DECC 2008).

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

OEH have developed a *Draft National Recovery Plan for the Grey-headed Flying-fox* (DECCW 2009). The plan was developed in 2009 and was proposed for a five year duration (to be revised in 2014). It considers the conservation requirements of the species throughout its range, sets objectives for recovery and identifies actions to be undertaken to reverse decline and ensure long-term viability.

The overall objectives of recovery of Grey-headed Flying-foxes are:

- To reduce the impact of threatening processes; to arrest decline throughout their range.
- To conserve their functional roles in seed dispersal and pollination of native plants.
- To improve the comprehensiveness and reliability of information available to guide recovery.

Specific objectives relevant to the five-year duration of the recovery plan aim to identify, protect and enhance key foraging and roosting habitat; to substantially reduce deliberate destruction associated with commercial fruit crops; to reduce negative public attitudes and conflict with humans; and to involve the community in recovery actions where appropriate. Further objectives aim to address the impact on the species of artificial structures such as powerlines, loose netting and barbed wire fences; and to improve knowledge of demographics and population structure (DECCW 2009).

No known roost sites would be removed or disturbed as a result of the proposal, although 7.75 hectares of potential foraging habitat would be removed. Some fleshy fruit trees are located within the study area, however the habitat to be removed is not considered to be limiting for the species in the locality. Therefore the proposal remains consistent with the objectives outlined by the recovery plans for these species.

**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 Grey-headed Flying-fox is threatened by the following key threatening process as listed under Schedule 3 of the TSC Act 1995:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve clearing of 7.75 hectares of woodland/forest and planted habitat that contains sections of native vegetation providing general foraging habitat for the species.

**Conclusion**

The proposal would have the following impacts on the Grey-headed Flying-fox:

- Approximately 7.75 hectares of potential foraging habitat would be cleared.
- The operation of one key threatening process.

The proposal is considered unlikely to result in a significant impact on a local population of Grey-headed Flying-fox, as:

- No limiting foraging resources would be removed.
- No potential roosting/breeding habitat would be removed.
- Potential habitat would not be fragmented or isolated.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.

*Yellow-bellied Sheathtail Bat Saccoleimus flaviventris*

*Eastern Freetail Bat Mormopterus norfolkensis*

*Eastern False Pipistrelle Falsistrellus tasmaniensis*

*Greater Broad-nosed Bat Scoteanax rueppellii*

The Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat are listed as Vulnerable under Schedule 2 of the TSC Act.

These four species have been considered together for this assessment based on their similar habitat requirements (ie tree hollow-dependant).

Note: a taxonomic revision of Australian molossids has led to a change of the eastern Freetail bat's scientific name from *Mormopterus norfolkensis* to *Micronomus norfolkensis* (Churchill 2008) however, as CAVs and OEH are yet to adopt the name change, *Mormopterus norfolkensis* is used in this report.

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

The Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat are known to be tree-hollow dependent (Churchill 2008). The greater broad-nosed bat and eastern Freetail bat tend to forage along gaps and edges of forests and bushland patches (Churchill 2008), whereas the Eastern False Pipistrelle and yellow-bellied Sheathtail bat are faster fliers with greater manoeuvrability. The Eastern False Pipistrelle forages below or within the forest canopy while the yellow-bellied Sheathtail bat forages above the canopy (Churchill 2008).

The study area provides known and/or potential foraging habitat for the four bat species within the eucalypt and riparian forests. The four microbats are likely to forage aerially for insects within the study area, however, the study area is not considered to provide limiting foraging resources. Potential breeding habitat occurs within the forests that contain hollow-bearing trees. The occurrence of hollow-bearing trees varies throughout the study area with a greater concentration within Illawarra gully wet forest, riverbank forest and South Coast grassy woodland, than within Shoalhaven sandstone forest and Currumbene lowlands forest.

All but the Eastern False Pipistrelle were recorded in the study area during the 2007-2009 Biosis field surveys. The Eastern False Pipistrelle was recorded to the north east of the study area during these field surveys also. Additional records exist for all four species within 10 kilometres of the study area. The proposal is unlikely to impact the foraging behaviour of the four microbats as no limiting foraging resources occur on site. Potential breeding habitat, ie tree hollows, would be removed by the proposal. Up to 3.48 hectares eucalypt and riverbank (riparian) forest containing tree hollows would be removed. This equates to only 0.02 per cent of similar plant communities (assumed to contain tree hollows) occurring in the locality (18644.75 hectares).

Given the relatively small loss of potential habitat within the locality, the poor condition of the potential habitat to be removed (ie disturbed roadside trees), and the high mobility of these species, it is considered unlikely that the proposal would have an adverse effect on the life cycle of the yellow-bellied Sheathtail bat, eastern Freetail bat, Eastern False Pipistrelle or greater broad-nosed bat such that a viable local population of these 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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act 1995 and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the yellow-bellied Sheathtail bat, Eastern Freetail bat, Eastern False Pipistrelle or Greater Broad-nosed Bat in NSW.

**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 threatened species.

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

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

The proposal would result in the removal of approximately 2.95 hectares of eucalypt forest and 0.53 hectares of riverbank (riparian) forest. A further 4.67 hectares and 0.74 hectares of eucalypt forest and riverbank forest would be indirectly impacted, respectively. These impacts equate to only 0.05 per cent of similar plant communities occurring in the locality (18644.75 hectares).

Up to 75 habitat trees (both dead stags and alive) containing hollows or exfoliating bark suitable for microbat roosting would also be removed and an additional nine that may be indirectly impacted.

No new edges would be created by the proposal as only roadside vegetation would be removed. Given this and the high mobility of the microbats, the proposal would not result in habitat fragmentation or isolation for these species.

The area of potential habitat to be removed by the proposal is small and disturbed (eg edge-effected) and is considered to be of low importance to the long-term survival of the yellow-bellied Sheathtail bat, eastern Freetail bat, Eastern False Pipistrelle and greater broad-nosed bat in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat.

**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 or threat abatement plan for these microbats. OEH, however, has listed 20, 18, 16 and 19 Priority Actions and recovery strategies, to help recover the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat, respectively. Those relevant to the proposal include:

- Retain hollow-bearing trees and provide for hollow tree recruitment.
- Ensure the largest hollow-bearing trees, including dead trees and paddock trees, are given highest priority for retention in PVP assessments.



- Retain foraging habitat.
- Conduct searches for the species in suitable habitat in proposal areas.
- Assess the site's importance to the species' survival, including linkages provided between ecological resources across the broader landscape.

A total of 75 roadside hollow-bearing trees (potential roosting/breeding habitat) would be removed. The proposal would involve clearing of native vegetation which constitutes foraging habitat for the four microbats. As such, the proposal is not entirely consistent with the objectives outlined by OEH (in the absence of a recovery 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.**

The Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat are threatened by the following key threatening processes as listed under Schedule 3 of the TSC Act:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) – the proposal would involve clearing of 3.48 hectares of native vegetation that provides general foraging habitat for the four microbat species.
- 'Loss of hollow-bearing trees' (NSW Scientific Committee 2007a) – the proposal would involve the removal of a small number of hollow-bearing trees (approximately 18), which could provide roosting and limited breeding opportunities for the four microbats.
- 'Removal of Dead Wood and Dead Trees' (NSW Scientific Committee 2003b) – some dead wood and dead trees may be removed by the proposal.

**Conclusion**

The proposal would have the following impacts on the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat:

- Approximately 3.48 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be cleared.
- Approximately 5.41 hectares of potential foraging and breeding habitat (including hollow-bearing trees) would be indirectly impacted.
- Up to 75 habitat trees (both dead stags and alive) containing hollows or exfoliating bark suitable for microbat roosting would also be removed and an additional nine that may be indirectly impacted.
- The operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat, as:

- No limiting foraging resources would be removed.
- A relatively small area of already highly disturbed potential breeding habitat would be removed from the study area constituting 0.05 per cent of eucalypt and riverbank forest of the locality.
- Potential habitat would not be fragmented or isolated.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an SIS is not considered necessary for these species.

*Southern Myotis*      *Myotis macropus*

The Southern Myotis is listed as vulnerable under Schedule 2 of the TSC Act.

The Southern Myotis requires permanent water bodies, including streams, lakes and reservoirs for foraging (Churchill 2008). The Southern Myotis most commonly forages by raking the surface of water bodies with their large, clawed feet to catch aquatic insects and small fish (Churchill 2008, Richards et al. 2008). This species also forages aerially taking prey such as moths, beetles, crickets and flies (Churchill 2008, Richards et al. 2008). The Southern Myotis roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage (Richards et al. 2008).

Foraging habitat for the Southern Myotis occurs throughout the subject site and study area in the form of permanent creeklines and farm dams. The species has been previously detected 12 times in the locality with the most recent recorded in 2010. One record of the Southern Myotis (recorded over four consecutive nights) is located just beyond the study area.

The current field surveys of the subject site and study area located 13 microbats roosting within two vertical crevices of the bridge crossing Flying Fox Creek. Although not confirmed, it is very likely that this species is the Eastern Bentwing-bat, not Southern Myotis given the characteristics of individuals observed. Several additional bridges and culverts within the subject site however are also considered to provide habitat for the Southern Myotis, although not all have been inspected.

Given the presence of roosting and foraging habitat throughout the study area, the following assessment of significance has been completed on the basis that additional targeted surveys for the Southern Myotis would be undertaken during the appropriate season to confirm the species occurrence throughout the study area and any roost sites once a detailed design of the proposal is available.

**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 proposal is likely to directly remove and/or modify about 1.62 hectares of potential foraging habitat for the Southern Myotis, with a further 1.19 hectares likely to be indirectly impacted. Given that the species is highly mobile and the abundance of water bodies available for foraging in the locality, the removal or modification of foraging habitat in the study area is not likely to adversely affect the life cycle of the species such that a viable local population of the species is placed at risk of extinction.

Thirteen microbats were located roosting in the bridge over Flying Fox Creek within the study area. It is very likely that this species was the Eastern Bentwing-bat, not Southern Myotis. However there are other structures such as culverts and bridges along the alignment that may contain suitable artificial roosting habitat for the species. Hollow-bearing trees and stags located within the study area may also provide roosting habitat for the Southern Myotis.

This assessment relies on the premise that the proposal would avoid, mitigate and offset residual impacts with the specific aim of ensuring works do not result in a significant impact to the Southern Myotis according to state legislation. Additional targeted surveys are required to identify roost habitats within the subject site following the detailed design of the proposal. Provided a Microbat Plan of Management is developed to ensure works would be undertaken in a manner that would ensure that both artificial and natural roosting habitat is either retained or supplemented through the establishment of bat roost boxes, and that harm to roosting individuals in the decommissioning of the existing roosts is avoided, a significant impact that places the local population placed at risk of extinction can be avoided.

**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.**

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of this species listed under the Act.

**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 threatened species.

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

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

The proposal is likely to directly remove and/or modify about 1.62 hectares of potential foraging habitat for the Southern Myotis, with a further 1.19 hectares that may be indirectly impacted through sedimentation or absence of prey species resulting from changes in water quality.

A total of 17 waterway crossings (bridges and/or culverts) under the existing alignment have the potential to contain artificial roost habitat for the Southern Myotis. The proposal may require the removal and/or modification of all 17 potential roost habitats during the construction phase (with eight replacement bridge or box culvert structures proposed), although it has not yet been ascertained whether microbats are present in all of these habitats. Natural roost habitat, in the form of hollow-bearing trees and stags, occurs throughout the study area. A total of 47 habitat tree locations were recorded in the habitat assessment. The proposal would require the direct removal of 75 hollow-bearing trees or stags and may indirectly impact an additional nine.

The majority of the study area consists of open grassland containing little native vegetation; wildlife corridors in the study area, therefore, are generally limited. The proposed alignment intersects vegetated corridors running east-west through the study area and the species is capable of negotiating the highway with records present on both sides. Therefore it is unlikely that the species would be impacted by the reduced connectivity resulting from the proposal within the locality.

Water bodies suitable for Southern Myotis are abundant throughout the locality, including major creeklines such as Flying Fox Creek and Broughton Creek and their associated tributaries, as well as Coomonderry Swamp to the east. The foraging habitat of the subject site is not considered limiting and is not important to the long-term survival of the species.

Given the landscape, the roosting artificial and natural habitat located along the alignment is considered to be a limited habitat resource of the locality. Additional targeted surveys are required to identify roost habitats within the subject site following the detailed design of the proposal. Provided a Microbat Plan of Management is developed if species is located to ensure works would be undertaken in a manner that would ensure that roosting habitat is either retained or supplemented through the establishment of bat roost boxes, and that no individuals are harmed in the decommissioning of the existing roosts, a significant impact that places the long-term survival of the species at risk can be avoided.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Southern Myotis (DECCW Threatened Species Unit).

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

To date, there are no recovery plans for the Southern Myotis. There are also no threat abatement plans relevant to this species. OEH lists a total of 15 Priority Actions and recovery strategies to help recover the species. The following are those relevant to the proposal:

- Ensure the largest hollow bearing trees in riparian zones are given highest priority for retention in planning assessments or other land clearing assessment tools.
- Prepare EIA guidelines which address the retention of hollow bearing trees maintaining diversity of age groups, species diversity, and structural diversity. Give priority to largest hollow bearing trees.
- Identify, protect and enhance roost habitat beneath artificial structures (eg bridges), especially when due for replacement, and assess effectiveness of the actions.
- Promote roosting habitat in new artificial structures within the species range.
- Encourage recovery of natural hydrological regimes, including retention and rehabilitation of riparian vegetation.

Additional targeted surveys are required to identify natural and artificial roost habitats within the subject site following the detailed design of the proposal. Although the proposal may require the removal or modification of up to 17 potential roost habitats along the alignment, all locations where microbats are identified will be supplemented using nest boxes to ensure the proposal is consistent with the priority actions for the species. The removal of 75 hollow-bearing trees and an additional nine that may be indirectly impacted by the proposal is not considered to be consistent with the priority actions.

It is unlikely however that the species is roosting in all potential habitats. Provided further surveys are completed to determine this and a Microbat Plan of Management is developed encompassing all located roost sites. Following this, works would be undertaken in a manner that would ensure that roosting habitat is either retained or supplemented through the establishment of bat roost boxes, and that no individuals are harmed in the decommissioning of the existing roosts. Therefore, the proposal would be then be consistent with the above priority actions.

**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.**

Key Threatening Processes are listed on Schedule 3 of the TSC Act. Those related to the Southern Myotis are:

- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' – few of the water bodies within the study area are natural waterways, having been dammed and channelled in the past. They are still however, considered to be Southern Myotis foraging habitat. The proposal has the potential to directly impact 1.62 hectares of water body through the decommissioning of water bodies as part of the highway realignment. An additional 1.19 hectares of potential foraging habitat may also be indirectly impacted through changes in water quality such as sedimentation, or changes in prey items.
- 'Clearing of native vegetation' – the proposal would involve the removal and/or modification of native vegetation that provides dispersal habitat for the Southern Myotis in the study area.
- 'Loss of hollow-bearing trees' – the proposal would require the removal of 75 hollow-bearing trees or stags and have the potential to indirectly impact an additional nine.



## Conclusion

The proposal would have the following impacts on the Southern Myotis:

- Direct removal of 1.62 hectares of potential foraging habitat considered to have low to moderate value in the locality.
- Direct removal of up to 17 potential artificial roost habitats and an additional 75 hollow-bearing trees or stags considered to be of varying value in the locality.
- Indirect modification of 1.19 hectares of potential foraging habitat considered to have low to moderate value in the locality.
- Indirect modification of an additional nine hollow-bearing trees or stags considered to be of varying value in the locality.
- The operation of three key threatening processes, being the 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands', 'Clearing of Native Vegetation' and 'Loss of hollow-bearing trees'.

This assessment of significance has been prepared on the basis of assuming that the recommended further targeted surveys would proceed during the detailed design phase. The outcomes of this assessment have also relied on the premise of avoiding, mitigating and offsetting residual impacts to biodiversity (RTA, 2011).

With the above statement taken into account, the proposal is considered unlikely to result in a significant impact on a local population of the Southern Myotis as works would be designed to ensure that a significant impact on a local population of the Southern Myotis does not result, including targeted surveys to identify key roost habitats and the development of a Microbat Management Plan if the species is located during targeted surveys.

### *Spotted-tailed Quoll* *Dasyurus maculatus maculatus*

The Spotted-tailed Quoll is listed as Vulnerable under Schedule 2 of the TSC Act 1995. The species is also listed as Endangered under the EPBC Act 1999.]

**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 Spotted-tailed Quoll uses hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites (DEC 2005). This species' habitat requirements include suitable den sites (such as hollow logs, tree hollows, rock outcrops or caves) and an abundance of food (NPWS 1999h). The diet of juveniles is dominated by invertebrates, small mammals and birds, while the diet of adults is dominated by medium-sized mammals (Belcher *et al.* 2008). Individuals require large areas of relatively intact vegetation through which to forage (NPWS 1999h). The home range of a female is between 180–1000 hectares, while males have larger home ranges of between 2000–5000 hectares (Belcher *et al.* 2008).

The Spotted-tailed Quoll has been previously recorded numerous times within 10 kilometre of the study area, predominantly to the north and west, with a few records in the south east. These records are dated between 1969 and 2006. The closest record (from 1992) occurs approximately 2.3 kilometres to the south west (DECCW 2009).

The study area provides potential foraging and denning habitat (eg tree hollows) for the Spotted-tailed Quoll within the eucalypt and riparian forests. Although only limited connectivity occurs within the study area, this species may utilise riparian corridors within the locality to move between areas of habitat.

Approximately 3.18 hectares of eucalypt and riverbank (riparian) forest (potential habitat) would be removed from the study area with a further 5.41 hectares affected by indirect impacts (eg edge effects). This equates to only 0.03 per cent of the potential habitat (eg eucalypt and riparian forest, rainforest and heathland) available within the locality (23519.93 hectares). Given the availability of potential habitat within the locality, the poor condition of potential habitat in the study area, the limited opportunities for connectivity within and beyond the study area, and the high mobility of this species, it is considered unlikely that the proposal would have an adverse effect on the life cycle of the Spotted-tailed Quoll such that a viable local population of these 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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Spotted-tailed Quoll in New South Wales.

**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 threatened species.

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

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

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

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

The proposal would impact potential habitat for the Spotted-tailed Quoll through the removal of eucalypt and riparian forest. The proposal is considered unlikely to affect habitat critical to the survival of the species, given the mobility of the species, the poor condition of the habitat to be removed (disturbed, roadside areas), the availability of surrounding eucalypt and riparian forests, and the small areas of proposed vegetation removal.

The proposal would result in the removal of approximately 2.41 hectares eucalypt forest and 0.53ha riverbank (riparian) forest. The habitat to be directly impacted represents less than 0.01 per cent of potential habitat within the locality (23519.93ha). A further 3.1 hectares and 0.74 hectares of eucalyptus forest and riverbank (riparian) forests respectively provide potential foraging habitat would be indirectly impacted. In total, less than 0.03 per cent of the potential habitat occurring in the locality may be impacted by the proposal.

Although it is considered possible the Spotted-tailed Quoll may occur in the study area from time to time, the habitat to be impacted consists of disturbed roadside and disturbed riparian vegetation and is considered to be of low importance for the long-term survival of the Spotted-tailed Quoll within the locality. Given the species' high mobility, the loss and/or disturbance of 0.03 per cent of potential habitat within the locality is considered unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Spotted-tailed Quoll.

**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 for this species; however OEH has listed 32 Priority Actions and recovery strategies to help recover the Spotted-tailed Quoll. Those relevant to the proposal include:

- Retain and protect large, forested areas with hollow logs and rocky outcrops, particularly areas with thick understorey or dense vegetation along drainage lines.
- Habitat requirements of Spotted-tailed Quolls to be adequately conserved within environmental planning instruments and through other legislative protection mechanisms, including property vegetation plans.
- At sections of roads where Spotted-tailed Quolls are frequently killed, incorporate methods to reduce the numbers of animals killed. Assess the effectiveness of different mitigation methods.

The proposal would result in the removal of 3.18 hectares of forested areas containing hollow logs and riparian vegetation suitable for foraging and temporary den locations when moving across the landscape. However, as discussed above, the areas to be removed are already disturbed. Similar habitat resources occur and would remain adjacent to the cleared areas.

Given the limited availability of connected habitat within the study area, the proposal is considered unlikely to increase the current rate of road kill for the Spotted-tailed Quoll in the locality.

Given the above, the proposal is considered to be consistent with the DECCW recovery actions for the Spotted-tailed Quoll.

**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 Spotted-tailed Quoll is threatened by the following key threatening processes:

- 'Clearing of native vegetation' (NSW Scientific Committee 2001) - the proposal would involve clearing of 3.18 hectares of native vegetation that is potential habitat for the Spotted-tailed Quoll.
- 'Removal of Dead Wood and Dead Trees' (NSW Scientific Committee 2003b) – limited dead wood and dead trees would be removed. These may provide shelter for the Spotted-tailed Quoll and its prey.
- 'Loss of hollow-bearing trees' (NSW Scientific Committee 2007a) - the proposal would involve the removal of hollow-bearing trees throughout the subject site, which could provide nesting opportunities for the Spotted-tailed Quoll and its prey.
- 'Predation by the European red fox' (NSW Scientific Committee 2005) – foxes are likely to inhabit the area. The proposal may, but is not likely to, increase edge effects, leading to an increase in fox numbers, which could increase pressure on the Spotted-tailed Quoll.
- 'Predation by feral cats' (NSW Scientific Committee 2007b) – feral cats may inhabit the study area. The proposal may, but is not likely to, increase edge effects, leading to an increase in feral cat numbers, which could increase pressure on the Spotted-tailed Quoll.

