# Waterfall Way Upgrade, Pacific Highway to Connells Creek

## PRELIMINARY ECOLOGICAL ASSESSMENT PART A – FLORA AND FAUNA INVESTIGATIONS

JUNE 2012

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# Roads and Maritime Services

# Waterfall Way Upgrade, Pacific Highway to Connells Creek

Preliminary Ecological Assessment Part A – Flora and Fauna Investigations
June 2012

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# Executive summary

GeoLINK has been engaged by the NSW Roads and Maritime Services (RMS) to prepare an ecological assessment in relation to the proposed upgrade to Waterfall Way between Raleigh Interchange at the Pacific Highway and Connells Creek for a length of approximately 3 km. This report forms 'Part A' of the ecological investigations and describes the biodiversity values of the study area. The second stage of the ecological assessment (Part B) would comprise an impact assessment, once the preferred Proposal option is identified.

A systematic flora and fauna desktop assessment and field survey was undertaken to update previous investigations and describe the biodiversity values of study area. The 78 ha study area was found to support six broad vegetation classes, comprising nine different vegetation types, including:

- Exotic species dominated open grassland (open grassland).
- Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest (moist sclerophyll forest).
- Blackbutt – Turpentine – Tallowwood open forest (moist sclerophyll forest).
- Blackbutt open forest (moist sclerophyll forest).
- Freshwater wetland (freshwater wetland).
- Broad-leaved Melaleuca / Swamp Mahogany swamp forest (swamp sclerophyll forest).
- Camphor Laurel forest (exotic species dominated forest).
- Radiata Pine forest (exotic species dominated forest).
- Mangrove forest (saline wetland).

Two *Threatened Species Conservation Act 1995* (TSC Act) listed endangered ecological communities (EECs) were recorded during the survey:

- *Swamp Sclerophyll Forest on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner Bioregions.* Covers approximately 3.31 ha of the study area.
- *Freshwater Wetlands on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner Bioregions.* Covers approximately 1.23 ha of the study area.

The mangroves within the Mangrove forest are protected under the *Fisheries Management Act 1994* (FM Act).

Rough-shelled Bush Nut (*Macadamia tetraphylla*) was the only threatened flora species recorded during the survey, which comprised ornamental plantings near a driveway entrance opposite Shortcut Road. The study area was considered to provide potential habitat for six other threatened flora species. One Rare or Threatened Australian Plant (RoTAP) listed species was recorded: Nambucca Ironbark (*Eucalyptus ancophila*), primarily within the Tallowwood – Narrow-leaved White Mahogany – Turpentine forest.

Six threatened fauna species have been recorded within the study area: Black-necked Stork, Koala (identified via scats below two trees), Grey-headed Flying-fox, Little Bentwing Bat, Eastern Bentwing Bat and Large-footed Myotis. The study area was considered to provide potential habitat for a further 25 threatened fauna species, which have been recorded locally. Four *Environment Protection and Biodiversity Conservation Act* (EPBC Act) listed migratory species were recorded within the study area, while an additional nine species were considered potential occurrences.

Overall the study area comprised of a rural / rural-residential landscape on the southern edge of

the Bellinger River floodplain. It supports a mosaic of forest and wetland habitat amongst the cleared/development land. While the entire study area shows signs of historic disturbances, it still retains known and potential habitat values for a range of threatened species and communities.

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# Glossary

| Acronyms | |
|---|---|
| BSC | Bellingen Shire Council |
| DoP | Department of Planning (NSW) |
| DPI | Department of Primary Industries (NSW) |
| EP&A Act | *Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process. |
| ESD | Ecologically sustainable development. Development which uses, conserves and enhances the resources of the community so that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased. |
| FM Act | *Fisheries Management Act 1994* (NSW) |
| ISEPP | State Environmental Planning Policy (Infrastructure) 2007 |
| LGA | Local Government Area |
| MNES | Matters of National environmental significance |
| NW Act | *Noxious Weeds Act 1993* (NSW) |
| NPW Act | *National Parks and Wildlife Act 1974* (NSW) |
| NRCMA | Northern Rivers Catchment Management Authority |
| OEH | Office of Environment and Heritage (NSW) |
| RoTAP | Rare or Threatened Australian Plants |
| RMS | Roads and Maritime Service (NSW) |
| SEPP | State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act. |
| SIS | Species Impact Statement |
| TSC Act | *Threatened Species Conservation Act 1995* (NSW) |

| Glossary of Terms | |
|---|---|
| Aquatic | Of or pertaining to the water as distinct from the land. |
| Biodiversity | First coined in 1988 as a contraction of biological diversity; diversity traditionally referring to species richness and species abundance. Biodiversity has been defined subsequently as encompassing biological variety at genetic, species and ecosystem scales (DASETT 1992). The maintenance of biodiversity, at all levels, is acknowledged internationally as a high conservation priority, and is protected by the International Convention on Biological Diversity 1992. |
| Conservation | The management of natural resources in a way that will benefit both present and future generations. |
| Ecologically Sustainable Development (ESD) | Using, conserving and enhancing the Community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future can be increased. Incorporates four key principles:<br>• the precautionary principle;<br>• inter-generational equity;<br>• conservation of biological diversity and ecological integrity; and<br>• improved valuation and pricing of environmental resources. |
| Endangered species | Those plant and animal species listed under Part 1 of Schedule 1 of the NSW *Threatened Species Conservation Act 1995* or listed as endangered under Subdivision A of Division 1 of Part 13 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. |
| Environment | The physical, biological, cultural, economic and social characteristics of an area, region or site. |
| Environmental assessment | For development that constitutes a Major Project under the State Environmental Planning Policy – Major Project, prepared pursuant to the *Environmental Planning and Assessment Act 1979*. |
| Fauna | Animals. |
| Flora | Plants. |
| Locality | Environment within 10 km of the site. |
| Precautionary principle | (*NSW Protection of the Environment Administration Act 1991* s6(2)):<br>*"if there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation".*<br>(i.e.: where adequate surveys have not been conducted within the study area due to limitations, the precautionary principle should always be adopted. This involves assuming that threatened biodiversity which are likely to occur in the study area (based on the presence of suitable habitat and recent records) inhabit the whole of the study area. |
| Risk | Likelihood of a specific undesirable event occurring within a specified period or in specified circumstances. Listed as a frequency or probability. |
| Study Area | The site and surrounding 100 m of land. This is the main area potentially affected by the Proposal. |
| Terrestrial | Of or pertaining to the land as distinct from the water. |

| Glossary of Terms | |
|---|---|
| The site | Area potentially directly affected by the Proposal. Incorporates both upgrade route options. |
| Threatened Species | Animals or plants listed as endangered or vulnerable under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. |
| Vulnerable species | Those plant and animal species listed under Part 1 of Schedule 2 of the NSW *Threatened Species Conservation Act 1995* or listed as vulnerable under Subdivision A of Division 1 of Part 13 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. |
| Weed | Naturalised, non-indigenous plant species which may be noxious weeds (or agriculture), environmental weeds or any other generally undesirable introduced species. |

# 1 Introduction

## 1.1 Introduction

GeoLINK has been engaged by the NSW Roads and Maritime Services (RMS) to prepare an ecological assessment in relation to the proposed Waterfall Way (Main Road 76) upgrade (the Proposal). The Proposal is to upgrade Waterfall Way between Raleigh Interchange at the Pacific Highway and Connells Creek for a length of approximately 3 km. The ecological assessment comprises of two parts:

- Part A – Flora and Fauna Investigations (this report) which describes the biodiversity values of the study area. It encompasses the Proposal route options ('the site') and surrounding land within 100 m (collectively termed the 'study area').
- Part B – Flora and Fauna Impact Assessment, which describes the predicted impacts of the Proposal once the preferred route option is identified.

The study area covers approximately 78 ha and is shown in **Illustrations 1.1** and **1.2**.

## 1.2 Legislative Requirements

**Table 1.1** lists the relevant legislation and associated provisions related with this ecological assessment.

Table 1.1 Relevant Legislation

| Legislation | Section(s) | Comment |
|---|---|---|
| National Parks and Wildlife Act 1974 (NSW) | Sections 118D(2)(b)(ii) | It is an offence to cause damage to habitat of threatened species, endangered populations or endangered ecological communities (EECs) unless it was essential for the carrying out of an activity in accordance with an approval of a determining authority within the meaning of Part 3A, 4 or 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) if the determining authority has complied with that Part.<br><br>Part B of this ecological assessment includes the required Part 5A Assessments. |
| Threatened Species Conservation Act 1995 (NSW) | Schedules 1, 1A, 2 and 3 | All actions must be assessed under the *Threatened Species Conservation Act 1995* (TSC Act) to determine if they are likely to result in harming or picking of a threatened species, population or ecological community, or in damage to their habitat. Where there is considered to be a likelihood of a significant impact on threatened species then a species impact statement must be prepared.<br><br>This ecological assessment (Parts A and B) assesses the impacts of the Proposal on listed threatened species, populations and ecological communities (Schedule 1, 1A and 2), and whether the Proposal constitutes any listed Key Threatening Processes (KTPs - Schedule 3). |

| Legislation | Section(s) | Comment |
|---|---|---|
| Fisheries Management Act 1994 (NSW) | Sections 198-202 | Consultation is required with the Minister for Department of Primary Industries (DPI) for dredge and reclamation works on land that is periodically inundated by water. |
| | Sections 219-220 | Consultation is required when barriers to the movement of fish including water course crossings are to be constructed or modified. |
| | Sections 204-205 | A person must not harm protected marine vegetation, except under the authority of a permit issued by the Minister under this Part.<br><br>Should the Mangroves along Connells Creek require harm (including trimming), a 'Permit to Harm' would need to be obtained from DPI. |
| | Schedules 4, 4A, 5 and 6 | All actions must be assessed under the *Fisheries Management Act 1994* (FM Act) to determine if they are likely to result in harming of a threatened species, population or ecological community, or their habitat. Where there is considered to be a likelihood of a significant impact on threatened species then a species impact statement must be prepared.<br><br>This ecological assessment (Parts A and B) assesses the impacts of the Proposal on listed threatened species, populations and ecological communities (Schedule 4, 4A and 5), and whether the Proposal constitutes any listed KTPs (Schedule 6). |
| Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) | | Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Matters of National Environmental Significance are required to be considered to assist in determining whether the Proposal should be referred to the Australian Government Department of Sustainability, Environment, Water, Population and Communities (SEWPAC). |
| Noxious Weeds Act 1993 (NSW) | | In NSW the administration of noxious weed control is the responsibility of the Minister of DPI under the *Noxious Weeds Act 1993*. The Act is implemented and enforced by the Local Control Authority for the area, usually local government or NSW Agencies. The RMS is therefore required to control noxious weeds on land under their control. |
| NSW State Environmental Planning Policy No. 14 – Coastal Wetlands | | The aim of this policy is to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of the State. |
| NSW State Environmental Planning Policy No. 26 – Littoral Rainforests | | The aim of this Policy is to provide a mechanism for the consideration of applications for development that is likely to damage or destroy littoral rainforest areas with a view to the preservation of those areas in their natural state. |

| Legislation | Section(s) | Comment |
|---|---|---|
| NSW State Environmental Planning Policy 44 – Koala Habitat Protection | | This policy aims to encourage the conservation and management of natural vegetation areas that provide habitat for Koalas, to ensure permanent free-living populations would be maintained over their present range. Clause 6 of SEPP 44 states that the SEPP applies only to land '*in relation to which a development application has been made*'. Clause 94 of *State Environmental Planning Policy (Infrastructure)* (ISEPP) precludes the Proposal from requiring consent therefore Part 2 of SEPP 44 does not apply to the Proposal. It is RMS policy, however, to consider environmental issues relating to their works to the fullest extent possible, including impacts on Koalas. |

## 1.3 Scope of the Report

The aim of the ecological assessment is to document the ecological values of the study area and assess the likely impacts of the Proposal in relation to the relevant legislation. The primary objectives are to:

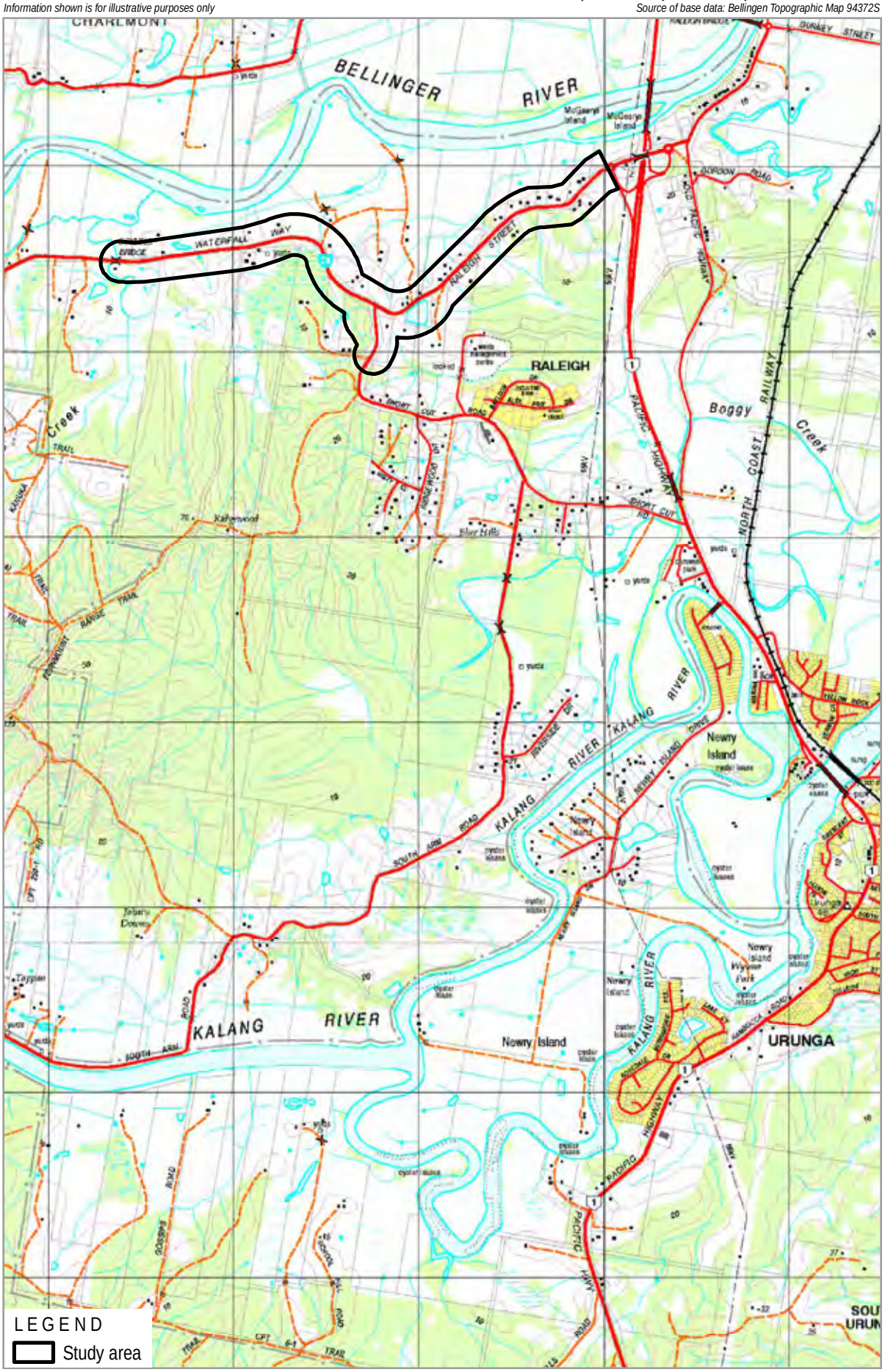
- Detail the existing biodiversity values of the study area through background research and terrestrial field surveys, in relation of the above legislation (Part A).
- Outline the likely ecological impacts of the Proposal on the biodiversity values of the study area and address any relevant legislative assessment requirements (Part B).
- Identify safeguards that may be implemented to avoid or minimise potential adverse ecological impacts (Part B).