**Conclusion**

The proposal would have the following impacts on the Spotted-tailed Quoll:

- Approximately 3.18 hectares of potential foraging habitat would be cleared.
- Approximately 5.41 hectares of potential foraging habitat would be indirectly impacted.
- The operation of five key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of Spotted-tailed Quoll, as:

- No limiting foraging resources would be removed.
- Only a small number of disturbed potential denning/breeding sites would be removed from 3.18 hectares of habitat.
- Potential habitat would not be fragmented or isolated.
- Only approximately 0.01 per cent of potential habitat would be removed from the locality.
- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of this species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.



### *Yellow-bellied Glider Petaurus australis*

The Yellow-bellied Glider is listed as Vulnerable under Schedule 2 of the TSC Act 1995.

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

The Yellow-bellied Glider lives in hollows of large mature eucalypt trees and occupies home ranges from 20 hectares up to 85 hectares depending on the quality of the habitat. This species feeds on a range of food resources including pollen, insects, nectar, sap, honeydew and manna (NPWS 1999j). Studies have shown that the amount of old growth forest in a landscape is important for Yellow-bellied Gliders (Lindenmayer 2002). Yellow-bellied gliders live in family groups of up to six individuals that strongly defend their territory to maintain exclusive use of their home range. This large exclusive area, together with the fact that their habitat is patchily distributed through broad forest areas, means that very large expanses of forest (>15,000 hectares) are required to conserve populations of this species (Goldingay 2008).

The study area provides potential habitat for the Yellow-bellied Glider in the form of foraging and breeding resources such as potential feed trees and large hollow-bearing trees.

This species has previously been recorded over 40 times to the south west of the study area (DECCW 2009). The closest record of this species occurs only 200 metre from the study site within Bomaderry Creek Regional Park. Other records also exist to the north, north west and south within 10 kilometres of the subject site.

The study area provides limited suitable breeding and foraging habitat for the species which is restricted to the south-western extent. Habitat located on the eastern side of the existing highway is restricted to small patches of either remnant bushland or regrowth and is not considered to be significant to the yellow-bellied glider.

Few hollow-bearing trees occur within the predominantly cleared subject site. Yellow-bellied Glider The potential habitat that would be removed by the proposal is unlikely to be optimal habitat for the species given that is currently fragmented by the existing highway, farming land, medium and high density housing and a change in landscape topography in the southern end of the study area limiting the formation of large hollow-bearing trees (shallow-soils). The proposal would remove approximately 2.41 hectares of potential habitat for this species which represents 0.01 per cent within the locality (17461.70 hectares).

In addition, up to 15 habitat trees containing large hollows will be removed. Is it unlikely that Yellow-bellied Glider would rely heavily on these tree hollows and feed trees given their roadside location and the species preference for large expanses of old growth forest.

Given the current barriers to limited suitable habitats available within the study area , the low condition of the potential habitat to be removed (ie isolated roadside trees), and the high mobility of these species, it is considered unlikely that the proposal would have an adverse effect on the life cycle of the yellow-bellied glider, such that a viable local population of these 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.**

An Endangered Population is a population listed under Part 2 of Schedule 1 of the TSC Act and is defined as a population that, in the opinion of the New South Wales Scientific Committee, is facing a very high risk of extinction in New South Wales in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

The population of the Yellow-bellied Glider that occurs on the Bago Plateau (a westward extension of the Kosciuszko highlands in southern New South Wales) is listed as an Endangered Population (NSW Scientific Committee 2008d). The population of Yellow-bellied Glider in the locality is not part of this population, and the proposal would not impact the Endangered Population.

**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 threatened species.

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

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

The proposal would remove approximately 2.41 hectares of potential habitat for the yellow-bellied glider. The habitat to be removed represents 0.01 per cent within the locality (17461.70 hectares). Whilst 15 suitably-sized tree hollows are present, they exist in a highly disturbed and fragmented roadside landscape. More suitably-sized tree hollows occur within the remainder of the study area and the locality.

The proposal would remove potential habitat in the form of roadside vegetation. Whilst this proposed action would increase the distance between patches of vegetation lying on either side of the existing highway, it is unlikely that the proposal would further fragment or isolate areas of potential habitat for this species, given its high mobility and ability to glide distances greater than those that would be imposed by the proposal (typical glides are 40 metre, but glides of over 140 metre have been recorded (Goldingay 2008)). The removal of only 2.41 hectares of vegetation along the existing road is not likely to further fragment potential habitats for this species.

The area of potential habitat to be removed by the proposal is small and provides only minimal breeding resources (eg few hollow-bearing trees). A local population of Yellow-bellied Glider would be unlikely to rely on the few isolated tree hollows within the subject site for ongoing survival. The potential habitat to be removed is disturbed (eg cleared, edge-effected) and is considered to be of low importance to the long-term survival of the Yellow-bellied Glider in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act 1995, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the yellow-bellied glider.

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

OEH has prepared a recovery plan for the yellow-bellied glider. Some of the main issues identified in the recovery plan (clearing, edge effects and fragmentation of habitat) relate to the proposal. It is anticipated that the proposed works would not exacerbate the existing fragmentation of potential habitat for this species within the study area.

OEH has also identified Priority Actions and recovery strategies to assist in the recovery of the yellow-bellied glider. Those most relevant to the proposal include:

- Habitat Management: Consider identification, protection and management of species habitat in planning instruments.
- Retain and protect areas of habitat, particularly mature or old growth forest containing hollow-bearing trees and sap-feeding trees.
- Maintain connectivity between habitat patches.
- In urban and rural areas retain and rehabilitate habitat to maintain or increase the total area of habitat available, reduce edge effects, minimise foraging distances and increase the types of resources available.

The proposal would result in the removal of some hollow-bearing trees and eucalypt forests which provide potential denning sites and foraging resources for the yellow-bellied glider. The trees to be removed exist as scattered roadside vegetation, the removal of which would not create any additional edge effects or fragment existing habitats. The proposal is not entirely consistent with the objectives outlined by OEH (in the absence of a recovery plan) as it involves the removal of forests containing mature hollow-bearing trees.

At the present time, there is no threat abatement plan relevant to the yellow-bellied glider.

**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 Yellow-bellied Glider is threatened by the following key threatening processes as listed under Schedule 3 of the TSC Act:

- ‘Clearing of native vegetation’ – the proposal would involve clearing of 2.41 hectares of eucalypt forest that provides general foraging habitat for the yellow-bellied glider.
- ‘Loss of hollow-bearing trees’ – the proposal would involve the removal of a small number of hollow-bearing trees, which could provide denning and limited breeding opportunities for the yellow-bellied glider.
- ‘Removal of Dead Wood and Dead Trees’ – some dead wood and dead trees may be removed by the proposal.

**Conclusion**

The proposal would have the following impacts on the yellow-bellied glider:

- Approximately 2.41 hectares of potential foraging habitat would be cleared.
- Approximately 5.41 hectares of potential foraging habitat would be indirectly impacted.
- The loss of 15 isolated, roadside hollow-bearing trees.
- The operation of three key threatening processes.

The proposal is considered unlikely to result in a significant impact on a local population of yellow-bellied glider, as:

- Only a small number of disturbed potential denning/breeding sites would be removed.
- Potential habitat would not be further fragmented or isolated from known habitat along the Shoalhaven River to the south west of the study area.
- Only approximately 0.01 per cent of eucalypt forests would be removed from the locality.

- The habitat to be impacted by the proposal is considered to be of low importance for the long-term survival of this species in the locality.

Based on the above assessment, an SIS is not considered necessary for this species.



# Appendix E

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EPBC Act assessments of significance

## Threatened flora species

### *Pterostylis gibbosa*

*Pterostylis gibbosa* is listed as an Endangered species on both the EPBC Act.

*Pterostylis gibbosa* is currently known from five locations: Milbrodale in the Hunter Valley, Yallah (2 sites) and Albion Park in the Illawarra and Nowra in the Shoalhaven. Worrigeer Nature Reserve at South Nowra is the only secure conservation reserve the species is known from and is considered by this assessment as an important population of the species. Some populations in Wollongong City Council Shellharbour City Council are in council reserves with the remaining populations in the Illawarra and Lower Hunter regions occurring either on private land or areas supporting major infrastructure.

The *Pterostylis gibbosa* (R.Br.) Illawarra Greenhood Orchid Recovery Plan has been prepared by NPWS (2002).

#### **Is the action likely to lead to a long-term decrease in the size of a population of the species?**

*Pterostylis gibbosa* was not recorded in the study area with the nearest populations of the species in the Shoalhaven LGA are at Worrigeer Nature Reserve to the south (**Figure 4**). To the north populations of the species are known at Albion Park in Shellharbour LGA and at Yallah in Wollongong LGA. The proposal would not directly or indirectly result in the decrease in the size of known populations of the species in the study area, the locality, or the Sydney Basin Bioregion.

#### **Is the action likely to reduce the area of occupancy of a population?**

The study area does not support a known population of the species. The proposal would not reduce the area of occupancy of the nearest known population at Worrigeer Nature Reserve to the south or those known from the Shellharbour or Wollongong LGA's further to the north.

#### **Is the action likely to fragment an existing population into two or more populations?**

The study area and locality do not support a population of the species. The nearest known populations of *Pterostylis gibbosa* in the Shoalhaven, Shellharbour and Wollongong LGA's and elsewhere in the Sydney Basin Bioregion would not be fragmented into two or more populations.

#### **Is the action likely to adversely affect habitat critical to the survival of a species?**

There is an approved recovery plan for *Pterostylis gibbosa* (NPWS 2002) but no habitat critical for the survival of the species has been listed on the Register of Critical Habitat maintained by the Minister for the Environment under the EPBC Act. Although there is no potential habitat identified for this species in the on the subject site and in the study area it is not considered to be habitat critical for survival of the species. Habitat that is important for the survival of the species in the locality (ie Worrigeer Nature Reserve) and elsewhere in the Shellharbour and Wollongong LGA's would not be adversely affected by the proposal. Additionally the proposal is unlikely to significantly affect the habitat of flora and fauna species associated with *Pterostylis gibbosa* to compromise its survival at a local, regional or bioregional scale.

A population of *Pterostylis gibbosa* occurs in the locality at Worrigeer Nature Reserve. *Pterostylis* species are generally pollinated by male gnats of the genus *Mycomya* (Fungus Gnats). Nothing is known of the habitat requirements of *Mycomya* however it is suggested they are probably very common, but are not often seen due to their small size. Abundance of *Mycomya* is believed to peak in September, which is the main month of flowering of *Pterostylis gibbosa* (NPWS 2002). Studies on pollination rates have indicated that suitable adjoining pollinator habitat to a known site may be important for pollination success in addition to pollinator availability (NPWS 2002). The seed is dispersed by wind and reliant on a mycorrhizal fungus to support the first stages of growth after germination. The species is capable of surviving fire, due to the regenerative capacity of its tuberoid.

Although some potential habitat for the species would be affected by the proposal, the majority of vegetated corridors in the locality would be retained that maintain pathways for the dispersal and exchange of genetic reproductive material and organisms that may be important components of the species lifecycle throughout the locality. This would include but not be limited to habitat for invertebrate or vertebrates providing pollination and seed dispersal for plant species that characterise vegetation *Pterostylis gibbosa* is strongly associated with.

The proposal is unlikely to affect fire frequency and intensity or the presence of mycorrhizal fungi the species is associated with such that the breeding cycle of any population in the region is disrupted.

**Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

Potential habitat for the species occurs in Currumbene lowlands forest and South coast grassy woodlands in the study area. Approximately 1.74 hectares of potential habitat for *Pterostylis gibbosa* would be cleared as part of the proposal with further potential indirect impacts to an additional 2.38 hectares of potential habitat. Habitat to be directly impacted by the proposal equates to 0.22 per cent of Currumbene lowlands forest and South coast grassy woodland within the locality.

The area of habitat to be removed would adjoin the Princes Highway resulting in minor additional fragmentation and effects on the quality of habitat for the species in the study area and the locality. The proposal would not result in a significant additional level of isolation of the remaining stands of vegetation from other areas of habitat for the species in the study area and locality.

Conservation reserves in the locality that support one or multiple vegetation communities that provide good quality habitat for the species are Bamarang, Triplarina and Wogamia Nature Reserves, Bomaderry Creek Regional Park and Seven Mile Beach National Park. The conservative estimate of habitat and vegetation that would be support to the main vegetation habitats for the species that is under land tenure primarily reserved for conservation is 3874 hectares. This amounts to an area of habitat and support to habitat greater than 1500 times the size of that proposed for removal from the subject site. The species is unlikely to decline from habitat loss that will occur from the proposal.

**Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?**

Native plant communities in the locality including those that may provide potential habitat for the species are affected by invasive exotic flora and fauna species as a result of current and previous land management. The proposal is unlikely to result in the further establishment of invasive flora and fauna species in the potential habitats of *Pterostylis gibbosa* in the locality.

**Is the action likely to introduce disease that may cause the species to decline?**

No diseases have been identified as threats to *Pterostylis gibbosa* by OEH or DSEWPaC. It is considered unlikely that the proposal would introduce any diseases that may cause the species to decline.

**Is the action likely to interfere with the recovery of the species?**

The overall objective of the recovery plan for the species is to protect known populations of *Pterostylis gibbosa* from decline and to develop a management regime, based on current knowledge, designed to promote the plant's conservation and evolutionary potential in situ (NPWS 2002). The recovery plan provides specific actions designed to recovery the species generally and for some populations including the preparation and implement a management plan for the protection of *P. gibbosa* within Worrigea Nature Reserve. The proposal is unlikely to interfere with the recovery of *Pterostylis gibbosa* at a local, regional or bioregional level including inconstancy with general and specific actions from the recovery plan.

## Conclusion

Based on the above assessment, *Pterostylis gibbosa* is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not considered necessary for these species.



## *Cryptostylis hunteriana*

*Cryptostylis hunteriana* is listed as Vulnerable on both the TSC and EPBC Acts.

The species is known from a number of localities along the coast of NSW, Victoria and Queensland. In NSW, it appears to be most common in the Shoalhaven area (DEWHA, 2008a), and observed in recent years at many sites between Batemans Bay and Nowra (DEC 2005). The species has been recorded in several conservation reserves including the following that occur in the locality, Cambewarra Range and Triplarina Nature Reserves and the following that occur in the region Meroo, Morton, Murramarang, Jervis Bay and Lake Conjola National Parks (DEWHA 2008).

Although this species is not recorded in the study area it is known from multiple records in the locality (**Figure 4** and **Appendix B Table A2-1**) and these are considered by this assessment to form the known viable local population. Habitat for this species in the study area is provided by preferred soils, plant community and plant species associations and these are also present throughout the locality.

Populations that are atypical and may be important for the species long term survival are the Victorian populations (southern extreme), the Queensland population (northern extreme), the Pigeon House Mountain populations, the Manyana Bendalong populations and the Bulahdelah population (largest known population and in dry forest habitat) (DEWHA 2008). In addition OEH have assigned medium and high priority actions to 'key' populations and defined these as populations with at least 20 or more individuals.

### **Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of the species?**

*Cryptostylis hunteriana* is not recorded in the study area in the current or previous surveys. Records of the species in the locality are considered to form the viable local population. Important populations of the species in the locality area are at Cambewarra Range and Triplarina Nature Reserves. Important populations of the species elsewhere in the region are at Meroo, Morton, Murramarang, Jervis Bay and Lake Conjola National Parks. Important populations of the species in the Sydney Basin Bioregion are at Bulahdelah, and those at Ku-ring-gai Chase and Morton National Parks. The proposal will not directly or indirectly result in the decrease in the size of the assumed viable population in the locality, the Illawarra and South Coast regions or Sydney Basin Bioregion.

### **Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?**

The subject site and study area do not support an important population of the species. The proposal will not reduce the area of occupancy of either the assumed viable local population or important populations in the locality, the Illawarra and South Coast regions or Sydney Basin Bioregion.

### **Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?**

The proposal will result in a minor level of additional fragmentation of potential habitat for the local viable population of the species assumed to occur at the nearest records to the south and west of the study area in the locality (**Figure 4**). Important populations of *Cryptostylis hunteriana* in the locality, the Illawarra and South Coast regions, or Sydney Basin Bioregion will not be fragmented into two or more populations.

### **Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?**

There is no recovery plan for this species and no habitat critical for the survival of the species has been listed on the Register of Critical Habitat maintained by the minister under the EPBC Act. The potential habitat identified for this species on the subject site and in the study area is not considered to be habitat critical for survival of the species. Additionally, the proposal is unlikely to significantly affect the habitat of flora and fauna species associated with *Cryptostylis hunteriana* to compromise its survival at a local, regional or bioregional scale.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?**

The subject site and study area do not support an important population of *Cryptostylis hunteriana*. Key features of the breeding cycle of the species include pollination by the male Ichneumon Wasp (*Lissopimpla excelsa*) and dispersal of seeds is spread via wind transportation (DSEWPaC 2012b). Although habitat for the species will be affected by the proposal on the subject site and in the study area vegetated corridors (although highly fragmented) will be retained that maintain pathways for the dispersal and exchange of genetic reproductive material and organisms that are important components of the species lifecycle throughout the locality. This would include but not be limited to habitat for the Ichneumon Wasp (*Lissopimpla excelsa*) and other invertebrate or vertebrates providing pollination and seed dispersal for plant species that characterise vegetation *Cryptostylis hunteriana* may be associated with.

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

Potential habitat for this species is considered to exist within Currumbene lowlands forest and Shoalhaven sandstone forest in the study area. Approximately 1.68 hectares of potential habitat for *Cryptostylis hunteriana* would be cleared as part of the proposal with further potential indirect impacts to an additional 3.92 hectares of potential habitat. The removal of 1.68 hectares of potential habitat in the study area constitutes approximately 0.15 per cent of similar potential habitat mapped in the locality.

The area of habitat to be removed will adjoin the Princes Highway resulting in minor additional fragmentation and effects on the quality of habitat for the species in the study area and the locality. The proposal will not result in a significant additional level of isolation of the remaining stands of vegetation from other areas of habitat for the species in the study area and locality.

Conservation reserves in the locality that support one or multiple vegetation communities that provide good quality habitat for the species are Bamarang, Cambewarra Range, Tapitallee, Triplarina Wogamia and Worrigeer Nature Reserves, Bomaderry Creek Regional Park and Seven Mile Beach National Park. The conservative estimate of habitat and vegetation that would be support to the main vegetation habitats for the species that is under land tenure primarily reserved for conservation is 4060ha. This amounts to an area of habitat and support to habitat greater than 2700 times the size of that proposed for removal from the subject site. The species is unlikely to decline from habitat loss that will occur from the proposal.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat?**

Invasive woody plant species such as *Lantana camara* and a range of exotic perennial grasses are well established and widespread throughout the subject site, study area and locality including areas of potential habitat. The proposal may result in an increase in the establishment of invasive species within the retained potential habitat of this species in the study area. This may occur as a result of increased edge effects and vegetation management for the maintenance of road reserves. However, the proposal is unlikely to result in the establishment of invasive species in the most important habitat for *Cryptostylis hunteriana* at Cambewarra Range and Triplarina Nature Reserves or elsewhere in the region at Meroo, Morton, Murramarang, Jervis Bay and Lake Conjola National Parks.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

No diseases have been identified as threats to *Cryptostylis hunteriana* by OEH or DSEWPaC. It is considered unlikely that the proposal would introduce any diseases that may cause the species to decline.

**Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?**

Habitat management, habitat protection, monitoring and survey, mapping and habitat assessment of known populations of the species have been summarised by DSEWPaC (2012b) as the key measures to assist the species recovery. No populations of the species are known from the subject site and study and the habitat likely to be impacted is not considered important for the species. The proposal is unlikely to interfere substantially with the recovery of *Cryptostylis hunteriana* at a local, regional or bioregional level.

**Conclusion**

Based on the above assessment, *Cryptostylis hunteriana* is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

## *Thesium australe*

*Thesium australe* is listed as Vulnerable under both the TSC and EPBC Acts.

The species is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. *Thesium australe* occurs in grassland, grassy woodland or coastal headland heaths and is often found in damp sites in association with *Themeda australis* Kangaroo Grass (OEH 2012a). The species is parasitic on roots of other plants and although Benson and McDougall (2001) suggest it is not selective of hosts, OEH 2012a note that it has a strong association with *Themeda australis* Kangaroo Grass.

Although this species is not recorded in the study area or locality (**Figure 4** and **Appendix B Table A2-1**) habitat for this species in the study area is provided by preferred soils, plant community and plant species associations and these are also present throughout the locality.

### **Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of the species?**

This species is not recorded in the study area or locality. The nearest and most records of the species are single record from Ulladulla in 1911 sixty kilometres to the south and a single record from Camden in 1803 eighty kilometres to the north. The majority of records of the species in NSW are concentrated in the northern tablelands, particularly around Armidale, to Inverell and Glen Innes. In southern NSW there is a concentration of records around the southern tablelands with clusters of records of the species in the northern portions of Kosciuszko NP. Given the age of the two nearest records of the species the populations in the northern and southern tablelands are considered to be the nearest viable and important populations. The proposal will not directly or indirectly result in the decrease in the size of important populations in the Sydney Basin, New England Tablelands or NSW South Western Slopes Bioregions.

### **Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?**

The subject site and study area do not support an important population of the species. The proposal will not reduce the area of occupancy of important populations in the in the Sydney Basin, New England Tablelands or NSW South Western Slopes Bioregions.

### **Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?**

The proposal will result in a minor level of additional fragmentation of potential habitat for the species. Important populations of *Thesium australe* in the in the Sydney Basin, New England Tablelands or NSW South Western Slopes Bioregions will not be fragmented into two or more populations.

### **Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?**

There is no recovery plan for this species and no habitat critical for the survival of the species has been listed on the Register of Critical Habitat maintained by the minister under the EPBC Act. The potential habitat identified for this species on the subject site and in the study area is not considered to be habitat critical for survival of the species. Additionally, the proposal is unlikely to significantly affect the habitat of flora and fauna species associated with *Thesium australe* to compromise its survival at a local, regional or bioregional scale.



**Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?**

The subject site and study area do not support an important population of *Thesium australe*. Little is known of the species reproductive biology however exposure to heat of fire or hot summers may stimulate mass germination, with land use and weather conditions in the following summer critical to survival. Although the species has good reproductive vigour, germination is very erratic in the wild. Plants are probably killed by fire. Importantly the species is parasitic on roots of other plants and although Benson and McDougall (2001) suggest it is not selective of hosts, OEH (2012a) note that it has a strong association with *Themeda australis*.

Although habitat for the species will be affected by the proposal on the subject site and in the study area vegetated corridors (although highly fragmented) will be retained that maintain pathways for the dispersal and exchange of genetic reproductive material and organisms that are important components of the species lifecycle throughout the locality. This would include but not be limited to habitat for invertebrates or vertebrates providing pollination and seed dispersal for plant species such as *Themeda australis* and vegetation types that of *Thesium australe* is strongly associated with.

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

Marginal potential habitat for the species occurs in Illawarra gully wet forest, Currumbene lowlands forest, Shoalhaven sandstone forest and derived South coast grassy woodland in the study area. Approximately 2.95 hectares of potential habitat for *Thesium australe* would be cleared as part of the proposal with further potential indirect impacts to an additional 4.67 hectares of potential habitat. This would equate to 0.42 per cent of the extent of communities Illawarra gully wet forest, Currumbene lowlands forest, Shoalhaven sandstone forest and derived South coast grassy woodland within the locality.

The area of habitat to be removed will adjoin the Princes Highway resulting in minor additional fragmentation and effects on the quality of habitat for the species in the study area and the locality. The proposal will not result in a significant additional level of isolation of the remaining stands of vegetation from other areas of habitat for the species in the study area and locality.

Conservation reserves in the locality that support one or multiple vegetation communities that provide good quality habitat for the species are Bamarang, Cambewarra Range, Tapitallee, Triplarina Wogamia and Worrigeer Nature Reserves, Bomaderry Creek Regional Park and Seven Mile Beach National Park. The conservative estimate of habitat and vegetation that would be support to the main vegetation habitats for the species that is under land tenure primarily reserved for conservation is 4060ha. This amounts to an area of habitat and support to habitat greater than 800 times the size of that proposed for removal from the subject site. The species is unlikely to decline from habitat loss that will occur from the proposal.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat?**

Invasive woody plant species such as *Lantana camara* and a range of exotic perennial grasses are well established and widespread throughout the subject site, study area and locality including areas of potential habitat. The proposal may result in an increase in the establishment of invasive species within the retained potential habitat of this species in the study area. This may occur as a result of increased edge effects and vegetation management for the maintenance of road reserves. However, the proposal is unlikely to result in the establishment of invasive species in the most important habitat for *Thesium australe* in the conservation reserves of the locality.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

No diseases have been identified as threats to *Thesium australe* by OEH or DSEWPaC. It is considered unlikely that the proposal would introduce any diseases that may cause the species to decline.

**Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?**

Management of known and key habitats including feral animal and weed control monitoring of populations and research into the species summarise the main priority actions to recover the species recommended by OEH. No populations of the species are known from the subject site, study or locality and the habitat likely to be impacted is not considered important for the species. The proposal is unlikely to interfere substantially with the recovery of *Thesium australe* at a local, regional or bioregional level.

**Conclusion**

Based on the above assessment, *Thesium australe* is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not considered necessary for this species.

## Threatened fauna species

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

The Green and Golden Bell Frog (GGBF) is listed as vulnerable under the EPBC Act. The species is also listed as endangered under Schedule 1 the TSC Act.

As there is potential for the proposal to result in "removal or degradation of aquatic or ephemeral habitat that has been assessed as being suitable according to the guideline" an Assessment of Significance has been undertaken in accordance with Matters of National Environmental Significance Significant Impact Guidelines 1.1 (DEWHA 2009a) that also addresses the significant impact thresholds outlined in DEWHA (2009b).

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal.
- Populations necessary for maintaining genetic diversity.
- Populations that are near the limit of the species range.

The Draft Recovery Plan for the GGBF (DEC 2005) refers to four Key Populations, one of which, located at Coomonderry Swamp, occurs in the locality, east of the study area. Although the GGBF has not previously been recorded within the study area, a network of permanent and ephemeral waterways provide connective habitat to what is considered to be an 'important population' of GGBF.

Note that the assessment is preliminary as targeted surveys for the GGBF have not yet been undertaken or a detailed design of the proposal developed.

#### **Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of a species?**

The GGBF has been previously recorded 106 times in the locality with the most recent record from 2012. All of these records are associated with the Coomonderry Swamp Key Population. This swamp is estimated to contain 670 hectares of GGBF habitat which is the largest semi-permanent freshwater swamp in NSW (Daly 1996).

The GGBF has not previously been recorded within the study area, although a network of permanent and ephemeral waterways provide connective habitat to the Coomonderry Swamp Key Population to the east. Given the recent range expansions in GGBF populations along the south-east coast, namely the Crookhaven River Floodplain population east of Nowra, the assessment of suitable GGBF habitat in the study area has been given careful consideration in the event that the species has successfully dispersed and established west of the core Coomonderry Swamp population during the ideal conditions of the 2011/2012 season.

Four water bodies considered to be suitable breeding habitat when assessed against DEWHA (2009b) are located within the direct subject site and an additional three are located within the indirect subject site. The remaining one suitable breeding habitat is located in the study area. The removal of these habitats as a result of the proposal is not considered to lead to a long-term decrease in the size of an important population of a species or its habitat.

#### **Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?**

No individuals have been recorded within the study area; however no targeted surveys have been undertaken to date. A network of permanent and ephemeral waterways provide connective habitat to the Coomonderry Swamp Key Population to the east.

Four water bodies considered to be suitable breeding habitat when assessed against DEWHA (2009b) are located within the direct subject site and an additional three are located within the indirect subject site. According to DEWHA (2009b), there is a possibility of a significant impact on the GGBF, and a referral under the EPBC Act should be considered, if the proposal results in the removal or degradation of terrestrial habitat within 200 metres of habitat identified in threshold 1. At least eight water bodies in the study area are considered to support suitable habitat features for the species (see above). When a 200 metre buffer is applied to the identified breeding habitats, the following terrestrial habitat may be removed or degraded as a result of the proposal:

- 20.97 hectares located within the direct subject site.
- 29.90 hectares located within the indirect subject site.

The remaining 69.28 hectares is terrestrial habitat located in the study area.

Note that not all water bodies within the study area were inspected. Although no breeding habitat has been recorded within the buffered 200 metre terrestrial habitat, it has been deemed to provide at least potential foraging and dispersal habitat for the GGBF in those times of range expansion. The removal of four water bodies and terrestrial foraging or dispersal habitat which may be used by the species on rare occasions is not likely to reduce the area of occupancy of an important population.

**Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?**

The GGBF is a highly mobile species (Goldingay and Lewis 1999), capable of moving several kilometres between breeding sites (Pyke and White 2001). Suitable breeding ponds for the species in the locality occur west of the Coomonderry Swamp Key Population (Daly 1996). The study area is likely to form the most western extent in terms of dispersal for the species being located at the limit of the coastal floodplain. While there is some connectivity from the eastern side of the study area to the west via the existing 17 temporary and permanent water bodies, it is unlikely that the species would disperse to habitats of higher altitude west beyond the study area.

According to DEWHA (2009b), there is a possibility of a significant impact on the GGBF, and a referral under the EPBC Act should be considered, if the proposal results in breaking the continuity of vegetation fringing ephemeral or permanent waterways or other vegetated corridors linking habitats meeting the criteria in threshold 1.

A number of fauna friendly culverts and bridge crossings (where appropriate reasonable and feasible) are proposed along major creek crossings which would assist in the maintenance of connectivity east-west across the study area post-construction. Therefore, it is not considered likely that the existing population Coomonderry Swamp (located five kilometres east) would be fragmented into two or more populations.

**Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?**

Following habitat assessments, at least eight water bodies are considered to support suitable habitat features for the species, including some if not all of the following:

- Presence of emergent aquatic vegetation such as *Phragmites australis* Common Reed and *Typha domingensis* Narrow-leaved Cumbungi.
- Presence of ground and shrub layers adjacent to the water body for foraging.
- Presence of ponding, shallow water (ie less than one metre deep) that is exposed to direct sunlight for at least six hours a day during the spring/summer season.
- Absence of predatory fish.
- Presence of a disturbance regime in the form of fluctuating water levels.



- Presence of areas that can be utilised by the species for access/egress to sheltering (over-wintering) sites such as rock, timber and other human artefacts as well as submerged and floating vegetation over the water body.

According to DEWHA (2009b), there is a possibility of a significant impact on the GGBF, and a referral under the EPBC Act should be considered, if the proposal results in the removal or degradation of aquatic or ephemeral habitat either where the green and golden bell frog has been recorded since 1995 or habitat that has been assessed as being suitable according to these guidelines. This can include impacts from chytrid or *Gambusia* originating off site.

Given the low-lying and rural nature of the locality resulting in a network of creeks, drainage channels and farm dams, the habitats of the study area are not considered to be limiting. There is no real chance or a possibility that the action will adversely affect habitat critical to the survival of the GGBF.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?**

Four water bodies considered to be suitable breeding habitat when assessed against DEWHA (2009b) are located within the direct subject site and an additional three are located within the indirect subject site. Targeted field surveys have not yet been undertaken to determine whether individuals have dispersed and/or established from the core population at Coomonderry Swamp, and are now breeding in aquatic habitats of the study area.

This assessment relies on the premise that the proposal would avoid, minimise and mitigate residual impacts with the specific aim of ensuring works do not result in a significant impact according to both State and federal legislation to the GGBF if it is found following targeted surveys.

Provided that, if the species is located within the study area, a GGBF Management Plan is developed to ensure works would be undertaken in a manner that would ensure as far as reasonably practicable, the most suitable habitat is retained and that works associated with the decommissioning of water bodies considered to be breeding habitat are completed with a zoologist experienced in the identification and management of the GGBF present, the action will not disrupt the breeding cycle of an important population.

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The study area has been deemed to provide at least potential foraging and dispersal habitat for the GGBF in those times of range expansion from the core population located at Coomonderry Swamp. The removal of four water bodies and terrestrial foraging or dispersal habitat which may be used by the species on rare occasions is not likely to decrease the availability or quality of habitat in the locality to the extent that the species is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?**

It is likely that invasive species including the red fox (*Vulpes vulpes*), domestic dog (*Canis lupus familiaris*) and cats (*Felis catus*) are already present within the locality and likely to be present within the study area. The proposal is unlikely to increase their extent or abundance within the study area that are harmful to GGBF.

The removal of submergent vegetation is thought to increase predation events as tadpoles cannot escape predatory fish, including *Gambusia holbrooki* (*Mosquito Fish*). Given that the study area provides little breeding opportunities, predation by Mosquito Fish is unlikely to increase in response to the proposal.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

The presence of amphibian chytrid fungus is not confirmed in the locality, or specifically at Coomonderry Swamp (Lachlan Wilmott, OEH, pers. comm.); however it has been recorded in the Shoalhaven LGA at South Nowra (Angie Radford, RMS pers. comm.).

According to DEWHA (2009b), there is a possibility of a significant impact on the GGBF, and a referral under the EPBC Act should be considered, if the proposal results in the removal or degradation of aquatic or ephemeral habitat either where the green and golden bell frog has been recorded since 1995 or habitat that has been assessed as being suitable according to these guidelines. This can include impacts from chytrid or *Gambusia* originating off site.

In this instance there is some chance the proposal may introduce amphibian chytrid fungus to the study area during the construction phase through the transport on vehicles or personnel working in various wetland habitats of the LGA (DECC 2008).

**Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?**

A national recovery plan has not yet been developed for the species, however OEH have prepared a draft recovery plan (DEC 2005). This plan has recognised the Coomonderry Swamp Key Population which is located just over five kilometres from the study area. The main objectives of the plan are:

- Manage threats impacting on currently known populations so as to stabilise and prevent further decline.
- Return the species to its former distribution, abundance and role in the ecosystem wherever possible.
- Five specific objectives that aim to achieve the overall recovery objectives above are:
  - Increase the security of key GGBF populations by preventing the further loss of habitat of key populations and where possible secure opportunities for increasing protection of habitat areas.
  - Ensure extant populations are managed to eliminate threats.
  - Implement habitat management initiatives.
  - Establish captive populations.
  - Increase the level of awareness of the conservation status of the GGBF and provide greater opportunity for community involvement in the implementation of the recovery plan.

Given the proximity to this core population and recent examples of how the species can rapidly disperse through the landscape, it may be likely that the GGBF could utilise the habitats of the study area on occasion. The proposal, and associated habitat removal, would be undertaken in accordance with the guidelines set out in the recovery plan for this species (pers comm. Josie Stokes, RMS).

A threat abatement plan relevant to the GGBF is the Predation by Mosquito Fish Threat Abatement Plan (NPWS 2003c). Predation by Mosquito Fish has been identified as a serious threat to the GGBF. The proposal is consistent with the objectives of the TAP.

**Conclusion**

Based on the above assessment according to DEWHA (2009b), the proposed works are unlikely to result in a significant impact to the GGBF, conditional upon the implementation of the proposal to avoid, minimise and mitigate residual impacts according to both State and federal legislation. As such, a Referral under the provisions of the EPBC Act is not considered necessary for this species.

### Australasian Bittern *Botaurus poiciloptilus*

The Australasian Bittern is listed as endangered under the EPBC Act 1999. The species is also listed as endangered under Schedule 1 of the TSC Act 1995.

A 'population of a species' is an occurrence of the species in a particular area. This may include either:

- A geographically distinct regional population, or collection of local populations.
- A population, or collection of local populations, that occurs within a particular bioregion.

The Australasian Bittern has been recorded on four occasions east of the study area within Coomonderry Swamp Nature Reserve, the most recent dating from 2008 as well as once south of the study area dating from 1990 near Brundee Swamp Nature Reserve. The Australasian Bittern is uncommon within the Shoalhaven.

There is no policy statement for the species.

#### **Is there a real chance or a possibility that the action likely to lead to a long-term decrease in the size of a population of a species?**

The habitat present within the study area provides potential foraging habitat (shallow water over grasslands) as well as potential breeding habitat (heavily vegetated deep water bodies), however the quality of these habitats is low and not likely to be an important resource for a local population. The removal of these four water bodies is unlikely to lead to the long term decrease of a population of Australasian Bittern.

#### **Is there a real chance or a possibility that is the action likely to reduce the area of occupancy of the species?**

There is no real chance or a possibility that the action will reduce the area of occupancy of the Australasian Bittern as the study area is not at the limit of distribution for this species and the proposal would not remove known breeding habitat or limited potential breeding and foraging habitat from the locality.

#### **Is there a real chance or a possibility that is the action likely to fragment an existing important population into two or more populations?**

There is no real chance or a possibility that the action will fragment an existing important population into two or more populations of Australasian Bittern as the proposal is not likely to restrict movement for this mobile species.

#### **Is there a real chance or a possibility that the action likely to adversely affect habitat critical to the survival of a species?**

Australasian Bittern may utilise resources within the study area on occasion, however are more likely to use resources within Coomonderry Swamp Nature Reserve to the east and Brundee Swamp Nature Reserve to the south. The habitats present within the study area provide marginal habitat for the species, being heavily disturbed through the alternation of water regimes, farming practices and clearing.

The removal or modification of habitat within the study area is unlikely to adversely affect habitat critical to the survival of the species.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?**

Good quality habitat and breeding habitat occurs approximately five kilometres east of the study area within Coomonderry Swamp Nature Reserve and to the south in Brundee Swamp Nature Reserve. Although the species is considered to be uncommon throughout the Shoalhaven, Australasian Bittern may move utilise these areas in response to changing environmental conditions, making them periodically important wetland habitats.

The study area however is unlikely to support regular breeding habitat given the overall low quality of habitat and high levels of disturbance. Therefore, it is unlikely that the action would disrupt the breeding cycle of a population of Australasian Bittern.

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The availability of habitats would be reduced as a result of the proposal, however given these habitats are not high quality and that better quality habitats occur within protected areas within the locality (eg Coomonderry Swamp Nature Reserve and Brundee Swamp Nature Reserve) it is unlikely that the proposal would cause the Australasian Bittern to decline.

The majority of the study area consists of open grassland containing little native vegetation, wildlife corridors in the study area, therefore already highly disturbed. Given the mobility of these species and the suboptimal quality of habitats present, the proposal is unlikely to isolate habitats present for these species.

Therefore, the proposal would not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that a local population of Australasian Bittern is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the endangered species' habitat?**

It is likely that invasive species including the red fox (*Vulpes vulpes*), domestic dog (*Canis lupus familiaris*) and cats (*Felis catus*) are already present within the locality and likely to be present within the study area. The proposal is unlikely to increase their extent or abundance or introduce additional invasive species within the study area that are harmful to Australasian Bittern.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

The proposal is unlikely to introduce a disease that may cause the Australasian Bittern to decline.

**Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?**

There is currently no recovery plan developed specifically for the Australasian Bittern; however Environment Australia (2000) has included the species within the *Action Plan for Australian Birds*. Two specific recovery actions were identified:

- To maintain existing population.
- To rehabilitate known former breeding sites.

The species has not been recorded within the study area and no high quality breeding habitat is available. Therefore the proposal is considered to be consistent with the recovery actions identified in Environment Australia (2000).



## **Conclusion**

Based on the above assessment, Australasian Bittern is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not considered necessary for this species.

### Swift Parrot *Lathamus discolor*

The Swift Parrot is listed as Endangered under the EPBC Act 1999. The species is also listed as Endangered under the TSC Act 1995.

#### **Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of a population of the species?**

The Swift Parrot is a highly nomadic species that occurs in woodlands and forests in New South Wales (Higgins 1999). It migrates in response to food availability and seasonal changes. It is often recorded in New South Wales between May and August and breeds in Tasmania during the warmer seasons (Higgins 1999).

While on the mainland, Swift Parrots occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter-flowering species such as *Eucalyptus robusta*, *Corymbia maculata*, *C. gummifera*, *E. sideroxylon*, and *E. albens*. Commonly used lerp-infested trees include *E. microcarpa*, *E. moluccana* and *E. pilularis* (DEC 2005).

The Swift Parrot has not been previously recorded within the study area. The closest record occurs approximately 9 kilometre to the south east at Shoalhaven Heads, recorded in 1984 (DECCW 2009). No other records of the species occur within 10 kilometre of the study area.

The study area provides potential foraging habitat for the Swift Parrot within the eucalypt forests. Three favoured feed tree species (*Corymbia maculata*, *C. gummifera* and *Eucalyptus pilularis*) occur within the study area. *Corymbia maculata* is dominant within Currumbene lowlands forest, *C. gummifera* is a dominant species within Shoalhaven sandstone forest and *E. pilularis* is dominant within Illawarra gully wet forest. The study area does not provide potential breeding habitat as the species breeds exclusively in Tasmania (Higgins 1999).

The proposal would impact potential foraging habitat for the Swift Parrot through the removal of roadside eucalypt forest. Approximately 1.98 hectares of eucalypt forest (potential foraging habitat) would be removed from the study area with a further 4.68 hectares affected by indirect impacts (eg edge effects). This equates to only 0.03 per cent of eucalypt forest within the locality (17457.50 hectares). Given the availability of potential foraging habitat within the locality (including habitat protected within Seven Mile Beach National Park), the fact that no breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that the proposal would lead to a long-term decrease in the size of a population of the Swift Parrot.

#### **Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?**

The study area does not lie at or near the limit of the area of occupancy of the Swift Parrot, which extends from south east Queensland through New South Wales, Victoria to South Australia and Tasmania (Pizzey and Knight 2007).

Given the presence of preferred feed tree species within the study area, and the record of the Swift Parrot within 10 kilometre of the study area, it is possible the parrot may utilise resources within the study area from time to time. However, given the high mobility of the Swift Parrot (able to migrate between Tasmania and south eastern mainland) and the availability of potential habitat in the locality (17457.50 hectares), the loss of 1.98 hectares eucalypt forest (disturbed roadside habitat) is unlikely to reduce the area of occupancy of the species.

**Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?**

Swift parrots are winter migrants to New South Wales, and travel to foraging sites on a cyclic basis depending on food availability (DEC 2005). The proposal would involve removal of potential feed trees from the study area. Some of the areas to be removed (roadside areas) are contiguous with intact forest that would remain (eg mapped vegetation communities of Currumbene Batemans lowland forest, Shoalhaven sandstone forest and Illawarra gully wet forest). Given the availability of surrounding eucalypt forests, the small areas of proposed vegetation removal (total of 1.98 hectares eucalypt forest) and the high mobility of the Swift Parrot, it is considered unlikely that the proposal would fragment an existing population into two or more populations.

**Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of the species?**

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. A Register of Critical Habitat is maintained by the Minister under the EPBC Act. To date, no critical habitat has been declared for the Swift Parrot (DEWHA 2009a).

Critical habitat can also refer to areas that are necessary for activities such as foraging, breeding or dispersal; for the long-term maintenance of the species; to maintain genetic diversity and long-term evolutionary development; or for the reintroduction of populations or recovery of the species (DEWHA 2009a).

The proposal would impact potential foraging habitat for the Swift Parrot through the removal of eucalypt forest, but no breeding habitat would be impacted as this species breeds in Tasmania. The proposal is considered unlikely to affect habitat critical to the survival of the species, given the mobility of the species, the availability of surrounding eucalypt forests, and the small areas of proposed vegetation removal.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population of the species?**

The Swift Parrot breeds exclusively in Tasmania during the warmer seasons (Higgins 1999). It is a highly nomadic species that occurs in woodlands and forests in New South Wales during winter, and migrates in response to food availability and seasonal changes (Higgins 1999).

Given the impacts to potential foraging habitat are unlikely to lead to a long-term decrease in the size of a population of the Swift Parrot (described above) and that no breeding habitat would be impacted (as the species breeds exclusively in Tasmania), it is considered unlikely that the proposal would disrupt the breeding cycle of a population of the Swift Parrot.

**Is there a real chance or a possibility that the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The proposal would directly impact up to 1.98 hectares of potential foraging habitat (eucalypt forest) for the Swift Parrot (much of which contains preferred feed tree species). Within the localities vegetation mapping (SCIVI - as amended following the field surveys), the habitat to be directly impacted represents 0.01 per cent of potential habitat within the locality (17457.50 hectares). A further 4.68 hectares of eucalypt forest would be indirectly affected (eg edge effects) by the proposal. This equates to approximately 0.02 per cent of potential habitat within the locality. In total, 0.03 per cent of the potential habitat occurring in the locality would be impacted by the proposal.

Although some preferred feed tree species of the Swift Parrot occur in the study area (*Corymbia maculata*, *C. gummifera* and *Eucalyptus pilularis*), the habitat to be impacted consists of disturbed, roadside vegetation and is considered to be of low importance for the long-term survival of the Swift Parrot within the locality. Given this, the absence of records of the species within the study area and locality, and the species' high mobility, the loss and/or disturbance of 0.03 per cent of potential habitat within the locality is considered unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Swift Parrot is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?**

Predation or competition by invasive species is not listed as a threat to the Swift Parrot by the OEH or DEWHA (Swift Parrot Recovery Team 2001). The proposal is unlikely to result in the introduction or exacerbation of any invasive species that is harmful to the Swift Parrot in the study area.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

Infection by *Psittacine circoviral* (beak and feather) disease (PCD) affecting endangered psittacine species is listed as a key threatening process (NSW Scientific Committee 2008b; DEH 2005). Swift parrots are considered to have a high potential for being adversely impacted by PCD due to their low population numbers and the fact that PCD has been recorded in wild birds in New South Wales (NSW Scientific Committee 2008b). The proposal is unlikely to result in the introduction of PCD into the study area, or increase the incidence of PCD in birds in New South Wales.

**Is there a real chance or a possibility that the action will interfere with the recovery of the species?**

DEWHA has developed a national recovery plan for the Swift Parrot (Swift Parrot Recovery Team 2001). One recovery objective outlined in this plan relevant to the proposal is:

- Implement management strategies at the landscape scale to protect and improve priority habitats and sites resulting in a sustained improvement in carrying capacity.

No breeding habitat would be impacted. Although a number of preferred feed tree species occur within the study area, the individuals to be removed occur in disturbed, roadside areas. Given the above, the low importance of the potential habitat within the study area and that only 0.04 per cent of potential habitat within the locality would be impacted; it is unlikely that the proposal would interfere with this recovery objective.

**Conclusion**

Based on the above assessment the Swift Parrot is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not considered necessary for this species.



## Spotted-tailed Quoll *Dasyurus maculatus maculatus*

The Spotted-tailed Quoll is listed as Endangered under the EPBC Act 1999. The species is also listed as Vulnerable under the TSC Act 1995.

### **Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of a population of the species?**

The Spotted-tailed Quoll occurs in a range of habitats including sclerophyll forest and woodlands, coastal heathlands and rainforests (Dickilometrean and Read 1992; Edgar and Belcher 1995). Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas (NPWS 1999h).

This species' habitat requirements include suitable den sites (such as hollow logs, tree hollows, rock outcrops or caves) and an abundance of food (NPWS 1999h). The diet of juveniles is dominated by invertebrates, small mammals and birds, while the diet of adults is dominated by medium-sized mammals (Belcher *et al.* 2008). Individuals require large areas of relatively intact vegetation through which to forage (NPWS 1999h). The home range of a female is between 180–1000 hectares, while males have larger home ranges of between 2000–5000 hectares (Belcher *et al.* 2008).

The Spotted-tailed Quoll has been previously recorded numerous times within 10 kilometre of the study area, predominantly to the north and west, with a few records in the south east. These records are dated between 1969 and 2006 and the closest record occurs approximately 2.3 kilometre to the south west (recorded in 1992) (DECCW 2009).

The study area provides potential foraging and denning habitat (eg tree hollows) for the Spotted-tailed Quoll within the eucalypt and riparian forests. Although only limited connectivity occurs within the study area, this species may utilise riparian corridors within the locality to move between areas of habitat.

Approximately 3.18 hectares of eucalypt and riverbank (riparian) forest (potential habitat) would be removed from the study area with a further 5.41 hectares affected by indirect impacts (eg edge effects). This equates to only 0.03 per cent of the potential habitat (eg eucalypt and riparian forest, rainforest and heathland) available within the locality (23519.93ha). Given the availability of potential habitat within the locality, the poor condition of potential habitat in the study area, the limited opportunities for connectivity within and beyond the study area, and the high mobility of this species, it is considered unlikely that the proposal would lead to a long-term decrease in the size of a population of the Spotted-tailed Quoll.

### **Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?**

The study area does not lie at or near the limit of the area of occupancy of the Spotted-tailed Quoll, which extends between the Victorian and Queensland borders in New South Wales (Belcher *et al.* 2008).

The study area lies south of a broader distribution of records of the species (between Barren Grounds Nature Reserve and Cambewarra Range Nature Reserve). Impacts to the Spotted-tailed Quoll within the locality of the study area are unlikely to reduce the species' extent through this broader distribution of records. Given this, and that the study area does not occur at or near the limit of the area of occupancy of the Spotted-tailed Quoll, the proposal is unlikely to reduce the area of occupancy for this species.

**Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?**

Given the distribution of records north, west and south east of the study area, it is considered possible that the Spotted-tailed Quoll passes through the study area from time to time. However, connectivity within and beyond the study area is limited to discontinuous riparian and roadside vegetation. Vegetated corridors occur east and west of the study area (eg Seven Mile Beach – Barren Grounds corridor to the east and Morton National Park to the west) and likely provide greater opportunity for movement throughout the locality and broader landscape. Given the availability of potential habitat and connectivity in the locality, the small areas of proposed vegetation removal (total of 3.18 hectares of eucalypt and riverbank forest) and the high mobility of the Spotted-tailed Quoll, it is considered unlikely that the proposal would fragment an existing population into two or more populations.

**Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of the species?**

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. A Register of Critical Habitat is maintained by the Minister under the EPBC Act 1999. To date, no critical habitat has been declared for the Spotted-tailed Quoll (DEWHA 2009a).

Critical habitat can also refer to areas that are necessary for activities such as foraging, breeding or dispersal; for the long-term maintenance of the species; to maintain genetic diversity and long-term evolutionary development; or for the reintroduction of populations or recovery of the species (DEWHA 2009a).

The proposal would impact potential habitat for the Spotted-tailed Quoll through the removal of eucalypt and riparian forest. The proposal is considered unlikely to affect habitat critical to the survival of the species, given the mobility of the species, the poor condition of the habitat to be removed (disturbed, roadside areas), the availability of surrounding eucalypt and riparian forests, and the small areas of proposed vegetation removal.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population of the species?**

The Spotted-tailed Quoll requires suitable den sites (such as hollow logs, tree hollows, rock outcrops or caves) for breeding (DEC 2005). Within the study area, hollow-bearing trees and hollow logs provide limited potential breeding habitat for this species. All the areas to be removed that contain such breeding resources are disturbed due to the existing road and ongoing agricultural practices. Some patches of vegetation to be removed are contiguous, however, with intact forest that also contains the same potential breeding resources (eg mapped vegetation communities of Currumbene Batemans lowland forest, Shoalhaven sandstone forest and Illawarra gully wet forest). Given the availability of surrounding habitat, the small areas of proposed vegetation removal (total of 3.18 hectares eucalypt and riparian forest) and the high mobility of the Spotted-tailed Quoll, it is considered unlikely that the proposal would disrupt the breeding cycle of a population of the Spotted-tailed Quoll.

**Is there a real chance or a possibility that the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The proposal would result in the removal of approximately 2.41 hectares of eucalypt forest and 0.53 hectares of riverbank (riparian) forest. The habitat to be directly impacted represents less than 0.01 per cent of potential habitat within the locality (23519.93ha). A further 3.1 hectares and 0.74 hectares of eucalypt forest and riverbank (riparian) forest respectively, would be indirectly affected (eg edge effects) by the proposal. In total, 0.03 per cent of the potential habitat occurring in the locality would be impacted by the proposal.

Although it is considered possible the Spotted-tailed Quoll may occur in the study area from time to time, the habitat to be impacted consists of disturbed roadside and disturbed riparian vegetation and is considered to be of low importance for the long-term survival of the Spotted-tailed Quoll within the locality. Given this, and the species' high mobility, the loss and/or disturbance of 0.03 per cent of potential habitat within the locality is considered unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Spotted-tailed Quoll is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?**

DEWHA identifies predation and competition by/with the red fox (*Vulpes vulpes*), dingo (*Canis lupus dingo*), domestic dog (*Canis lupus familiaris*) and cats (*Felis catus*) as a threat to the Spotted-tailed Quoll (DEWHA 2009b). These species are likely to be already present within the study area and may already be having an effect on the Spotted-tailed Quoll. The proposal, however, is unlikely to increase their extent or abundance within the study area.

Although only anecdotal evidence exists, DEWHA identifies poisoning by the cane toad (*Bufo marinus*) as a potential threat to the Spotted-tailed Quoll (DEWHA 2009b). However, the study area occurs well south of the southern limit of the cane toad's current distribution and the proposal is unlikely to result in this species becoming established in the study area or locality.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

Neither DEWHA nor DECCW list disease as a threat to the Spotted-tailed Quoll (DEWHA 2009b; DEC 2005). The proposal is unlikely to lead to the introduction of a disease that would cause a decline in the Spotted-tailed Quoll.

**Is there a real chance or a possibility that the action will interfere with the recovery of the species?**

There is currently no recovery plan for the Spotted-tailed Quoll, however the DECCW has listed 32 priority actions and recovery strategies to help recover this species. Those relevant to the proposal include:

- Retain and protect large, forested areas with hollow logs and rocky outcrops, particularly areas with thick understorey or dense vegetation along drainage lines.
- Habitat requirements of Spotted-tailed Quolls to be adequately conserved within environmental planning instruments and through other legislative protection mechanisms, including property vegetation plans.
- At sections of roads where Spotted-tailed Quolls are frequently killed, incorporate methods to reduce the numbers of animals killed. Assess the effectiveness of different mitigation methods.

The proposal would result in the removal of some forested areas containing hollow-bearing trees and hollow logs, including riparian vegetation. However, as discussed above, the areas to be removed are already disturbed. Similar habitat resources occur and would remain adjacent to the cleared areas.

Given the limited connectivity within the study area, the proposal is considered unlikely to result in a higher rate of road kill for the Spotted-tailed Quoll.

Given the above, the proposal is considered to be consistent with the OEH recovery actions for the Spotted-tailed Quoll.

## **Conclusion**

Based on the above assessment the Spotted-tailed Quoll is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not considered necessary for this species.



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

The Grey-headed Flying-fox is listed as vulnerable under the EPBC Act 1999. The species is also listed as vulnerable under Schedule 2 of the TSC Act 1995.

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal.
- Populations necessary for maintaining genetic diversity.
- Populations that are near the limit of the species range.

The study area does not contain breeding or roosting habitat for the Grey-headed Flying-fox. The closest known camp is located 1.5 kilometres to the south along Bomaderry Creek, which has records of between 80-7000 individuals (OEH 2013a). Given the distribution of records of the species within 10 kilometres, individuals from the Bomaderry Creek camp site are likely to utilise resources within the study area on occasion, however these habitats are not considered to be limiting in the locality. Therefore the study area does not contain a key source population either for breeding or dispersal nor does it contain a population that is necessary for maintaining genetic diversity of the species.

Populations of the Grey-headed Flying-fox are found within 200 kilometres of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria (DECCW 2009). The study area is not at, or near, the limit of distribution for this species.

Therefore the study area is not considered to contain an 'important population' of Grey-headed Flying-fox that is necessary for a species' long-term survival and recovery.

A policy statement is available for the species; however it has been developed with the purpose to discuss control measures that seek to balance this need with the protection and recovery of the species in reference to crop and orchid damage (DEH 2003). Therefore, it has not been referred to herein.

### **Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of a species?**

There is no real chance or a possibility that the action would lead to a long-term decrease in the size of an important population of Grey-headed Flying-fox as the study area is not considered to contain an 'important population' of the species.

### **Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?**

There is no real chance or a possibility that the action would reduce the area of occupancy of an important population of Grey-headed Flying-fox as the study area is not considered to contain an 'important population' of the species.

### **Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?**

There is no real chance or a possibility that the action would fragment an existing important population into two or more populations of Grey-headed Flying-fox as the study area is not considered to contain an 'important population' of the species.

**Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?**

The study area does not contain breeding or roosting habitat for the Grey-headed Flying-fox. The closest known camp is located 1.5 kilometres to the south along Bomaderry Creek, which has records of between 80-7000 individuals (OEH 2013a). Given the distribution of records of the species within 10 kilometres, individuals from the Bomaderry Creek camp site are likely to utilise resources within the study area on occasion, however these habitats are not considered to be limiting in the locality.

There is no real chance or a possibility that the action would adversely affect habitat critical to the survival of the Grey-headed Flying-fox as the study area is not considered to contain critical habitat for the species.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?**

There is no real chance or a possibility that the action would disrupt the breeding cycle of an important population of Grey-headed Flying-fox as the study area is not considered to contain an 'important population' of the species.

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The majority of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation. Approximately 7.75 hectares of non-limiting woodland/forest and planted vegetation habitat would be removed from the study area as a result of the proposal. This equates to only 0.02 per cent of the potential habitat (e.g. eucalypt and riparian forest, rainforest, mangroves and paperbark swamps) available within the locality.

Given the availability of known and potential habitat within the locality, including protected habitat within Seven Mile Beach National Park, that no breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that the proposed upgrade would will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?**

It is likely that invasive species including the red fox (*Vulpes vulpes*), domestic dog (*Canis lupus familiaris*) and cats (*Felis catus*) are already present within the locality; however it is unlikely that these ground-dwelling species are having an effect on Grey-headed Flying-fox's foraging within the study area. The proposal is unlikely to increase their extent or abundance or introduce additional invasive species within the study area that are harmful to Grey-headed Flying-fox.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

Australian flying-foxes, including the Grey-headed Flying-fox has been identified as natural reservoirs of three zoonotic diseases being Australian bat lyssavirus, Hendra virus and Menangle virus (DECCW 2009) and can be fatal to the species.

Australian bat lyssavirus is a fatal disease that is transmitted to humans through bites or scratches when the saliva of infected bats comes into contact with an open wound (Anon 1996). There is no evidence that the two paramyxoviruses can be transmitted directly from bats to humans, although each has been transmitted to humans by domestic animals (horses and pigs) (DECCW 2009).

The proposal would not disturb or remove any Grey-headed Flying-fox camps and would not further introduce disease that may cause the species to decline.

**Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?**

OEH have developed a *Draft National Recovery Plan for the Grey-headed Flying-fox* (DECCW 2009). The overall objectives of recovery of Grey-headed Flying-foxes are:

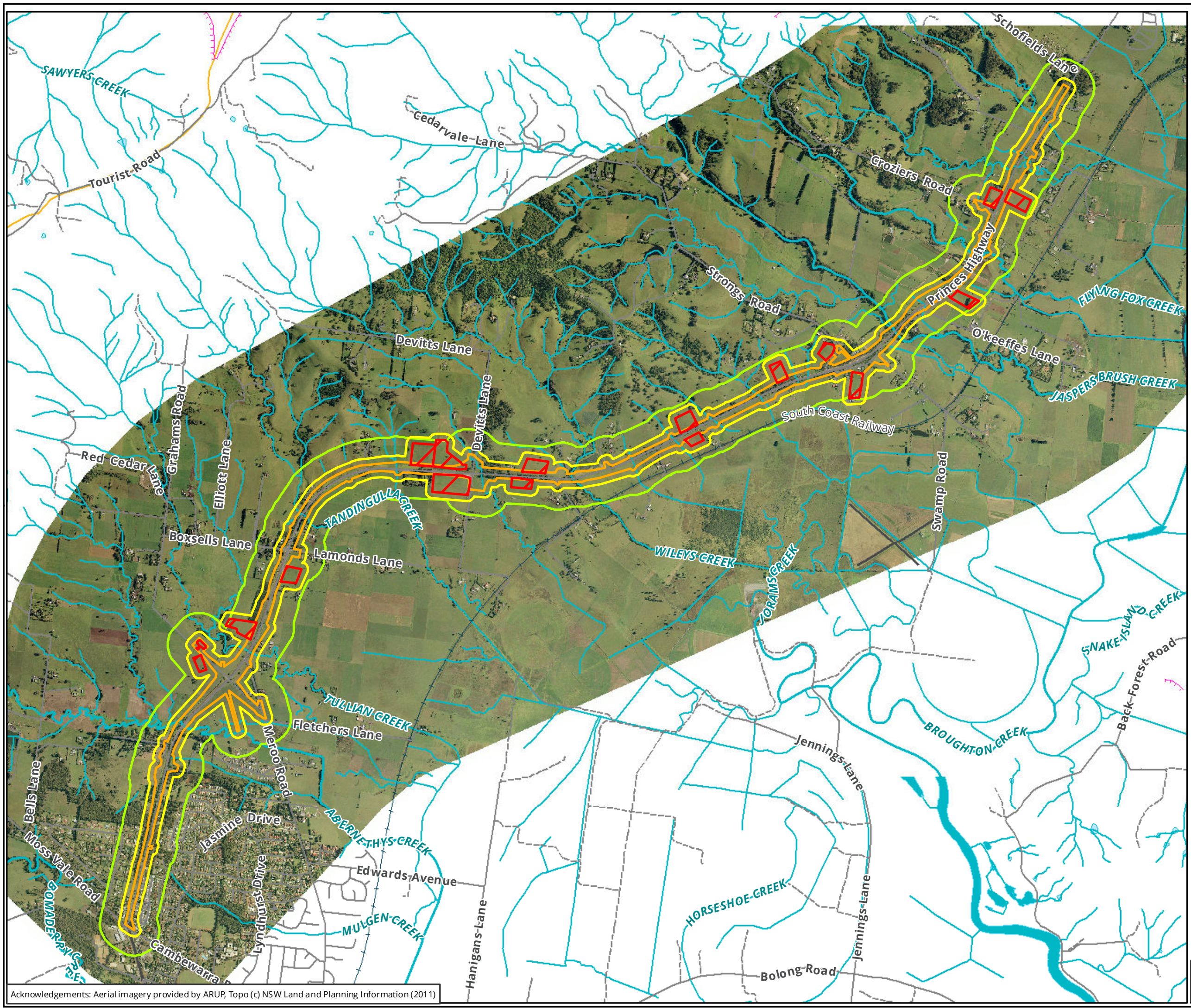
- To reduce the impact of threatening processes; to arrest decline throughout their range.
- To conserve their functional roles in seed dispersal and pollination of native plants.
- To improve the comprehensiveness and reliability of information available to guide recovery.

No known roost sites would be removed or disturbed as a result of the proposal, although 7.75 hectares of potential foraging habitat would be removed. Some fleshy fruit trees are located within the study area, however the habitat to be removed is not considered to be limiting for the species in the locality. Therefore the proposal remains consistent with the objectives outlined by the recovery plans for these species.

**Conclusion**

Based on the above assessment the Grey-headed Flying-fox is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not considered necessary for this species.