The findings of the assessment would be considered when assessing:

- Principles of Ecologically Sustainable Development (ESD) and during decision making when identifying RMS's preferred Proposal option.
- The significance of any impact on threatened species as defined by the TSC Act and/or FM Act, in section 5A of the EP&A Act and therefore the requirement for a Species Impact Statement.
- Whether the Proposal is likely to have a significant impact on the environment and therefore the necessity for approval to be sought under Part 3A of the EP&A Act.
- The potential for the Proposal to significantly impact a matter of national environmental significance or Commonwealth land and the need to make a referral to the Australian Government SEWPAC for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

*Information shown is for illustrative purposes only*

*Drawn by: DSA Checked by: RE Reviewed by: VJS Date: Novemeber 2011*
*Source of base data: Bellingen Topographic Map 9437 2S*

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# Site Locality

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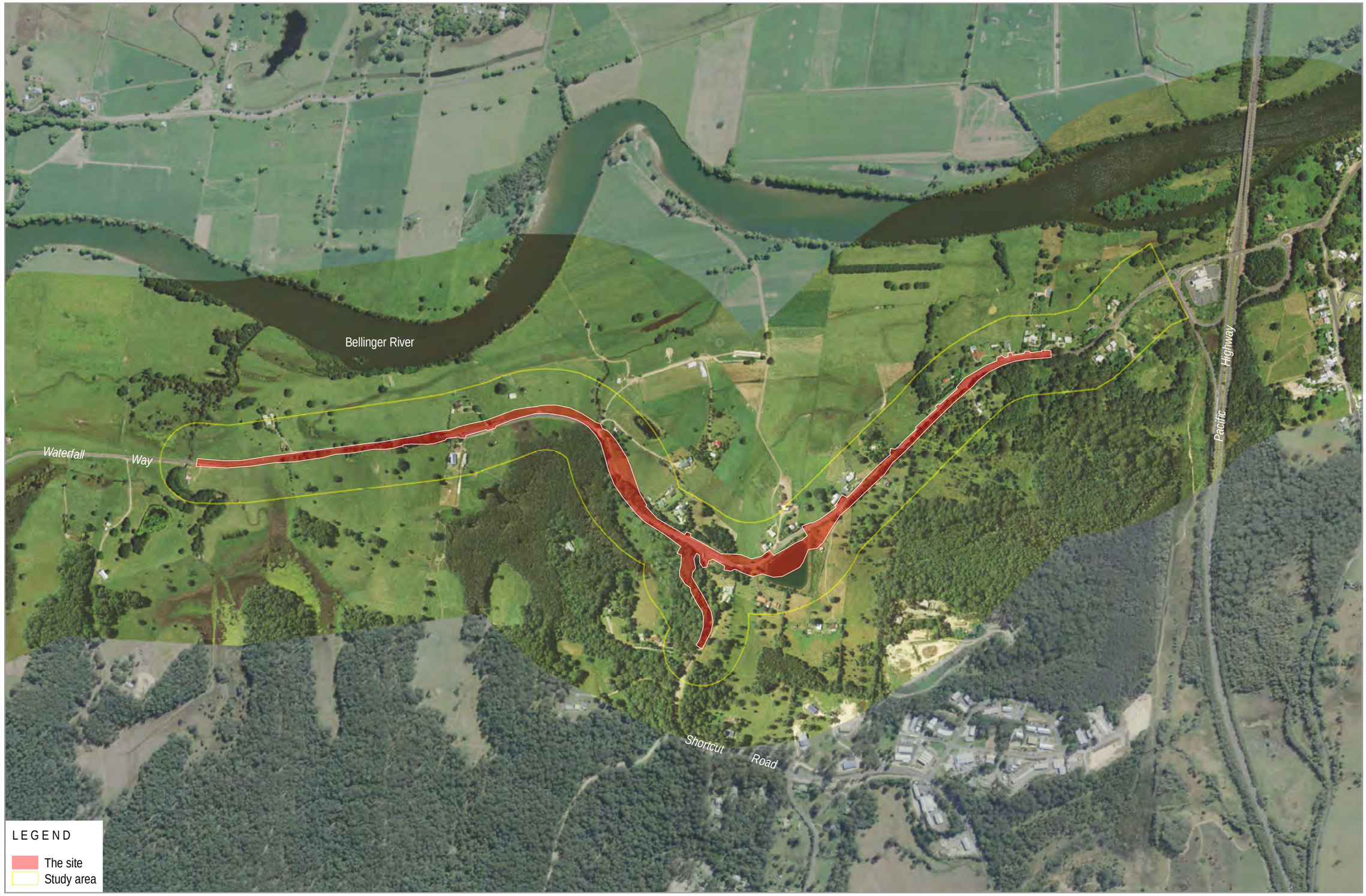
Waterfall Way Upgrade, Pacific Highway to Connells Creek
Ecological Assessment Part A - Flora and Fauna Investigations
1782794

Illustration 1.1

*Information shown is for illustrative purposes only*

*Drawn by: DSA Checked by: RE Reviewed by: VJS Date: November 2011*
*Source of base data: Roads and Maritime Services*

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Aerial Photo

Illustration 1.2

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Waterfall Way Upgrade, Pacific Highway to Connells Creek
Ecological Assessment Part A - Flora and Fauna Investigations
1782795

# 2 Method

## 2.1 Overview

The methodology for this flora and fauna survey and assessment has been formulated based on a review of the OEH *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft, November 2004* (Department of Environment and Conservation 2004) and SEWPAC Survey Guidelines (SEWPAC website: www.environment.gov.au accessed 20/05/2011). The methodology broadly is as follows:

- Undertake a literature review.
- Undertake flora and fauna field surveys.
- Assess the habitat value for listed threatened flora and fauna species, populations and communities.
- Assess the ecological impacts of the Proposal (Part B).
- Outline safeguards to be implemented to reduce potential impacts (Part B).

## 2.2 Literature Review

A desktop review was undertaken to identify existing known ecological values of the study area. This included:

- Database searches for records of EPBC Act listed threatened species, communities or species habitat likely to occur within a 10 km radius (i.e. ~375 $km^2$) around the site using the SEWPAC Protected Matters Online Search Tool (SEWPAC 2011) on the 7/05/2012.
- Database searches of the OEH BioNet for threatened flora and fauna species, and endangered populations recorded within a 20 km x 23 km (460 $km^2$) area surrounding the site on the 8/05/2012.
- Review of OEH Key Habitat and Corridors mapping.
- Search of the OEH's Critical Habitat register.
- Review of DPI Key Fisheries Habitat Mapping (www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/332919/Bellingen.pdf) and Records Viewer (http://www.dpi.nsw.gov.au/fisheries/species-protection/records/viewer) for the Bellingen Local Government Area (LGA) on the 8/05/2012.
- Review of the Department of Planning (DoP) SEPP 14 – Coastal Wetland mapping.
- Review of the DoP SEPP 26 – Littoral Rainforest mapping.
- Review of previous environmental assessments undertaken within the study area:
    - Environmental Resources Management (ERM 2003) *Proposed MR76 Waterfall Way Upgrade.*
    - Marine Pollution Research (MPR 2003) *Proposed Road Realignment Waterfall Way at Cameron's Corner: Aquatic Ecological Survey.*
    - EcoLogical (2009) *Review of Environmental Factors for Waterfall Way Realignment: Cameron's Corner.*
    - GeoLINK (2011) *Preliminary Environmental Investigation: Waterfall Way Upgrade Raleigh Interchange to Connells Creek.*

## 2.3 Field Surveys

Flora and fauna field surveys were undertaken on the following dates:

- 5-6 July 2011: Flora and opportunistic diurnal fauna survey (winter survey).
- 28 August 2011: Frog survey targeting Wallum Froglet (*Crinia tinnula*) (winter survey).
- 7-12 November 2011: Nocturnal and diurnal fauna, and flora surveys (late spring survey).

Flora and opportunistic fauna surveying covered the entire study area, while targeted fauna surveys primarily focused on the site (i.e. Proposal options footprint).

Specific weather conditions during the survey are described in Appendix A. In general the weather for the survey dates was:

- 5-6 July 2011: Fine and mild to warm.
- 28 August 2011: Wet and mild, with isolated showers and periods of moderate rainfall occurring in the week prior to the survey.
- 7-12 November 2011: Hot and humid conditions with variable cloud cover.

## 2.4 Flora Surveys

Flora surveys were conducted in order to provide a list of plant species present in the study area; identify vegetation communities; and determine the occurrence / likelihood of occurrence for threatened flora species. A total survey effort of 30 person hours was dedicated to flora surveys. The identification of flora species was recorded in the field and those that required further clarification were collected and keyed-out using relevant literature.

### 2.4.1 Quadrat Surveys

Thirteen 20 x 20 m quadrats were undertaken across the study area covering each of the identified vegetation classes, as follows:

- Five quadrats in the moist sclerophyll forest.
- Two quadrats in the swamp sclerophyll forest.
- Two quadrats in the freshwater wetland.
- Two quadrats in the open grassland.
- Two quadrats in the exotic species dominated forest.

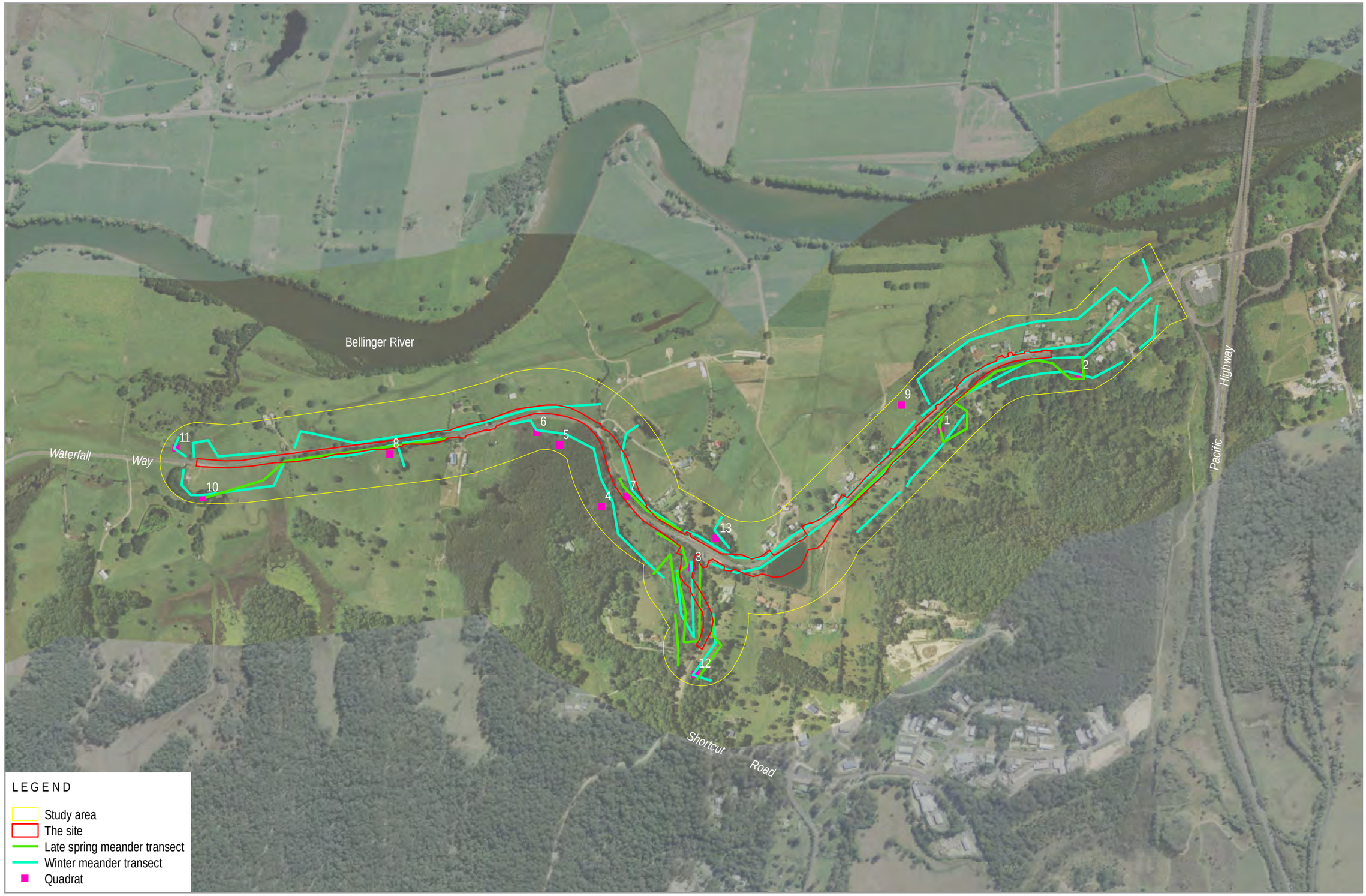
Every plant species detected within each quadrat was recorded (excluding ornamental plants) as well as floristic composition and cover. The survey incorporated targeted searches for threatened plant species known or likely to occur from the background research. The locations of the quadrats are shown in Illustration 2.1.

### 2.4.2 Meander Surveys

The 'meander' survey method was undertaken to record general flora species and also target potential threatened species. The floristic composition and structure of vegetation communities was also recorded. The winter (July) survey covered the entire study area, while the late spring (November) survey targeted the Proposal options footprint. The location of the flora meander surveys are shown in Illustration 2.1.

*Information shown is for illustrative purposes only*

*Drawn by: DSA Checked by: RE Reviewed by: VJS Date: November 2011*
*Source of base data: Roads and Maritime Services*

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# Flora Survey

Illustration 2.1

## 2.5 Fauna Surveys

### 2.5.1 General Fauna Surveys

The methodology for the fauna survey was based on a review of the relevant OEH and SEWPAC survey guidelines, giving due consideration to the habitats within the site, previous survey sampling undertaken (ERM 2003, EcoLogical 2009, GeoLINK 2011) and results of relevant database searches (refer to **Section 3.1**). General fauna surveying included opportunistic recordings of fauna encountered. This included noting the location and species of any fauna encountered during general field work (i.e. not specific targeted surveys). In general, the following fauna survey methodology follows guidelines set out in DEC (2004) and Murray *et. al,* (2002).

Following an initial habitat assessment, target species were determined and surveys were undertaken for those species that were identified as having potential habitat within the site.