- Legend**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 1: Overview of the study area**

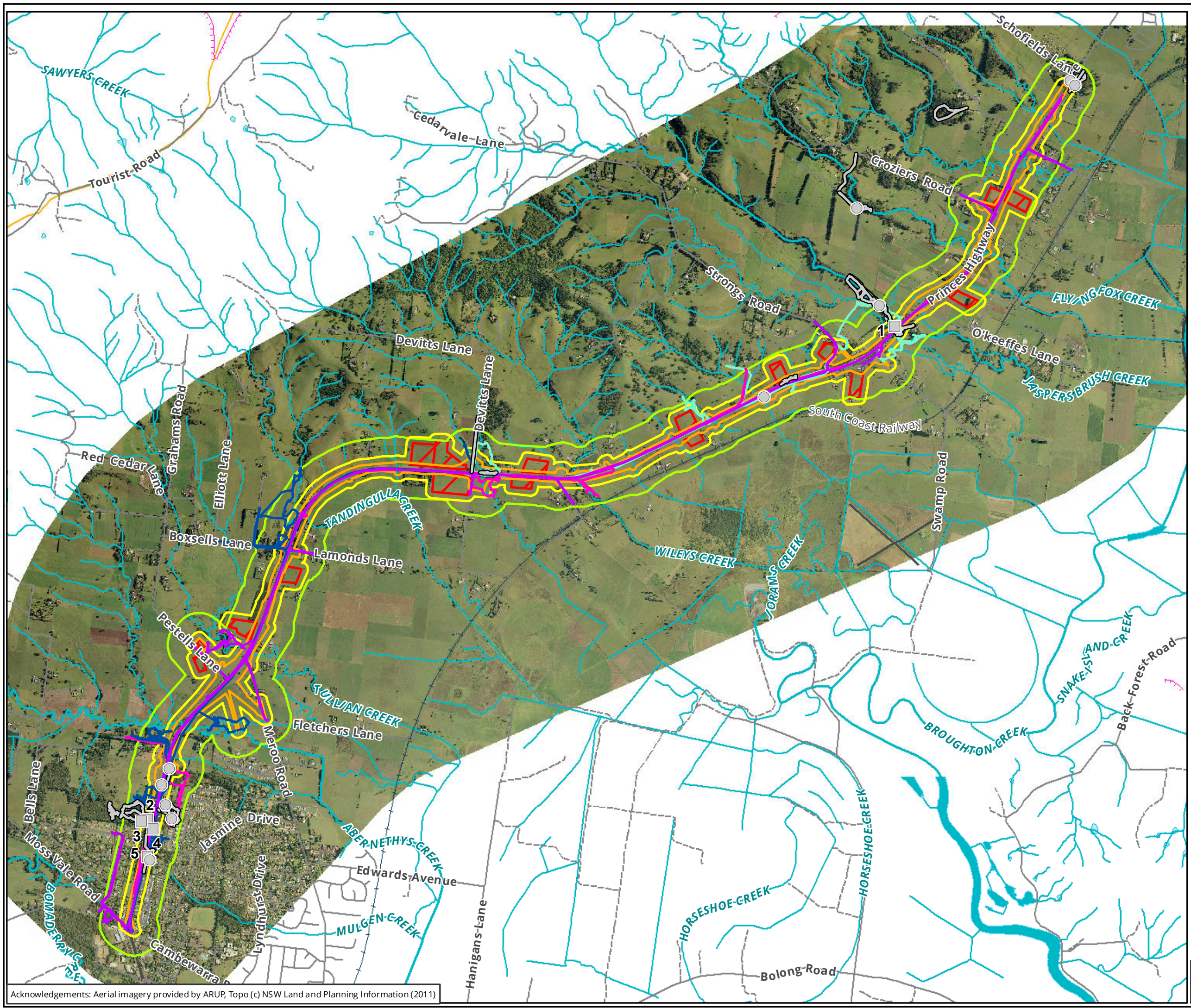
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 Date: 12 August 2013,  
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 Location: P:\15800s\15896\mapping\15896\_F1\_Overview\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)





**Legend**

**2013 flora survey**

- Random meander 20 March 2013
- Random meander 21 March 2013
- Random meander 22 March 2013
- Random meander 26 March 2013

**2009 flora survey**

- Habitat condition assessment
- Quadrat
- Random meander transect

**Survey area**

- ▭ Subject site (direct impacts)
- ▭ Subject site (indirect impacts)
- ▭ Study area (ancillary buffer)
- ▭ Potential construction ancillary facilities

**Figure 2.1: Flora surveys including 2013 and 2009**

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Meters

Scale: 1:28,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

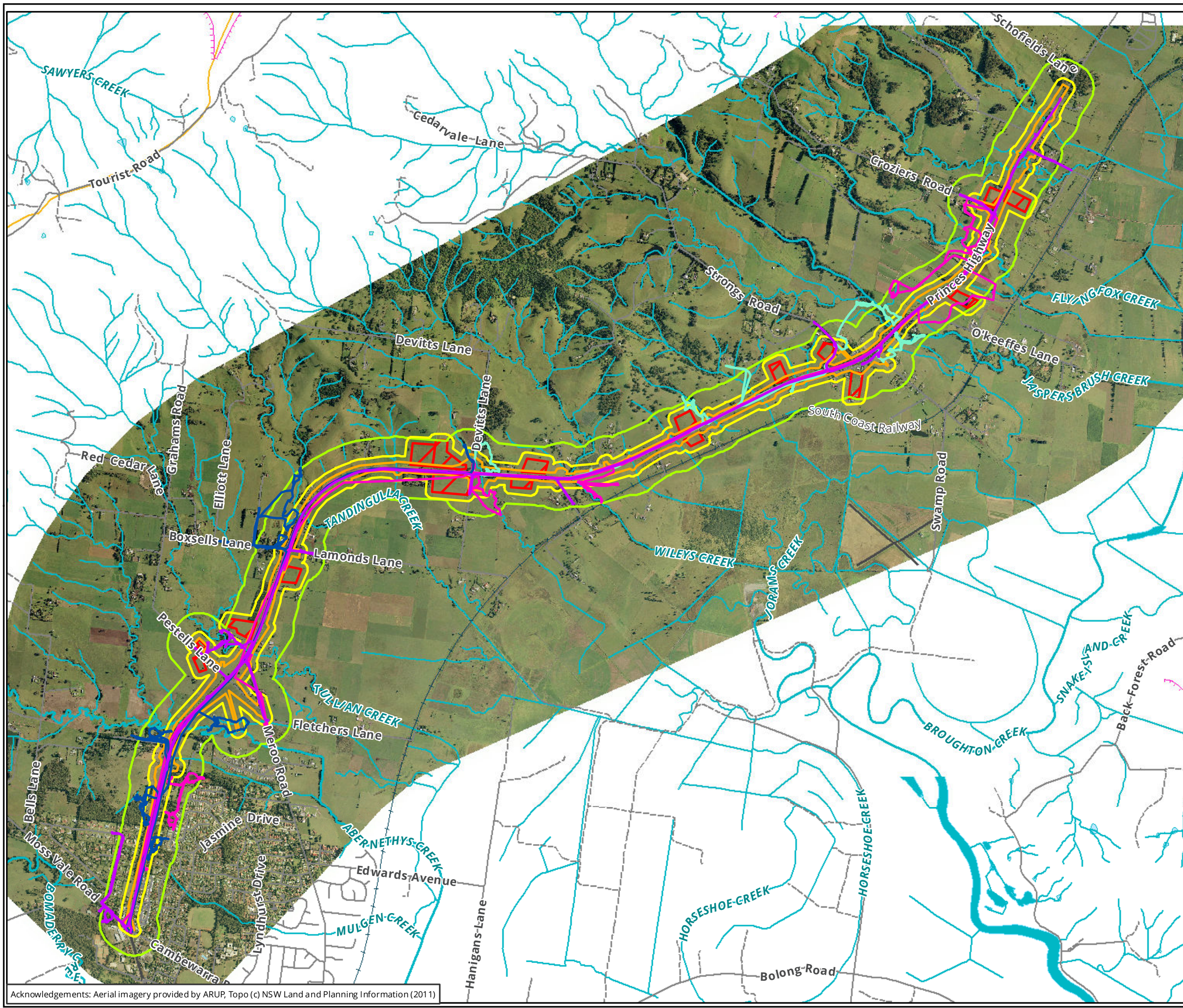
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- Legend**
- 2013 fauna survey**
- Random meander 20 March 2013
  - Random meander 21 March 2013
  - Random meander 22 March 2013
  - Random meander 26 March 2013
- Survey area**
- ▭ Subject site (direct impacts)
  - ▭ Subject site (indirect impacts)
  - ▭ Study area (ancillary buffer)
  - ▭ Potential construction ancillary facilities

**Figure 2.2: Fauna surveys**

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Meters

Scale: 1:28,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

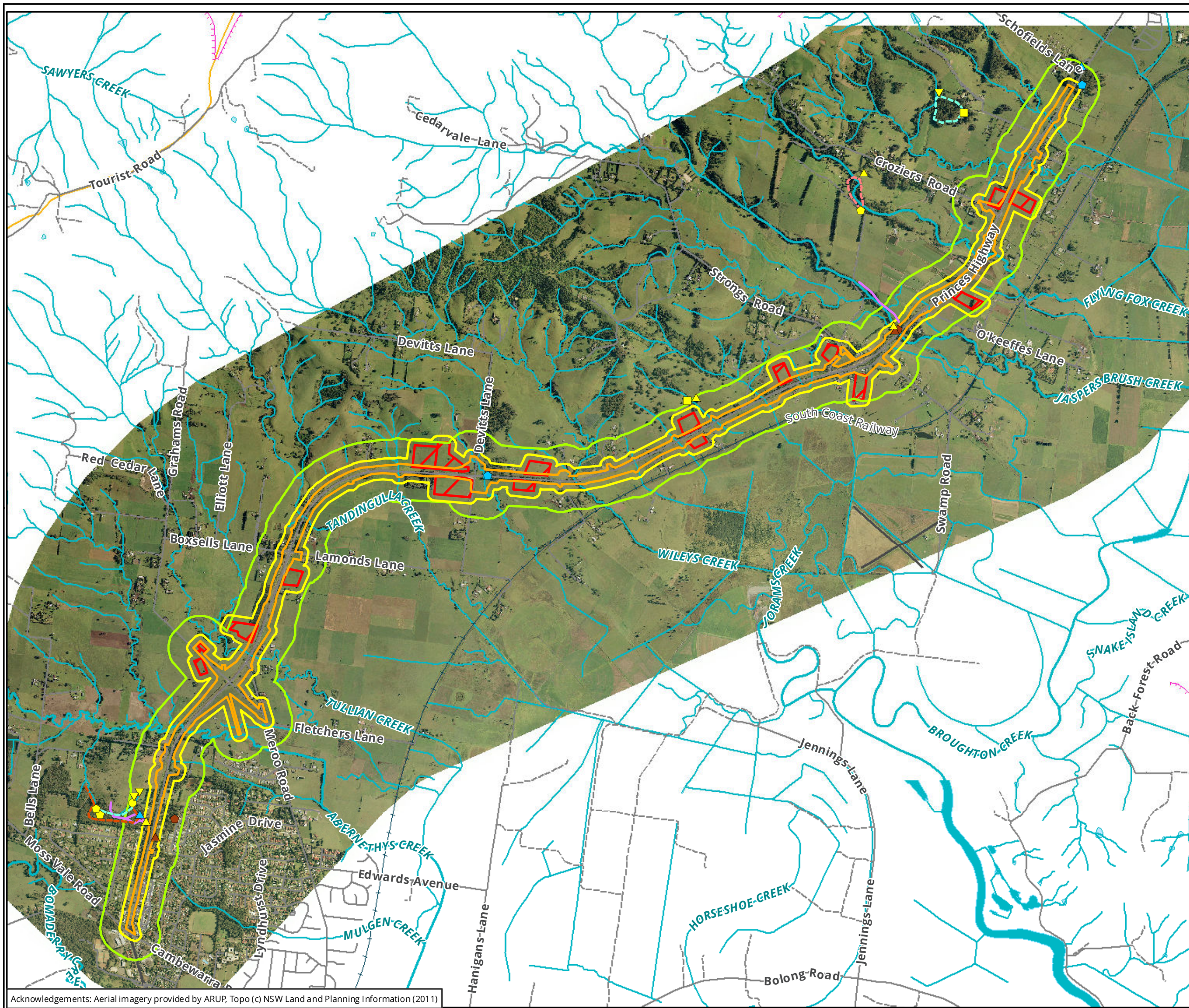
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Location: P:\15800s\15896\mapping\15896\_F2.2\_FaunaSurvey\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)





**Legend**

**Previous surveys**

**Summer 2007**

- Anabat
- Anabat/Harp trap
- ▲ Bird survey
- ▼ Frog survey
- ◆ Habitat assessment

**Spring 2008**

- ▲ Bird survey
- ◆ Habitat assessment

**Autumn 2009**

- ▲ Bird survey
- ◆ Habitat assessment

**Previous transects**

**Spring 2008**

- Spotlighting

**Summer 2007**

- Bird survey
- Spotlighting
- Spotlighting/Nocturnal bird survey

**Survey area**

- Subject site (direct impacts)
- Subject site (indirect impacts)
- Study area (ancillary buffer)
- Potential construction ancillary facilities

**Figure 2.3: Fauna survey effort**

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Meters

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Coordinate System: GDA 1994 MGA Zone 56

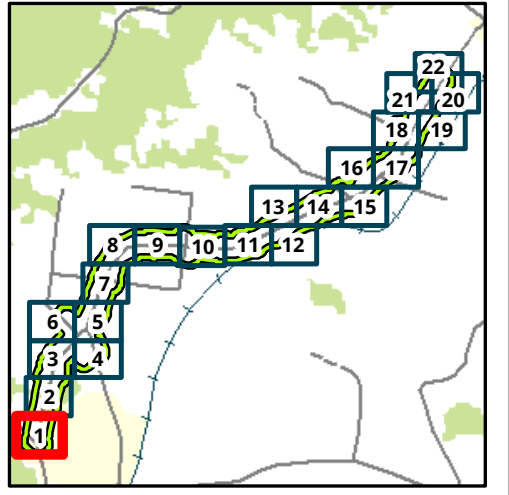
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Location: P:\15800s\15896\mapping\15896\_F2.3\_FaunaSurvey\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)





- Legend**
- Native vegetation (Biosis 2013)**
    - Shoalhaven sandstone forest
  - Constructed (Biosis 2013)**
    - Planted
  - Native vegetation (SCIVI 2010)**
    - Currambene-Batemans Lowlands
    - Forest
    - Illawarra Gully Wet Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.1: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

0 25 50 75 100 125  
Metres

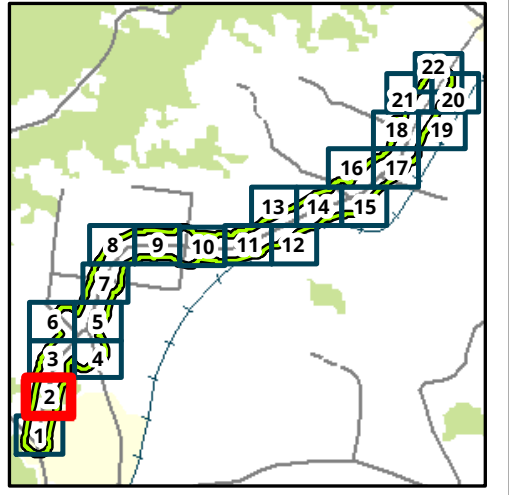
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Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Native vegetation (Biosis 2013)**
    - Currumbene Batemans lowland forest
    - Illawarra gully wet forest
    - Shoalhaven sandstone forest
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
    - Reedland
  - Constructed (Biosis 2013)**
    - Planted
  - Native vegetation (SCIVI 2010)**
    - Currumbene-Batemans Lowlands Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.2: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

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Metres

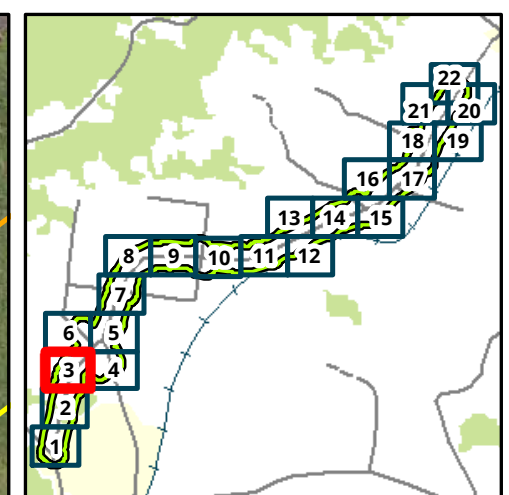
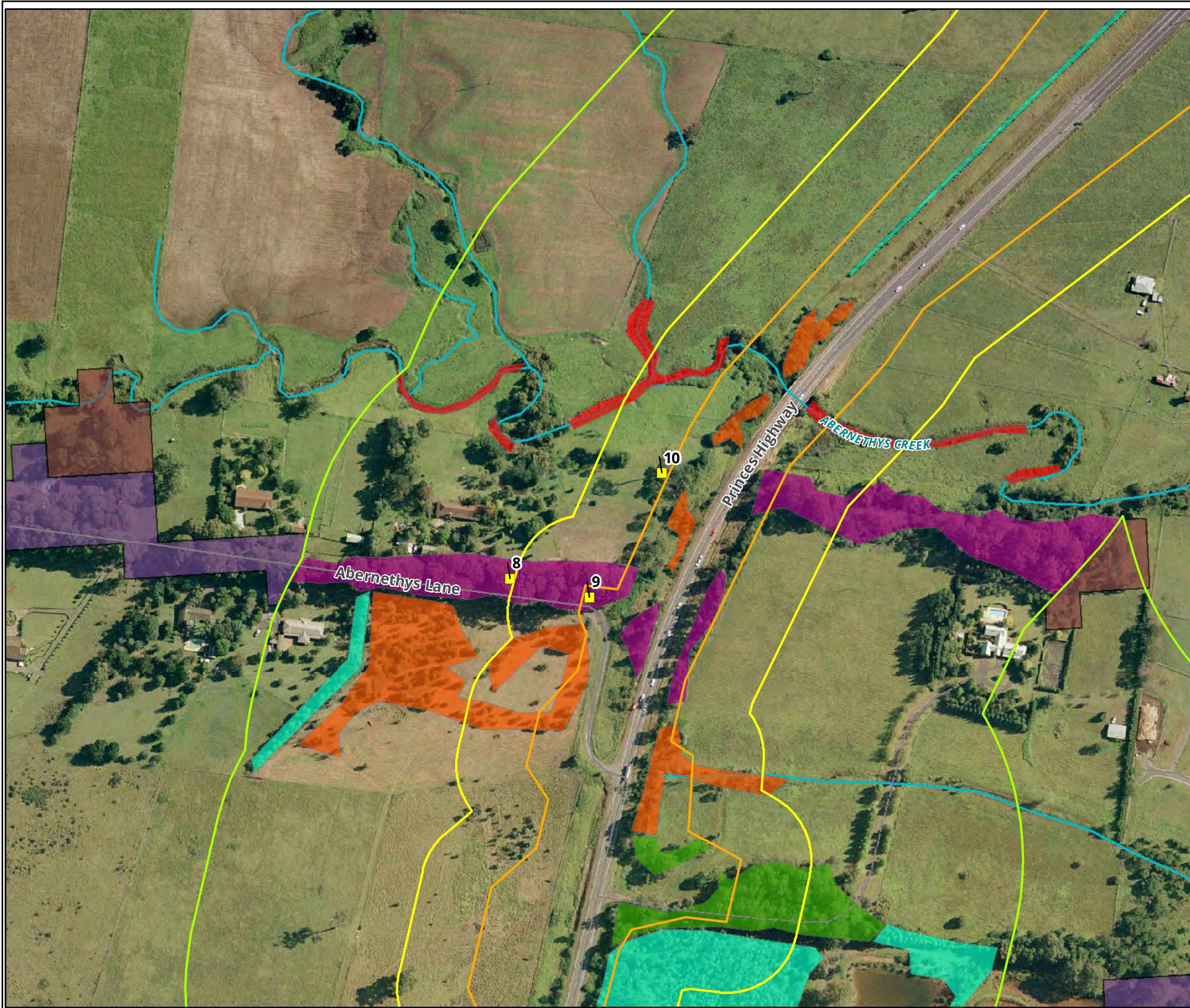
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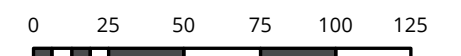
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- Legend**
- Hollow bearing tree
  - Stag
- Native vegetation (Biosis 2013)**
- Currumbene Batemans lowland forest
  - Illawarra gully wet forest
- Derived vegetation (Biosis 2013)**
- Acacia scrub
  - Reedland
- Constructed (Biosis 2013)**
- Planted
- Native vegetation (SCIVI 2010)**
- Currumbene-Batemans Lowlands Forest
  - Illawarra Gully Wet Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.3: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



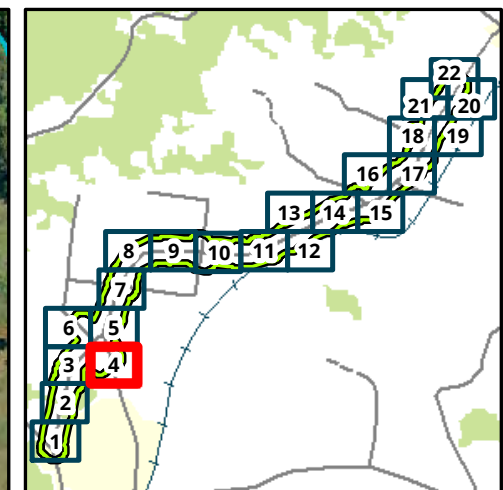
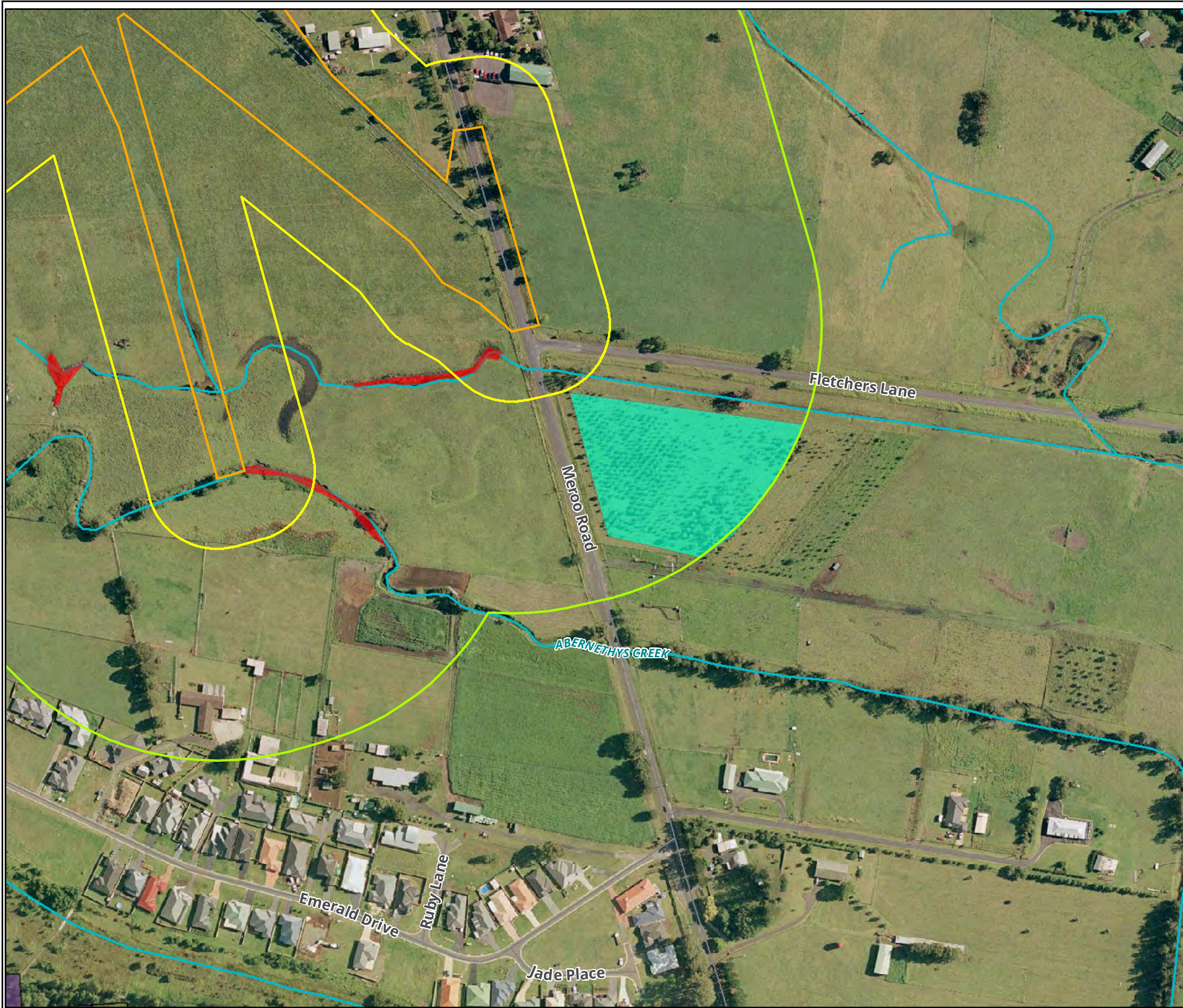
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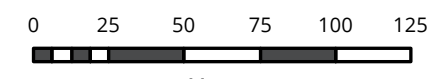
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 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Derived vegetation (Biosis 2013)**
    - Reedland
  - Constructed (Biosis 2013)**
    - Planted
  - Native vegetation (SCIVI 2010)**
    - Currambene-Batemans Lowlands
    - Forest
    - Floodplain Swamp Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.4: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