### 2.5.2 Amphibian Survey

The Green and Golden Bell Frog (*Litoria aurea*), Green-thighed Frog (*Litoria brevipalmata*) and Wallum Froglet (*Crinia tinnula*) were the threatened amphibian species targeted during the survey. These species were surveyed via diurnal and nocturnal survey methods detailed below. It is acknowledged that the survey effort adopted was below the DEC (2004) guidelines recommendations for the target species (e.g. the Green-thighed Frog was unlikely to be calling during the survey period due to inadequate rain to stimulate breeding; only one winter survey was undertaken targeting the Wallum Froglet; no known reference sites were sampled, etc). Local records and habitat evaluation was consequently also considered when determining the likelihood of the target species occurring. Additionally, the main amphibian habitats within the study area occur outside the site (e.g. Cameron's Corner wetland), hence would not be directly affected by the Proposal.

*Diurnal Searches*
Surveys were concentrated along the minor ephemeral drainage lines on the site within the moist sclerophyll forest; and within the broader study area at adjacent dams, the swamp sclerophyll forest and freshwater wetlands (refer to **Illustration 2.2**). Specific habitat searches included the investigation of potential basking and sheltering sites such as track edges, low vegetation along water bodies and ground litter. A total of 2 hours were spent on diurnal searches specifically for amphibians.

*Nocturnal Surveys*
Nocturnal surveys were conducted along the minor drainage lines on the site within the moist sclerophyll forest; and within the broader study area at adjacent dams, the swamp sclerophyll forest and freshwater wetlands (refer to **Illustration 2.2**). They involved call playback of pre-recorded threatened frog calls, listening for calls and spotlight searches. Frog calls not able to be identified during field surveys were recorded and played back against pre-recorded frog calls for positive identification. A total of 5 hours was spent on nocturnal surveying for amphibians.

### 2.5.3 Reptile Survey

Herpetofauna searches were undertaken across the site within areas representing potential reptile habitat. The Stephens' Banded Snake (*Hoplocephalus stephensii*) was the primary target species. Diurnal surveys involved inspections and searches under logs, decorticated bark and deep leaf litter accumulations. A total of 1 hour was spent undertaking targeted diurnal reptile surveys, with additional opportunistic searches undertaken as part of general fauna surveys and habitat evaluation (refer to **Illustration 2.2**).

During night surveys, spotlighting targeting reptiles was incorporated into general spotlighting activities, targeting potential nocturnal reptile habitats (e.g. tree trunks, fallen logs, areas with deep

leaf litter accumulations, etc).

### 2.5.4 Diurnal Bird Survey

The area search method as outlined within DEC (2004) was conducted as part of this study. Target species were diurnal species identified as known/likely occurrences within the locality from the OEH and EPBC Act database searches (refer to Section 3.1). Specific observations were recorded from visual and vocal identification conducted during peak morning and late – afternoon activity periods. Bird calls not able to be identified during field surveys were recorded and played back against pre-recorded bird calls for positive identification.

### 2.5.5 Nocturnal Bird Survey

*Call Playback, Spotlighting and Stag Watches*
The nocturnal bird survey methodology employed included call playback and spotlighting. Target species were threatened forest owls including Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*), Barking Owl (*Ninox connivens*) and Powerful Owl (*Ninox strenua*); and the Bush-stone Curlew (*Burhinus grallarius*). Call playback involved broadcasting pre-recorded vocalisations of the target species using a 15 watt 'TOA' megaphone ER-1215S. An initial listening period of 5 minutes was undertaken at the call playback broadcast site followed by 5 minutes spotlighting the immediate area. Calls were then broadcast intermittently for approximately 5 minutes followed by a 5 minute listening period. After all calls had been broadcast a further 15 minutes of spotlighting was undertaken within the broadcast area. Call playback was undertaken over four nights during the survey period with a total survey effort of 4 hours.

To minimise disturbances to adjacent residences, the call playback survey effort and methodology adopted differed from the DEC (2004) guideline recommendations. To counter this, habitat evaluation and the precautionary principle was applied when determining the likelihood of target species occurring in the study area. Call playback locations are shown in Illustration 2.3).

Spotlighting targeting threatened birds was also incorporated into general spotlighting activities (refer to Section 2.5.6).

### 2.5.6 Mammal Survey (Excluding Microchiropteran Bats)

The mammal survey methodology employed included terrestrial Elliott A trapping, arboreal Elliott B trapping, spotlighting, call playback, searches for tracks, scats and other traces (diggings, prints, scratches, etc) and habitat analysis. The specific methodologies adopted are detailed below. Survey methods such as wire cage trapping and hair tube sampling were not undertaken due to the highly modified state of the majority of the site (hence low habitat value for many target species), public access / fauna welfare concerns and/or conservative use of habitat evaluation. Similarly these issues dictated the locations of survey methods adopted, particularly ground Elliott A trapping which was undertaken only on private land.

*Arboreal Elliott A Trapping*
Twenty-five Elliott A traps were set for four nights (100 trap nights in total) in the moist sclerophyll forest south-west of the Waterfall Way / Shortcut Road intersection (refer to Illustration 2.3). The traps were baited with a honey, peanut butter and rolled oats mixture and set 7 to 15 m apart at the base of hollow bearing trees, amongst / adjacent to hollow logs and / or in areas with denser ground or shrub layer vegetation. Target species were small terrestrial mammals and the Brush-tailed Phascogale (*Phascogale tapoatafa*).

*Arboreal Elliott B Trapping*
Nineteen arboreal Elliott B traps were set for four nights (76 trap nights in total) within the sclerophyll forest in the eastern, central and western portions of the site (refer to Illustration 2.3). The traps were baited with a honey, peanut butter, apple and rolled oats mixture, targeting the

Brush-tailed Phascogale and Squirrel Glider (*Petaurus norfolcensis*). Trap trees were sprayed with a honey, vanilla essence and water solution as an attractant.

*Stag Watches*

Stag watches were undertaken on four different trees on four nights (refer to Illustration 2.3 for stag watch locations). The methodology as outlined within DEC (2004) was adopted.

*Spotlighting*

Spotlighting was undertaken over four nights on foot using a 100 watt spotlight (refer to Illustration 2.3 for spotlighting transect locations). The moon phase during spotlighting was approaching the full moon, however cloud cover maintained dark conditions during most periods. Survey effort covered four nights, each being for a period of 1.5 hours commencing roughly 1 to 2 hours after dark, totalling 6 person hours. All habitat components were targeted, (i.e. tree canopies for arboreal mammals, ground vegetation for terrestrial mammals, etc).

*Call Playback*

Koala call playback surveys were conducted in conjunction with spotlighting and nocturnal bird call playback (refer to Illustration 2.3). This involved call playback of pre-recorded Koala calls, listening for calls / responses and spotlight searches. A total of one hour (0.25 hours per night for four nights) was undertaken. The call playback survey methodology adopted differed from the DEC (2004) guidelines to minimise disturbances to adjacent residences. Habitat evaluation and other Koala targeted survey techniques were adopted to counter this limitation (e.g. spotlighting, scat searches).

*Tracks, Scats and other Traces*

During surveys, opportunistic recordings of tracks, scats, scratches, diggings and other traces were observed and/or collected for further analysis and reference to Triggs (2004). This included searches for Koala scats below all primary (Tallowwood *Eucalyptus microcorys*) and secondary (Small-fruited Grey Gum *Eucalyptus propinqua*) Koala food tree species (DECC 2008) at the site, and opportunistic scat searches below other trees evidencing arboreal activity via scratches / tracks. A total of 7 hours was devoted specifically to habitat searches.

### 2.5.7 Megachiropteran Species (Flying-foxes, Fruit Bats)

*Spotlighting*

Spotlighting was undertaken on foot using a 100 watt spotlight. Survey effort covered four nights, each being for a period of 1.5 hours commencing roughly 1 hour after dusk.

*Vocal Detection*

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is known to emit audible vocal calls especially during territorial disputes when feeding (Christensen and Nelson 2000). Listening for vocal calls was undertaken during night surveys over four consecutive nights.

### 2.5.8 Microchiropteran Bats

*Ultrasonic Echolocation Detection*

Microchiropteran bats (microbats) emit high frequency echolocation calls to navigate and forage. Ultrasonic call detection and analysis is recognised as an effective way of surveying microbat species within a range of habitats (Murray *et.al.* 2002). An Anabat SD1 CF bat detector was set at a number of fixed point locations and held during spotlighting and call playback activities to actively record calls for 2.5 hours per night for four nights during the survey period (refer to Illustration 2.3). A total of 10 hours of Anabat recording was undertaken, with recorded echolocation calls analysed by Ms Anna Lloyd, GeoLINK Ecologist and Anabat echolocation call analysis specialist.

It is acknowledged that the total hours of Anabat usage was below that recommended in the DEC (2004) guidelines and methods such as harp trapping were not adopted. This was due to a

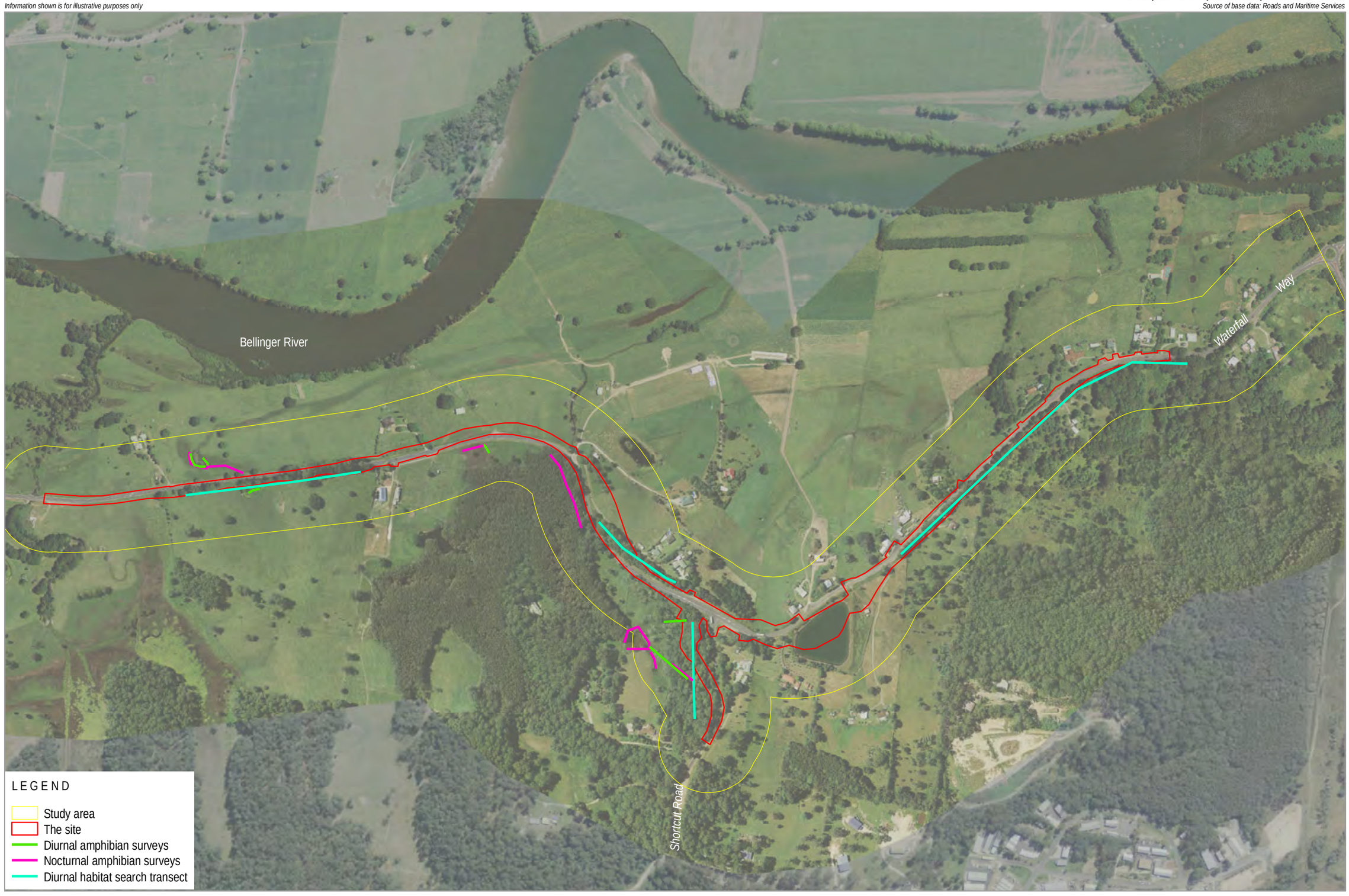
number of factors including public accessibility of the study area and livestock disturbance risk. Consequently habitat evaluation and the precautionary principle were applied when determining the likelihood of target species occurring in the study area.

*Culvert and Bridge Inspections*

Torch inspections were undertaken in accessible culverts and below Connells Creek. Cavities within the culverts and below the bridge were targeted for roosting microbats. Comprehensive inspection of several of the culverts in the study area (including that at Cameron's Corner) was not possible due to their small size and/or water inundation. While other artificial structures may provide potential opportunities for microbats to roost occur within the study area (e.g. buildings), none of these structures occur within the site. Consequently no additional artificial structures were inspected.

*Information shown is for illustrative purposes only*

*Drawn by: DSA Checked by: RE Reviewed by: VJS Date: November 2011*
*Source of base data: Roads and Maritime Services*




North

0 150

GeoLINK environmental management and design

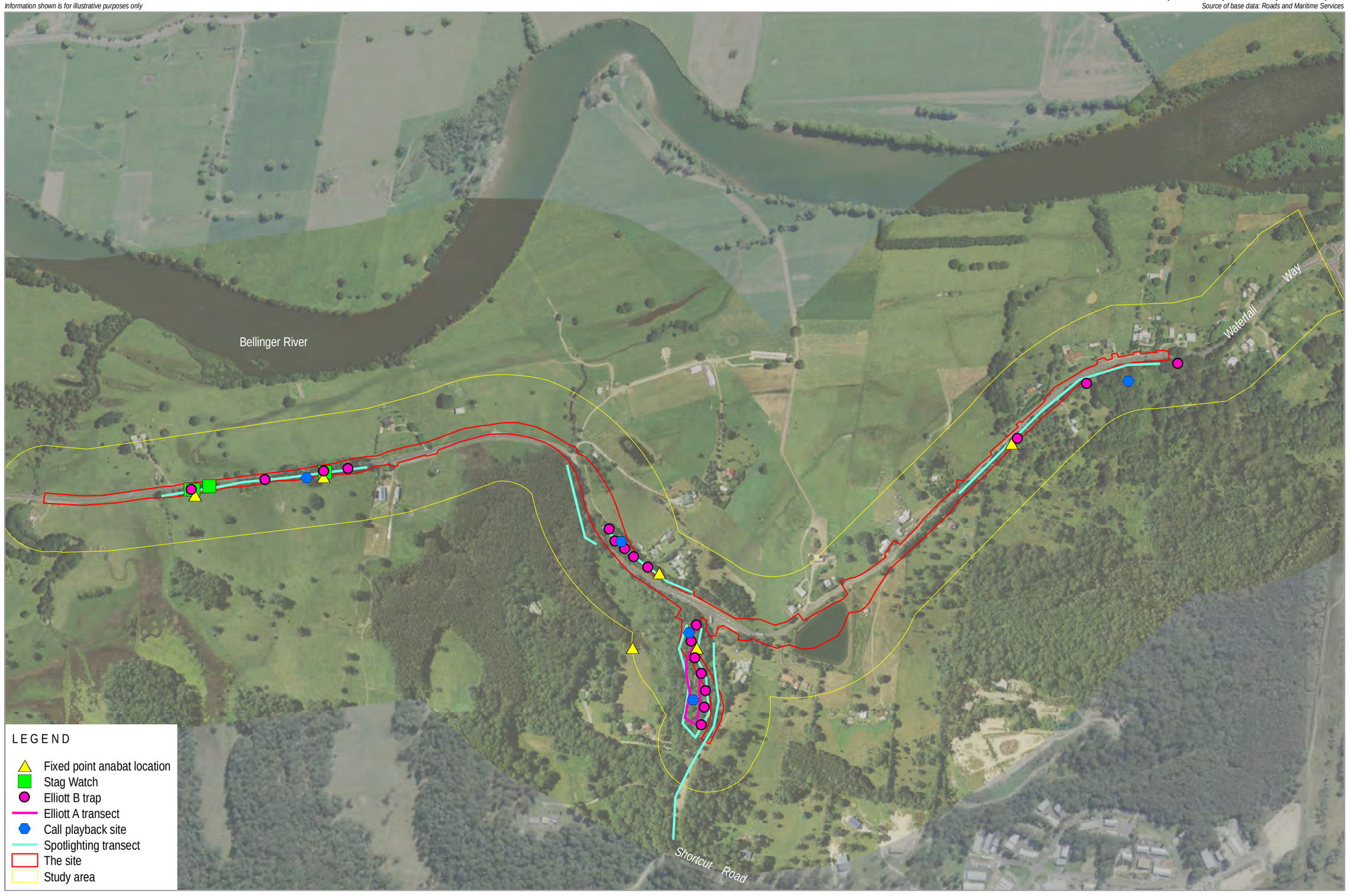
Waterfall Way Upgrade, Pacific Highway to Connells Creek
Ecological Assessment Part A - Flora and Fauna Investigations
1782803