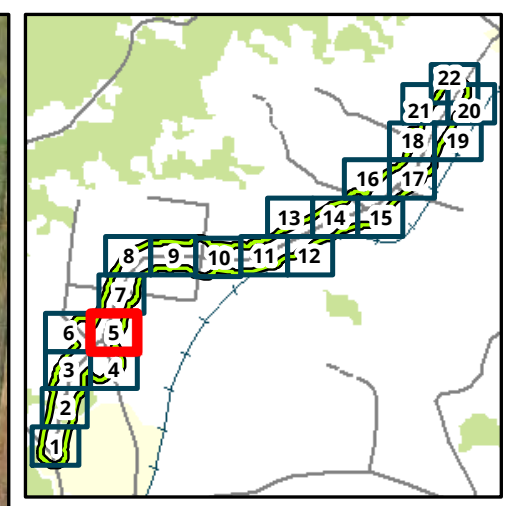
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 Date: 12 August 2013  
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 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing trees
  - Native vegetation (Biosis 2013)**
    - Currumbene Batemans lowland forest
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
  - Constructed (Biosis 2013)**
    - Planted
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.5: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

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Metres

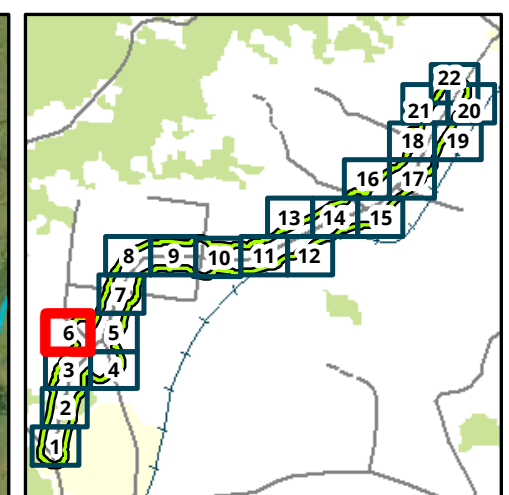
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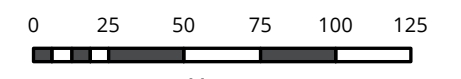
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Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Stag
- Derived vegetation (Biosis 2013)**
- Reedland
- Constructed (Biosis 2013)**
- Planted
- Native vegetation (SCIVI 2010)**
- Illawarra Gully Wet Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.6: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



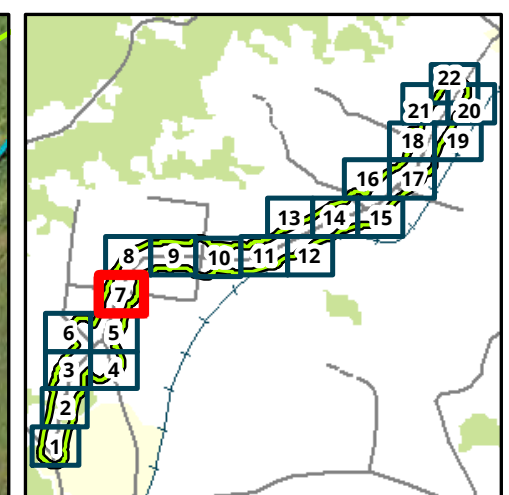
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Hollow bearing trees
- Native vegetation (Biosis 2013)**
- Currumbene Batemans lowland forest
- Derived vegetation (Biosis 2013)**
- Reedland
- Constructed (Biosis 2013)**
- Planted
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.7: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

0 25 50 75 100 125  
Metres

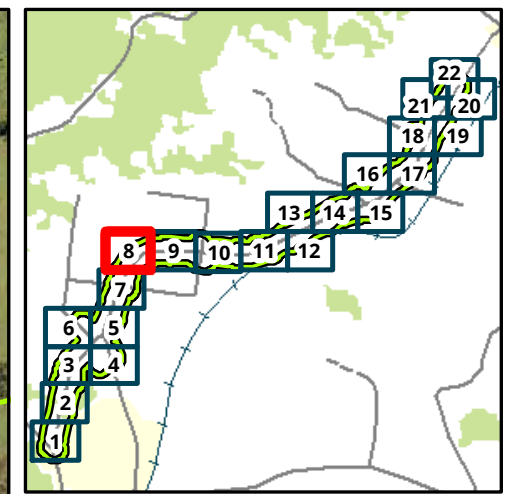
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

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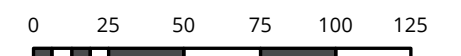
Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing trees
  - Constructed (Biosis 2013)**
  - Planted
  - Native vegetation (SCIVI 2010)**
  - Currumbene-Batemans Lowlands
  - Forest
  - Illawarra Gully Wet Forest
  - Warm Temperate Layered Forest
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.8: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



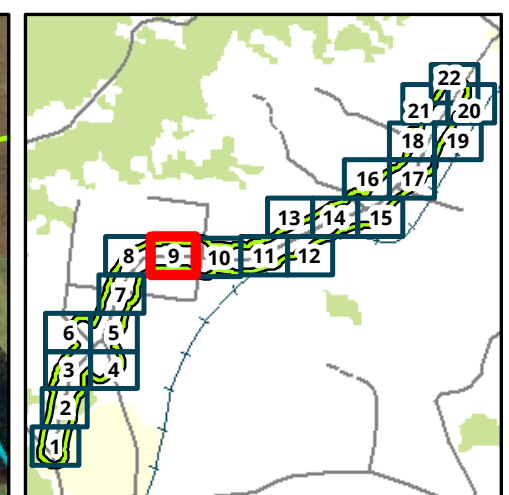
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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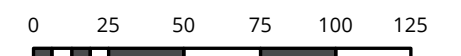
Matter: 15896  
 Date: 12 August 2013  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Stag
  - Native vegetation (Biosis 2013)**
    - Currambene Batemans lowland forest
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.9: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



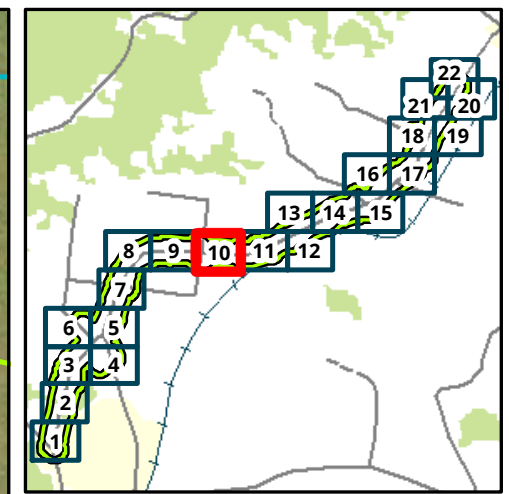
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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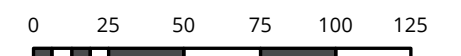
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Stag
- Native vegetation (Biosis 2013)**
- Currumbene Batemans lowland forest
- Derived vegetation (Biosis 2013)**
- Acacia scrub
- Constructed (Biosis 2013)**
- Planted
- Native vegetation (SCIVI 2010)**
- Currumbene-Batemans Lowlands
  - Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.10: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



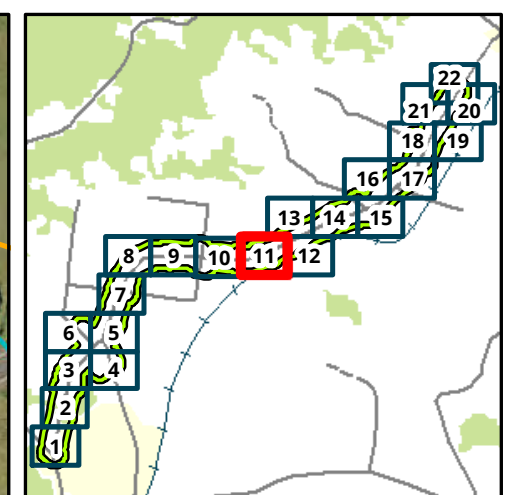
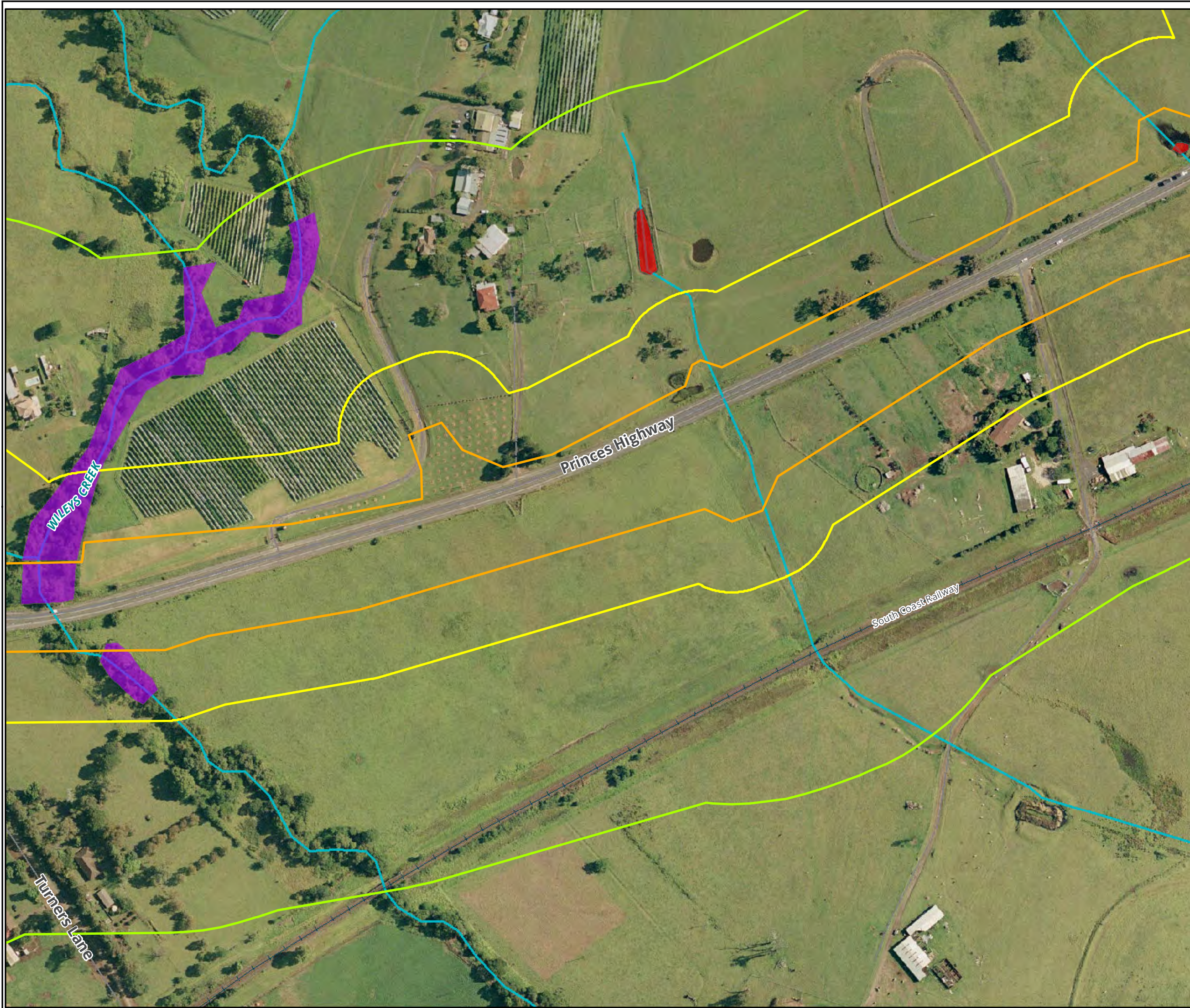
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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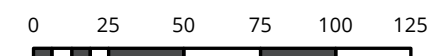
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location n:P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Native vegetation (Biosis 2013)**
    - Riverbank forest (River-flat eucalypt forest on coastal floodplains)
  - Derived vegetation (Biosis 2013)**
    - Reedland
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.11: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



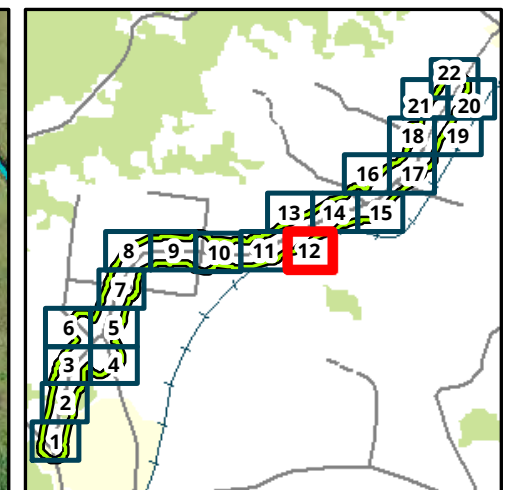
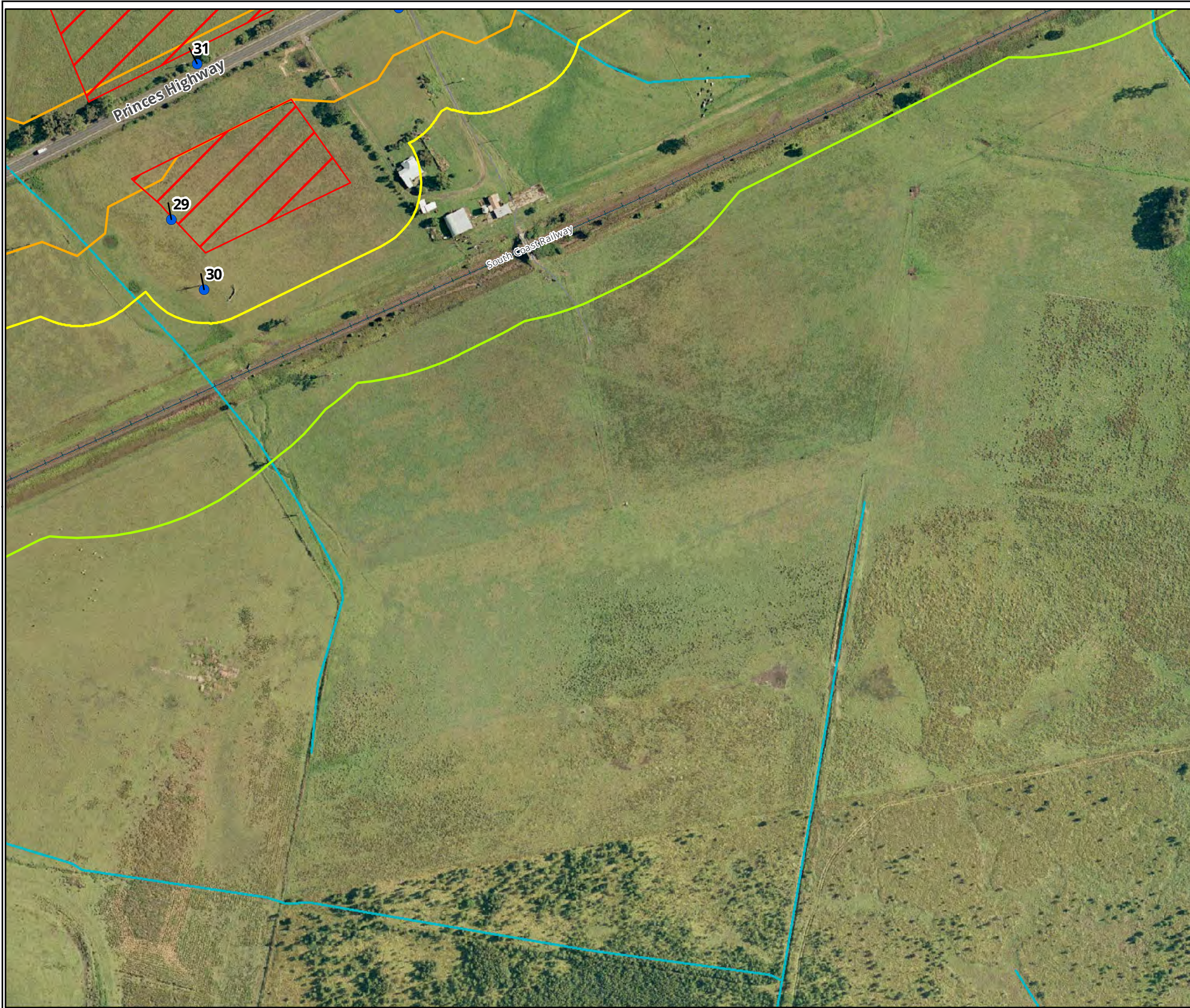
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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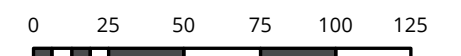
Matter: 15896  
 Date: 12 August 2013  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Stag
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.12: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



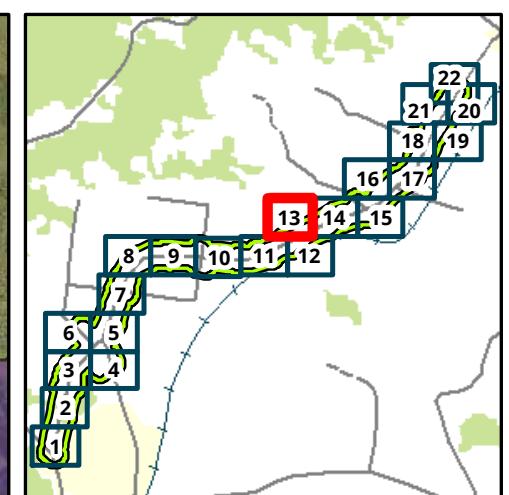
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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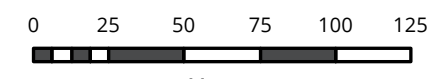
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Stag
  - Native vegetation (Biosis 2013)**
    - Illawarra gully wet forest
    - South Coast grassy woodland
    - (Illawarra lowlands grassy woodland)
  - Derived vegetation (Biosis 2013)**
    - Reedland
  - Native vegetation (SCIVI 2010)**
    - Currambene-Batemans Lowlands
    - Forest
    - Floodplain Swamp Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.13: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