# Amphibian and Habitat Search Survey Locations

Illustration 2.2

*Information shown is for illustrative purposes only*

*Drawn by: DSA Checked by: RE Reviewed by: VJS Date: May 2012*
*Source of base data: Roads and Maritime Services*

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North

# Nocturnal Fauna Survey Locations

GeoLINK environmental management and design

Waterfall Way Upgrade, Pacific Highway to Connells Creek
Ecological Assessment Part A - Flora and Fauna Investigations
1782804

Illustration 2.3

## 2.6 Summary of Survey Effort

Table 2.1 provides a summary of the total survey effort undertaken as part of this survey.

Table 2.1 Survey Effort

| Survey Technique | Winter Survey | Summer Survey | Total Survey Effort |
|---|---|---|---|
| *Flora* | | | |
| Flora Quadrat | 13 | - | 13 |
| Meander transect | 7,780 m | 3,170 m | 10,950 m |
| Total Hours | 23 hours | 7 hours | 30 hours |
| *Fauna* | | | |
| Diurnal Amphibian Survey | 1 hour | 1 hour | 2 hours |
| Nocturnal Amphibian Survey (call playback/spotlight) | 2 hours | 3 hours | 5 hours |
| Diurnal Reptile Searches | - | 1 hour | 1hour |
| Nocturnal Bird Call Playback | - | 4 hours | 4 hours |
| Koala Call Playback | - | 1 hour | 1 hour |
| Stag watches | - | 6 hours | 4 stag watches |
| Spotlighting | - | 6 hours | 6 hours |
| Ground Elliott A trapping | - | 100 trap nights | 100 trap nights |
| Arboreal Elliott B trapping | - | 76 trap nights | 76 trap nights |
| Habitat searches | 2 hours | 5 hours | 7 hours |
| Anabat Recording | - | 10 hours | 10 hours |

## 2.7 Habitat Assessment

As it is recognised that not all species can be detected during surveys, habitat assessments were undertaken to identify any potential habitats (especially for threatened species).

### 2.7.1 Random Meander Surveys

The 'random meander' method, as explained in DEC (2004) was undertaken to assess the habitat present. The following features of fauna habitat were recorded:

- Land use and disturbance history.
- Vegetation structure.
- Dominant plant species.
- Level of disturbance.
- Presence of scats, tracks, scratches and pock marks, etc.
- Tree hollows and spouts.
- Connectivity.

- Rocky outcrops or caves.
- Aquatic habitats.

## 2.8 Survey Limitations

The surveys were conducted in winter and late spring, to cover the peak detectability period of most target species. However while some species may utilise the study area, they may have avoided detection due to their rarity, cryptic nature or the sporadic utilisation of the study area. These are discussed in detail in DEC (2004). Other logistic constraints include:

- The location of the study area along a main arterial road and associated traffic disturbances (noise and vehicle lights).
- High number of rural and rural-residential dwellings within the study area. Access to all lots was not always possible and surveying (particularly nocturnal surveying) in proximity to dwellings was minimised to reduce disturbances to local residents.

Notwithstanding, given the relatively small size of habitat areas on the site and the disturbed nature of the study area, the survey effort was considered adequate in determining the habitat values present and providing sufficient information to assess the impacts of the Proposal (Ecological Assessment Part B). In addition, the precautionary principle has been applied in determining those threatened species not detected but considered to have potential to occur based on habitat suitability and local records. Adoption of the precautionary principle helps counter unavoidable survey constraints and limitation.

# 3 Results

## 3.1 Study Area Landscape Context

The study area is located within the NSW North Coast Bioregion, within the Bellingen Shire Council (BSC) LGA on the NSW mid-north coast. It is located between 170 to 890 m south of the Bellinger River, and comprises two distinct landscapes:

- Rolling low hills and hills (erosional soil landscape of 'Pine Creek'). This covers the majority of the eastern and central portions of the study area, as well as the low hills in the western portion of the study area between Connells Creek and Cameron's Corner. This is the dominant landscape directly south of the Bellinger River floodplain locally, and extends south and east of the study area.
- Bellinger River floodplain, which comprises three soil landscapes:
  - Swamp landscape referred to as 'Charlmont' which comprises broad, flat to gently inclined swampy floodplain and backplains.
  - Alluvial landscape referred to as 'Gleniffer' which comprises level to undulating high relict alluvial terraces.
  - Alluvial landscape referred to as 'Raleigh' which comprises long narrow curved fluvial levees and scrolls (Milford 1999).

  These soil landscapes occur in a mosaic near Cameron's Corner and in the far western portion of the study area, and dominate the local landscape north of the study area along the Bellinger River floodplain.

The majority of the study area comprises mostly cleared rural land, used for grazing (refer to Illustration 1.2). Rural-residential development occurs in the eastern and central portions of the study area on the rolling hills directly adjacent to Waterfall Way. Raleigh Dam, located in the centre of the study area, was established as a water reservoir, however it is not utilised. The remaining elevated forested areas show signs of historic logging, and/or full or partial clearing; and are currently largely unmanaged. The swamp sclerophyll forest at Cameron's Corner is essentially unmanaged forested land.

State forests and conservation reserves within the locality include:

- Tarkeeth State Forest, located approximately 1.4 km south of the study area.
- Pine Creek State Forest, located approximately 4.5 km north of the study area.
- Newry State Forest, located approximately 5 km south of the study area.
- Bongil Bongil National Park, located approximately 6.5 km north-east of the study area.
- Jaaningga Nature Reserve, located approximately 8.7 km south-west of the study area.
- Tuckers Nob State Forest, located approximately 9 km north of the study area.
- Gladstone State Forest, located approximately 9 km west of the study area.
- Little Newry State Forest, located approximately 9 km south of the study area.