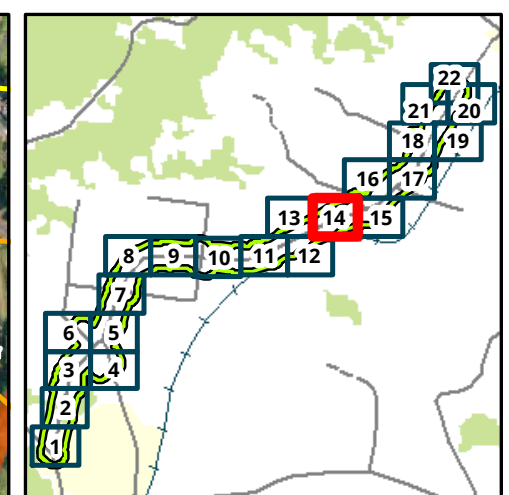
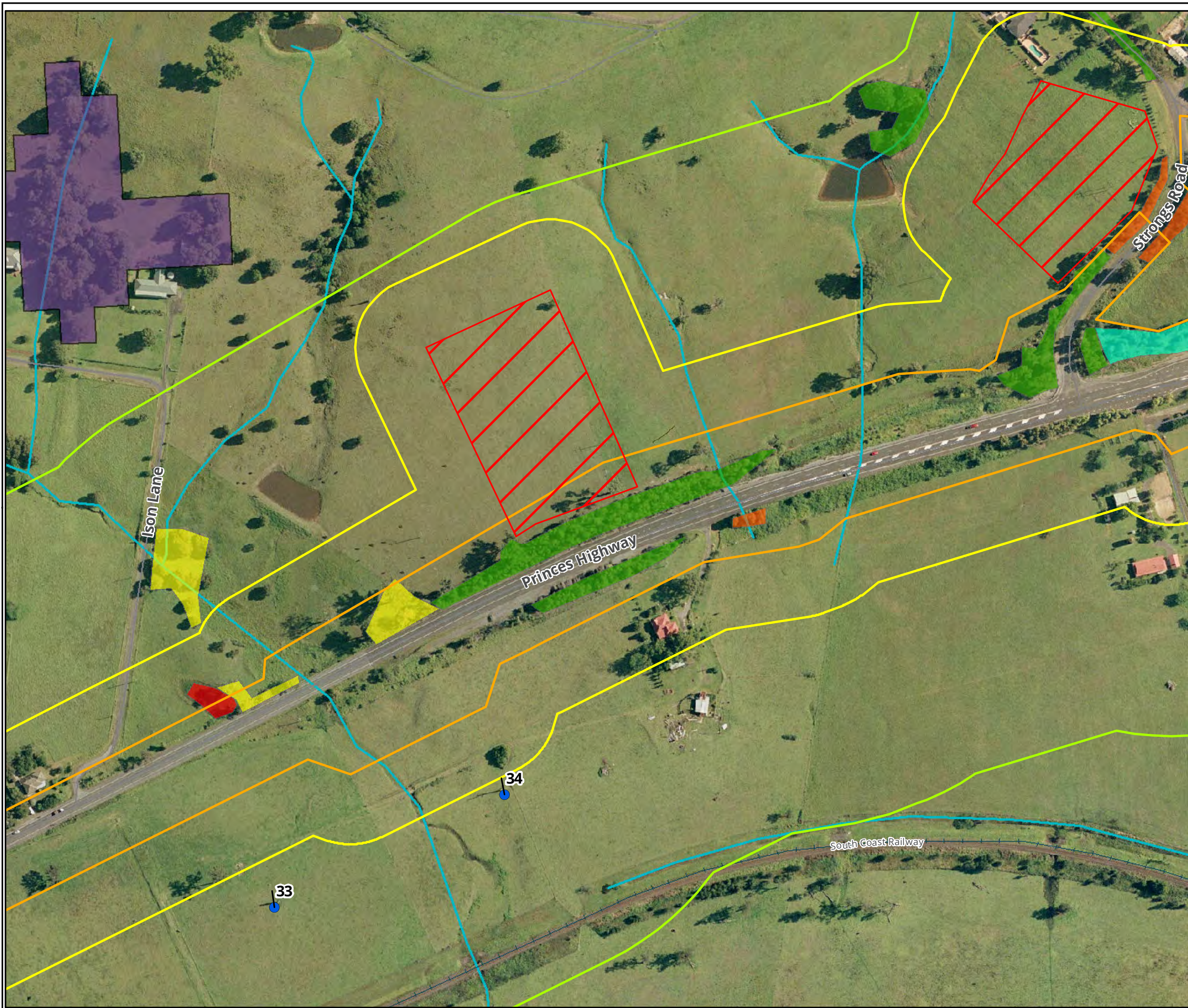
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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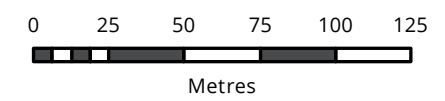
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Stag
  - Native vegetation (Biosis 2013)**
    - Illawarra gully wet forest
    - South Coast grassy woodland
    - (Illawarra lowlands grassy woodland)
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
    - Reedland
  - Constructed (Biosis 2013)**
    - Planted
  - Native vegetation (SCIVI 2010)**
    - Currambene-Batemans Lowlands
    - Forest
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.14: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



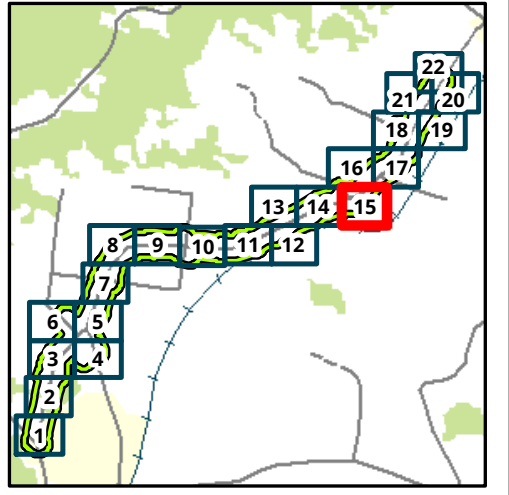
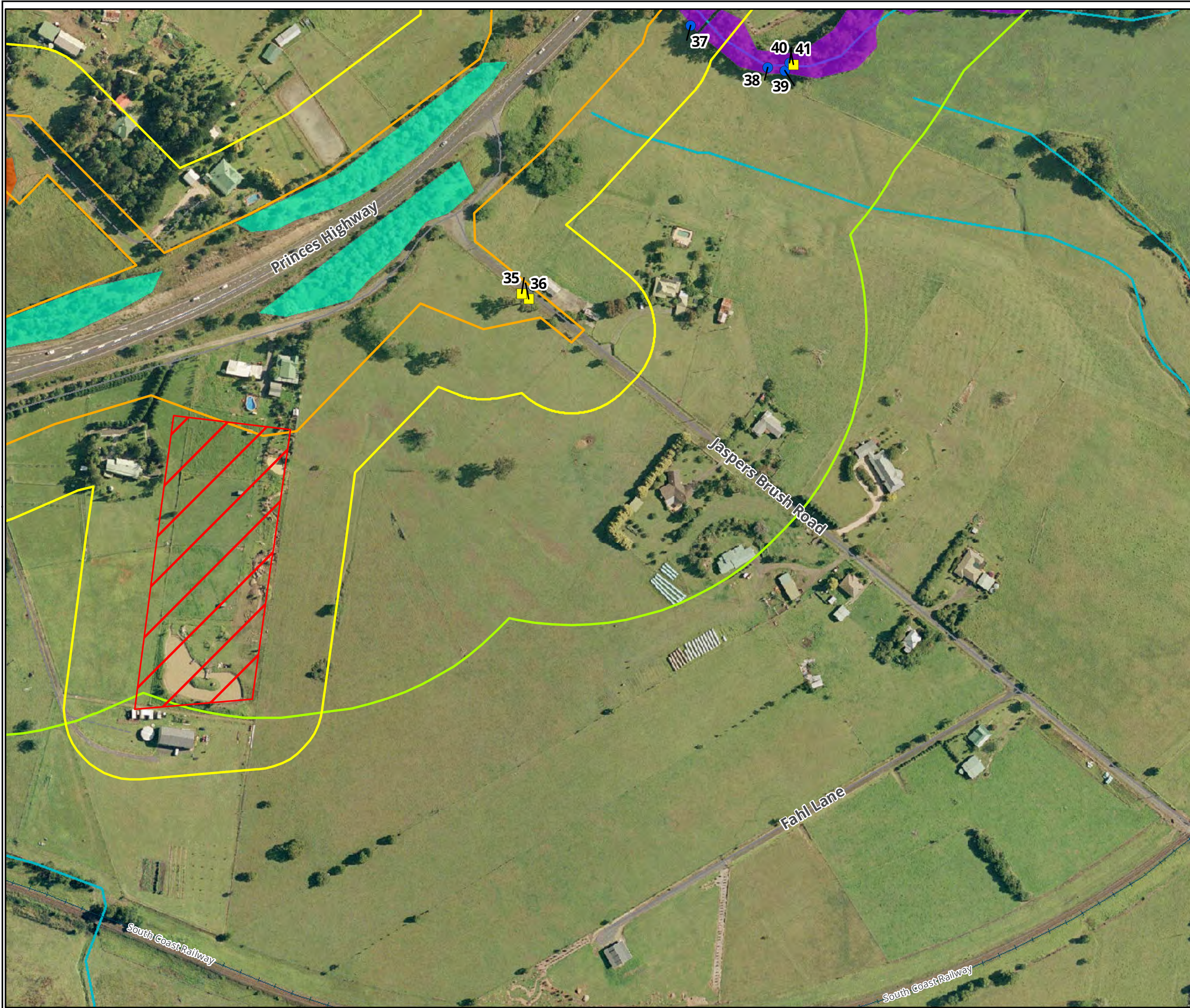
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



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Matter: 15896  
Date: 12 August 2013  
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Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Stag
- Native vegetation (Biosis 2013)**
- Riverbank forest (River-flat eucalypt forest on coastal floodplains)
- Derived vegetation (Biosis 2013)**
- Acacia scrub
- Constructed (Biosis 2013)**
- Planted
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

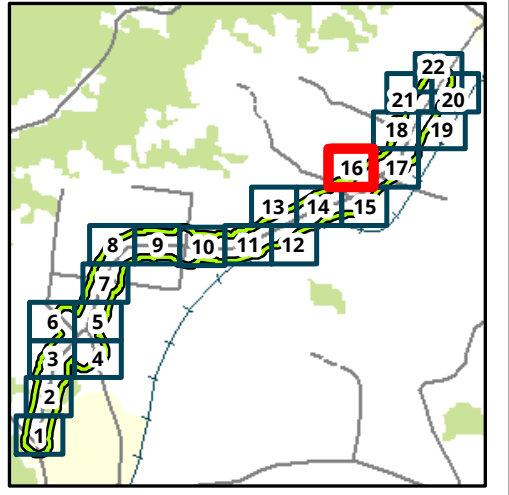
**Figure 3.15: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

0 25 50 75 100 125  
Metres  
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Stag
- Native vegetation (Biosis 2013)**
- Illawarra gully wet forest
  - Riverbank forest (River-flat eucalypt forest on coastal floodplains)
- Derived vegetation (Biosis 2013)**
- Reedland
- Constructed (Biosis 2013)**
- Planted
- Native vegetation (SCIVI 2010)**
- Currumbene-Batemans Lowlands Forest
  - Illawarra Gully Wet Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.16: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

0 25 50 75 100 125  
Metres

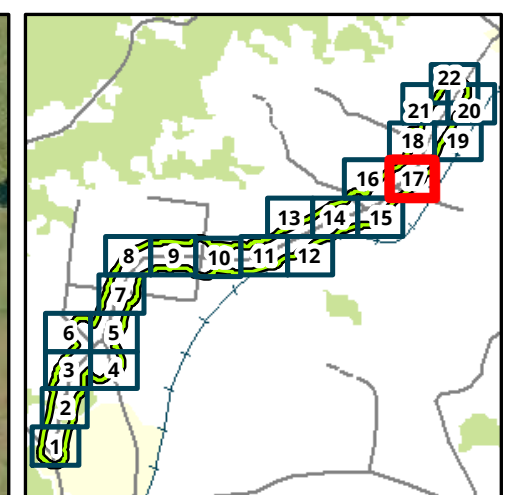
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

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Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Native vegetation (Biosis 2013)**
    - Riverbank forest (River-flat eucalypt forest on coastal floodplains)
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
  - Constructed (Biosis 2013)**
    - Planted
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.17: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**

0 25 50 75 100 125  
Metres

Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

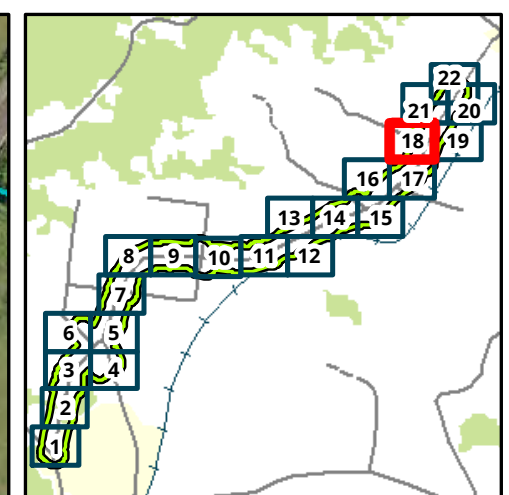
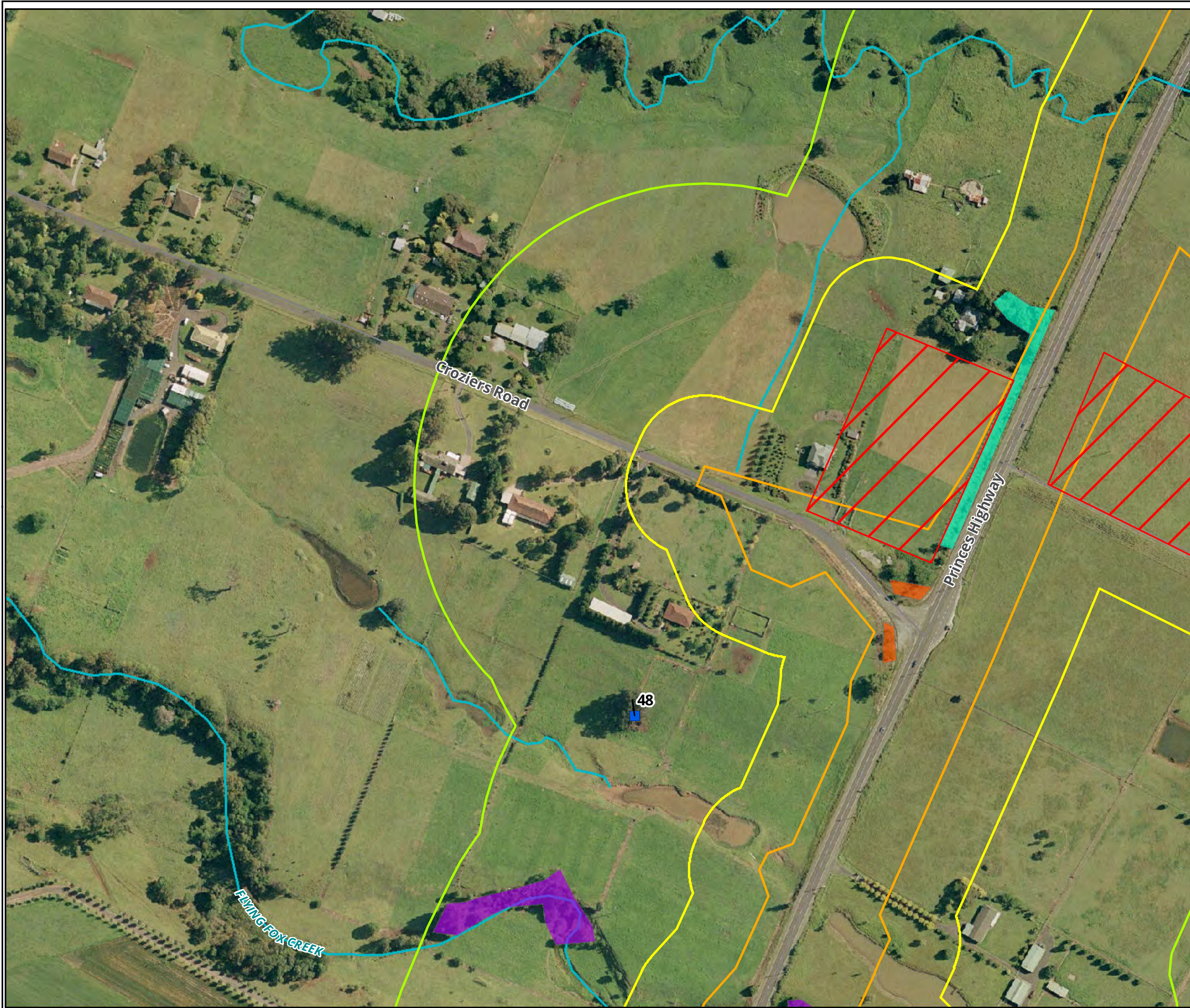


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Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813

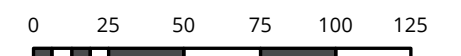
45 46 47





- Legend**
- Hollow bearing trees
  - Native vegetation (Biosis 2013)**
    - Riverbank forest (River-flat eucalypt forest on coastal floodplains)
  - Derived vegetation (Biosis 2013)**
    - Acacia scrub
  - Constructed (Biosis 2013)**
    - Planted
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.18: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



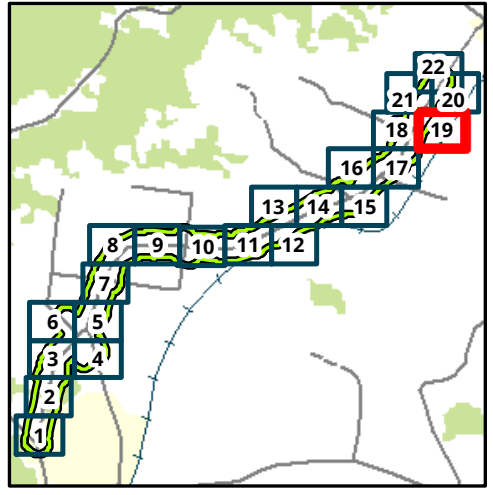
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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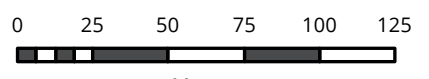
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Derived vegetation (Biosis 2013)**
    - Reedland
  - Habitat Feature**
    - Drainage line
  - Survey area**
    - Subject site (direct impacts)
    - Subject site (indirect impacts)
    - Study area (ancillary buffer)
    - Potential construction ancillary facilities

**Figure 3.19: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



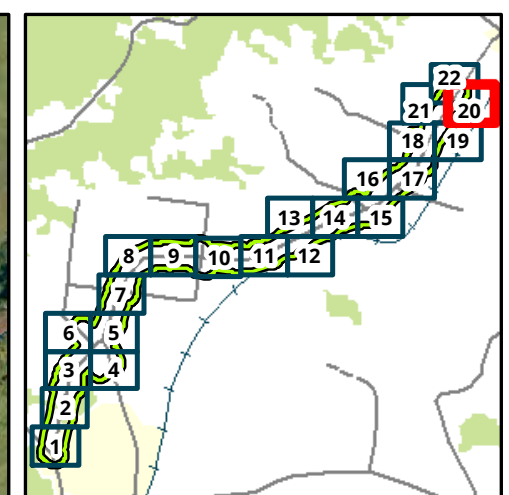
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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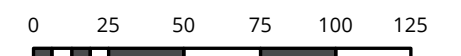
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Native vegetation (Biosis 2013)**
  - Illawarra gully wet forest
  - Derived vegetation (Biosis 2013)**
  - Acacia scrub
  - Native vegetation (SCIVI 2010)**
  - Currumbene-Batemans Lowlands Forest
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.20: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



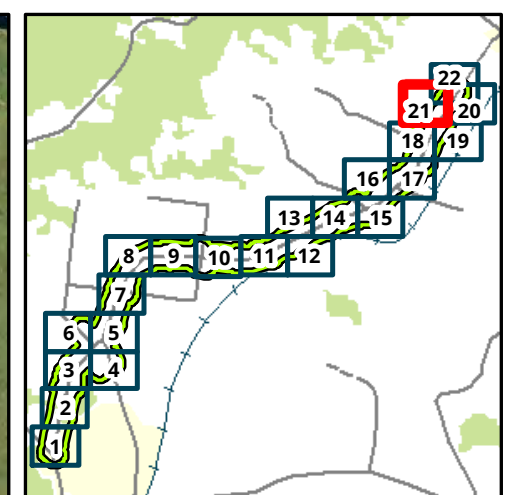
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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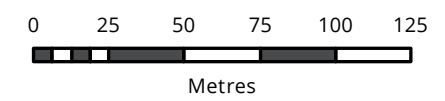
Matter: 15896  
 Date: 12 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Native vegetation (Biosis 2013)**
- Illawarra gully wet forest
- Derived vegetation (Biosis 2013)**
- Acacia scrub
  - Reedland
- Native vegetation (SCIVI 2010)**
- Coastal Warm Temperate Rainforest
  - Currambene-Batemans Lowlands
  - Forest
  - Illawarra Gully Wet Forest
- Habitat Feature**
- Drainage line
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.21: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



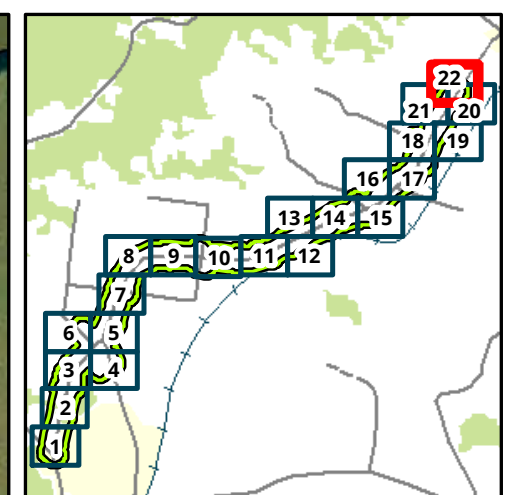
Scale: 1:2,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 56



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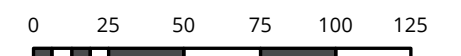
Matter: 15896  
Date: 12 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





- Legend**
- Hollow bearing tree
  - Native vegetation (Biosis 2013)**
  - Illawarra gully wet forest
  - Native vegetation (SCIVI 2010)**
  - Currumbene-Batemans Lowlands
  - Forest
  - Floodplain Swamp Forest
  - Habitat Feature**
  - Drainage line
  - Survey area**
  - Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 3.22: Vegetation mapping (SCIVI 2010; Biosis 2013) and fauna features (Biosis 2013)**



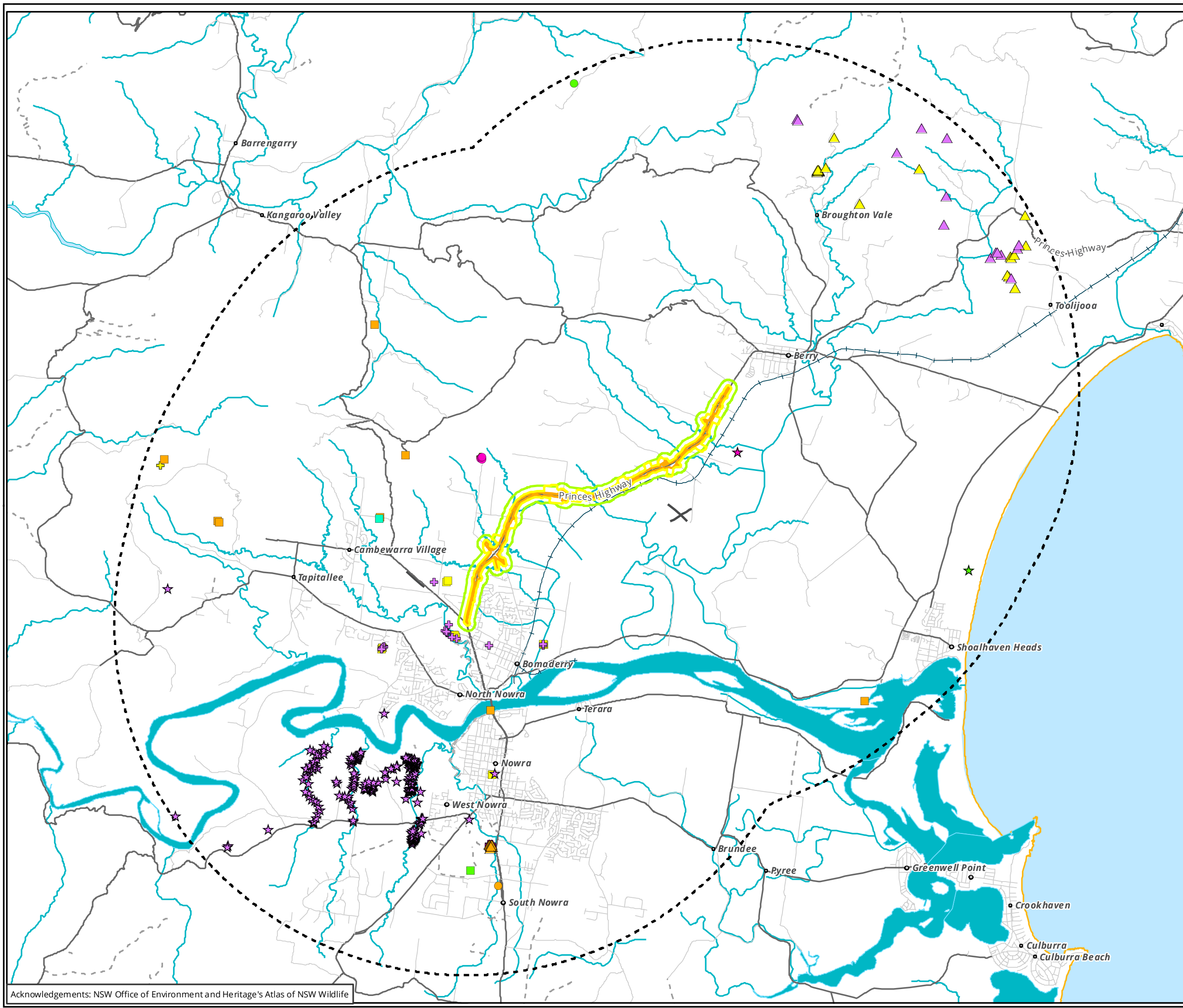
Scale: 1:2,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



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Matter: 15896  
 Date: 12 August 2013,  
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 Location: P:\15800s\15896\mapping\15896\_F3\_Vegetation\_20130813





**Legend**

**Threatened flora**

- Acacia pubescens
- Boronia deanei
- ★ Chamaesyce psammogeton
- ✚ Cryptostylis hunteriana
- ▲ Daphnandra johnsonii
- Eucalyptus langleyi
- Genoplesium baueri
- ★ Lastreopsis hispida
- ✚ Pterostylis gibbosa
- ▲ Pterostylis vernalis
- Solanum celatum
- Syzygium paniculatum
- ★ Triplarina nowraensis
- ✚ Zieria baeuerlenii
- ▲ Zieria granulata
- Zieria tuberculata

**Survey area**

- Subject site (direct impacts)
- Subject site (indirect impacts)
- Study area (ancillary buffer)
- 10km search area

**Figure 4: Threatened flora records (OEH 2013)**

0 1 2 3 4 5  
Kilometers

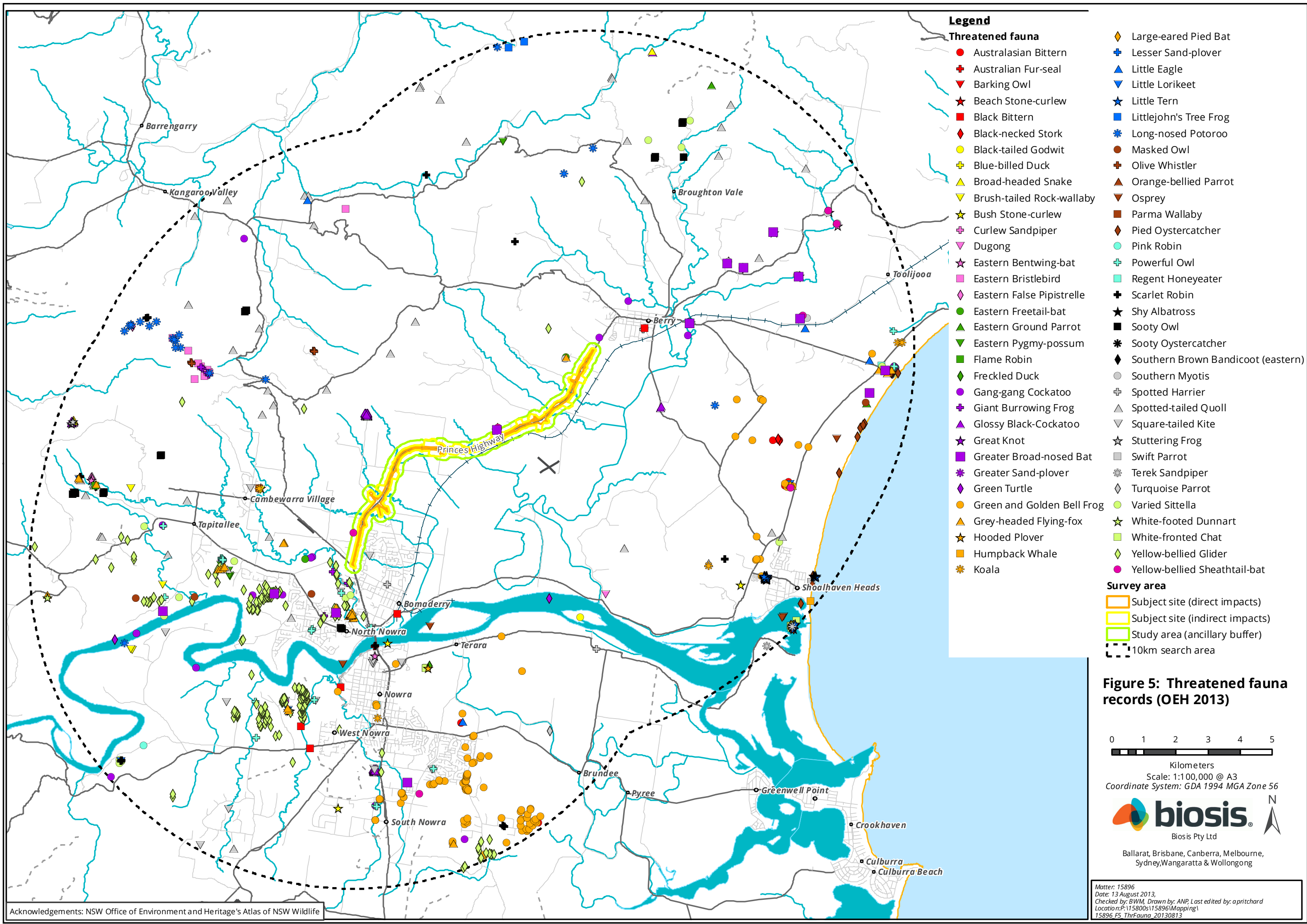
Scale: 1:1 00,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

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Sydney, Wangaratta & Wollongong

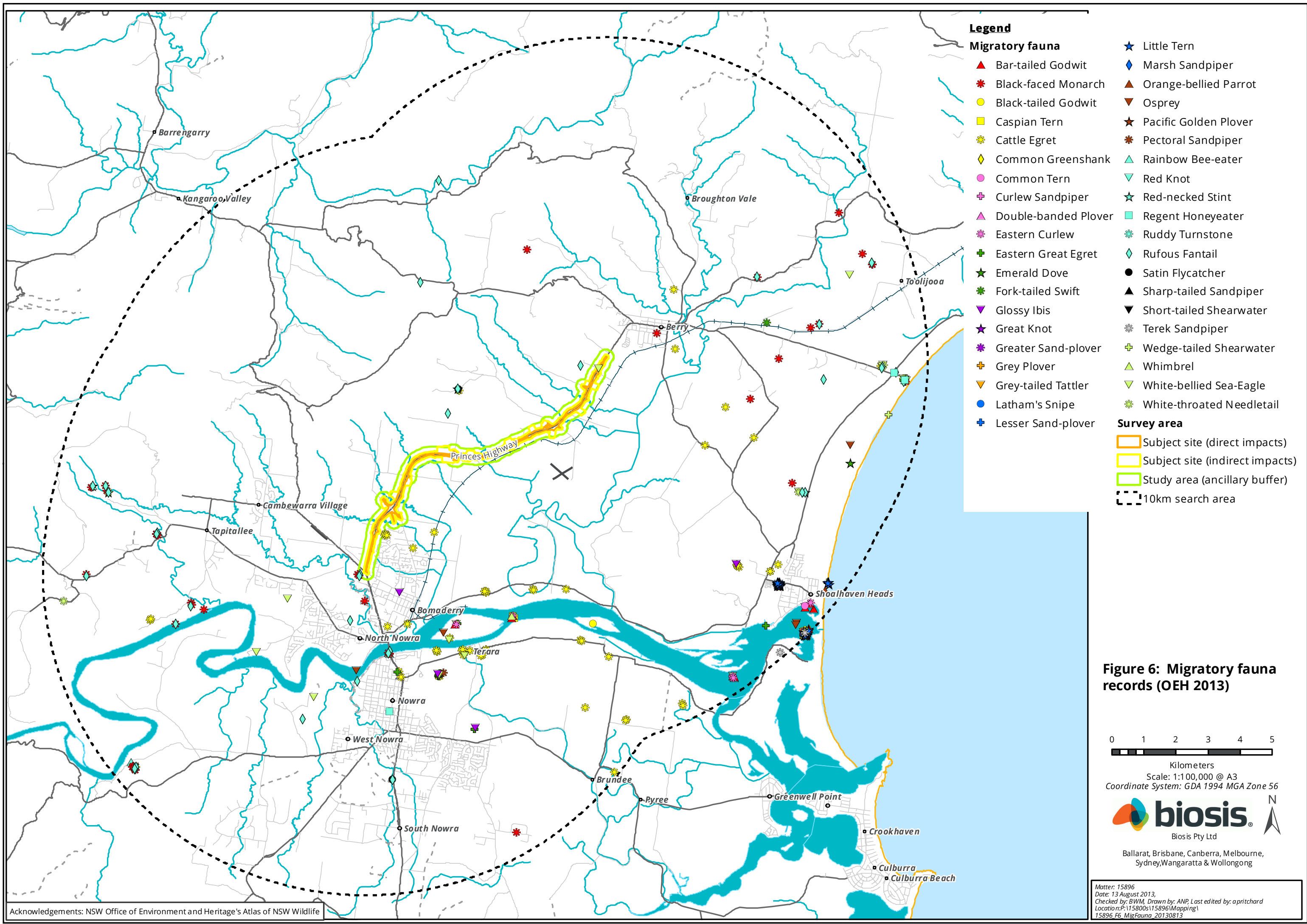
Matter: 15896  
Date: 13 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
Location: P:\15800s\15896\mapping\15896\_F4\_ThrFlora\_20130813

Acknowledgements: NSW Office of Environment and Heritage's Atlas of NSW Wildlife



Acknowledgements: NSW Office of Environment and Heritage's Atlas of NSW Wildlife





**Figure 6: Migratory fauna records (OEH 2013)**

0 1 2 3 4 5  
Kilometers

Scale: 1:1 00,000 @ A3  
Coordinate System: GDA 1994 MGA Zone 56

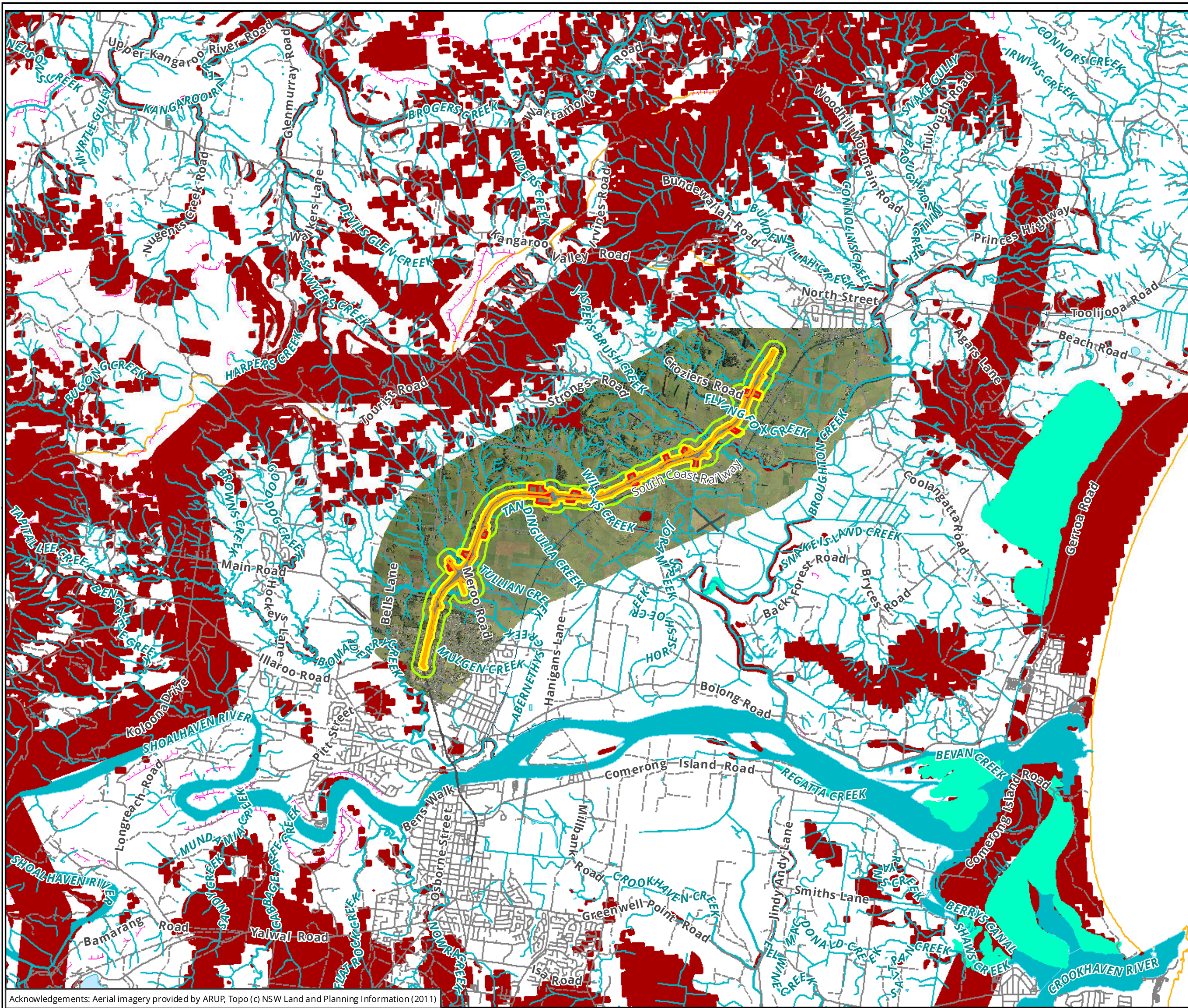


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Matter: 15896  
Date: 13 August 2013,  
Checked by: BWM, Drawn by: ANP, Last edited by: a pritchard  
Location: P:\15800s\15896\mapping\15896\_F6\_MigFauna\_20130813

Acknowledgements: NSW Office of Environment and Heritage's Atlas of NSW Wildlife





- Wildlife corridors SCRPC (DECCW)
- SEPP 14 wetlands SCRPC (DECCW)
- 
- 
- 
- Potential construction ancillary facilities

**Figure 7.1: Wildlife corridors and SEPP 14 wetlands - South Coast Regional Conservation Plan (SCRPC) (DECCW 2010)**

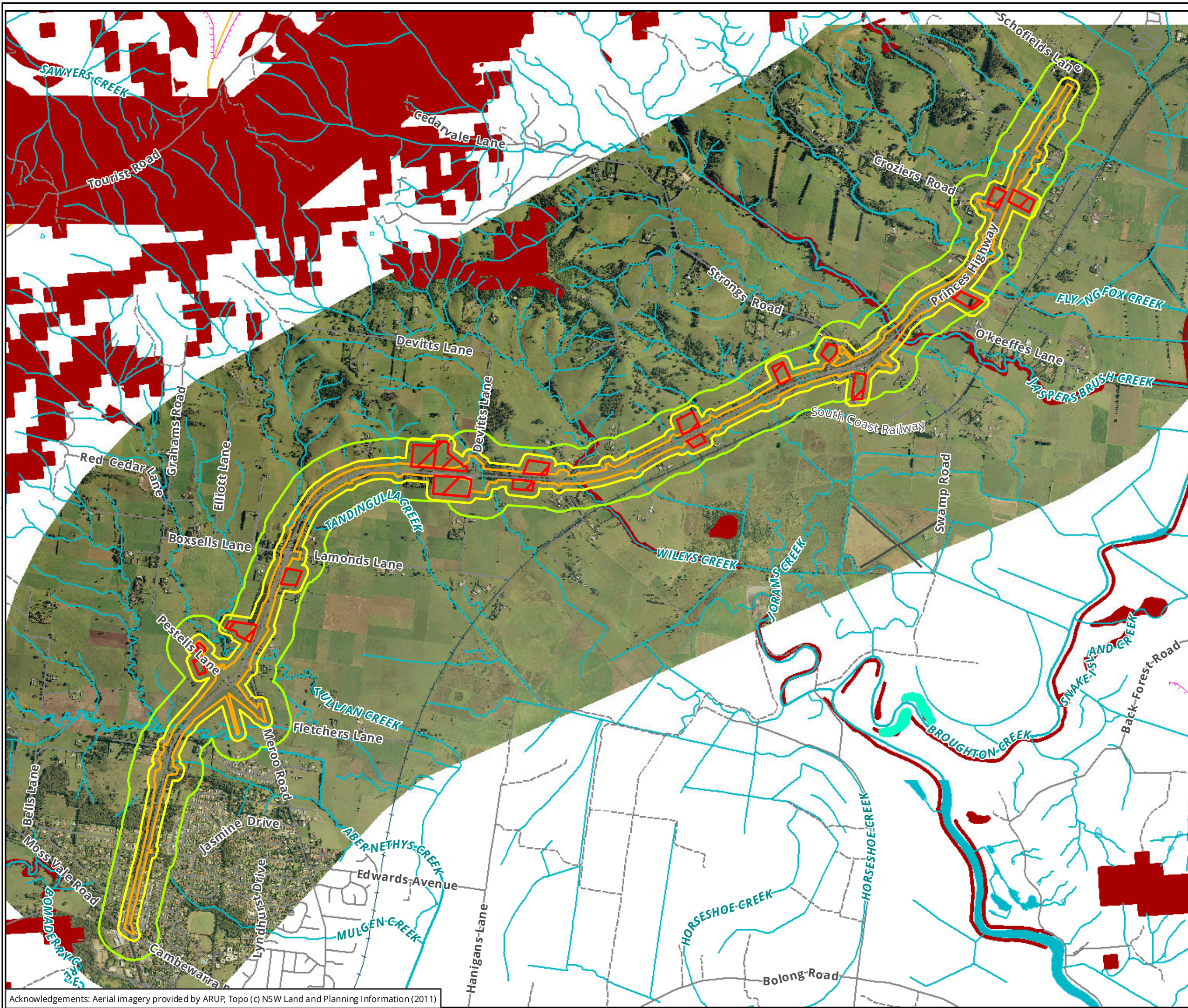
0 0.75 1.5 2.25 3 3.75  
 Kilometers  
 Scale: 1:75,000 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56

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Matter: 15896  
 Date: 28 August 2013,  
 Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
 Location: P:\15800s\15896\mapping\15896\_F7.1\_Corridors\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)





- Legend**
- Wildlife corridors SCRCP (DECCW 2010)
  - SEPP 14 wetlands SCRCP (DECCW 2010)
- Survey area**
- Subject site (direct impacts)
  - Subject site (indirect impacts)
  - Study area (ancillary buffer)
  - Potential construction ancillary facilities

**Figure 7.2: Wildlife corridors and SEPP 14 wetlands - South Coast Regional Conservation Plan (SCRCP) (DECCW 2010)**

0 280 560 840 1,120 1,400  
 Meters  
 Scale: 1:28,000 @ A3  
 Coordinate System: GDA 1994 MGA Zone 56



Matter: 15896  
 Date: 28 August 2013  
 Checked by: BWM, Drawn by: ANP, Last edited by: a.pritchard  
 Location: P:\15800s\15896\mapping\15896\_F7.2\_Corridors\_20130813

Acknowledgements: Aerial imagery provided by ARUP, Topo (c) NSW Land and Planning Information (2011)