## 3.2 Literature Review

### 3.2.1 EPBC Act Protected Matters Online Search Tool Results

*Threatened Species*

The Protected Matters Search Tool identified 58 threatened species (12 flora and 46 fauna species) listed under the EPBC Act as species or species habitat that are likely or may occur within the search area (10 km radius around the site). The database search results are provided in Appendix B and an assessment of the likelihood of occurrence of these species within the

study area is provided in **Appendix C**). Marine species are not considered further due to the absence of suitable habitat within the study area.

*Migratory Species*
A total of 47 migratory species listed under the EPBC Act were identified within the search area by the Protected Matters Search Tool (refer to **Appendix B**). Eight are listed as Migratory Terrestrial Species, five are listed as Migratory Wetland Species and the remainder are listed as Migratory Marine Birds.

*Threatened Ecological Communities*
Two threatened ecological communities listed under the EPBC Act were identified within the search area by the Protected Matters Search Tool (refer to **Appendix B**):

- *Littoral Rainforest and Coastal Vine Thicket of Eastern Australia*.
- *Lowland Rainforest of Subtropical Australia*.

Both communities are listed as Critically Endangered.

### 3.2.2 BioNet

The BioNet database searches for threatened flora and fauna identified records of 71 threatened species (16 flora and 55 fauna species) listed under the TSC Act within 10 km of the site. The database search results are provided in **Appendix B** and an assessment of the likelihood of occurrence of these species within the study area is provided in **Appendix C**. Marine species are not considered further due to the absence of suitable habitat within the study area.

The corresponding OEH Coffs Harbour and Dorrigo threatened species 1:100,000 map sheets were also reviewed, which shows:

- No threatened flora records within the study area.
- Records of the two threatened fauna:
    - Koala (*Phascolarctos cinereus*): A single Koala record from 'Dan Lunney's Community Wildlife Survey 2004 – 2006' in the central portion of the study area, east of Shortcut Road.
    - Black-necked Stork (*Ephippiorhynchus asiaticus*): Nine Black-necked Stork records occur within the study area. These are located in proximity to wetlands / floodplain pastures mainly from Cameron's Corner west, with a single record shown west of Shortcut Road, which is likely to be associated with a large farm dam.

### 3.2.3 OEH Key habitat and Corridors Mapping

The study area does not form part of any OEH mapped key habitats or corridors (refer to **Illustration 3.1**). There are no OEH mapped key habitats or corridors proximate to the study area.

### 3.2.4 TSC Act Critical Habitat

A search on the Register of Critical Habitat indicated that the study area does not contain or adjoin any areas of declared or recommended critical habitat (search 14/11/2011).

### 3.2.5 DPI Fisheries

Connells Creek is mapped by DPI as Key Fisheries Habitat. Site surveys found the western

northern portion of this creek in the study area supported Mangroves which are protected under the FM Act.

There are no records of FM Act listed threatened species within the Bellingen LGA on the DPI records viewer (search 14/11/2011).

### 3.2.6 SEPP 14 – Coastal Wetland

No land mapped as SEPP 14 - Coastal Wetlands occur within the study area. The closest examples occur >1 km to the south and south-east of the study area. Consequently no SEPP 14 - Coastal Wetlands are likely to be affected by the Proposal and SEPP 14 is not considered further.

### 3.2.7 SEPP 26 – Littoral Rainforest

No land mapped as SEPP 26 Littoral Rainforest occurs within the study area. The closest examples occur >5 km to the north-east and south-east of the study area. Consequently no SEPP 26 – Littoral Rainforest are likely to be affected by the Proposal and SEPP 26 is not considered further.

Information shown is for illustrative purposes only

Drawn by: DSA Checked by: RE Reviewed by: VJS Date: Novemeber 2011
Source of base data: Bellingen Topographic Map NSW and Office of Environment and Heritage


0 1.5 km

North

# OEH Regional Corridors and Key Habitats Mapping

GeoLINK environmental management and design

Waterfall Way Upgrade, Pacific Highway to Connells Creek
Ecological Assessment Part A - Flora and Fauna Investigations
1782814

Illustration 3.1

### 3.2.8 *Proposed MR76 Waterfall Way Upgrade* (ERM 2003)

ERM (2003) undertook a comprehensive flora and fauna survey as part of former proposed road upgrade works along Waterfall Way at Cameron's Corner. The survey focused on the Cameron's Corner section of Waterfall Way and included the following survey techniques:

- Vegetation surveys: Random meander (survey effort not known); quadrat sampling (four quadrats) and transect sampling (two x 40 m long).
- Habitat Assessment: General habitat assessment and Koala habitat assessment (including checking all Schedule 2 of SEPP 44 listed preferred Koala food trees within the study area during both winter and late spring surveys periods).
- Terrestrial fauna survey: Undertaken over two survey periods and included diurnal bird survey (9 hours); fauna features search (9 hours); dusk census (9 hours); spotlighting (13.5 hours); call playback (6 hours); remote bat detection (54 hours); and stationary bat detection (4.5 hours).

Key findings of this survey include:

- No threatened flora were recorded or considered likely occurrences.
- No Koalas or evidence of their occurrence was recorded during the Koala habitat assessment.
- Five threatened fauna listed on the TSC and/or EPBC Acts were recorded: Black-necked Stork (*Ephippiorhynchus* asiaticus), Grey-headed Flying-fox (*Pteropus poliocephalus*), Little Bentwing Bat (*Miniopterus* australis), Large Bentwing Bat (*Miniopterus schreibersii*) and possible Large-footed Myotis (*Myotis macropus*). An additional seven species were considered potential occurrences.
- Two EPBC Act listed migratory species were recorded: White-bellied Sea-eagle (*Haliaeetus leucogaster*) and Great Egret (*Ardea alba*).

### 3.2.9 *Proposed Road Realignment Waterfall Way at Cameron's Corner: Aquatic Ecological Survey* (MPR 2003)

MPR (2003) undertook an aquatic ecological survey of the wetland along Waterfall Way at Cameron's Corner as part of a former proposed road realignment project. Key relevant findings include:

- No FM Act listed threatened or protected species (at that time) were considered likely occurrences.
- The creek between the 'Cameron's Corner Wetland' and Bellinger River provides potential fish passage, despite being in low condition.

### 3.2.10 *Review of Environmental Factors for Waterfall Way Realignment: Cameron's Corner* (EcoLogical 2009)

EcoLogical (2009) undertook an ecological survey and impact assessment along Waterfall Way at Cameron's Corner as part of a previous proposed RMS project. The assessment was based primarily on the ERM (2003) survey findings, though additional flora and diurnal fauna surveys were undertaken (survey effort not detailed). Key findings of this assessment include:

- No threatened flora or fauna were recorded. Twenty-three threatened fauna and one threatened flora species were considered potential occurrences.
- Two EECs listed under the TSC Act were identified:
    - *Swamp Sclerophyll Forest on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner Bioregions.*
    - *Freshwater Wetlands on Coastal Floodplain of the NSW North Coast, Sydney Basin*

*and South East Corner Bioregions.*

*Note: These EECs were listed in 2004 after the ERM (2003) assessment.*

### 3.2.11 *Preliminary Environmental Investigation: Waterfall Way Upgrade Raleigh Interchange to Connells Creek* (GeoLINK 2011)

The biodiversity components of the *Preliminary Environmental Investigation: Waterfall Way Upgrade Raleigh Interchange to Connells Creek* (GeoLINK 2011) included a desktop review and site inspection (which was restricted to the existing Waterfall Way road reserve footprint), to provide a general overview of the development constraints and opportunities of the study area relating to ecological issues. Approximately 6.5 hours of flora survey was undertaken.

Based on local records and the habitat present, it was identified that potential habitat for 26 threatened fauna was present and seven threatened fauna species were recorded within the study area. No threatened flora species were recorded during targeted searches within the road reserve. No Koala scats were detected during searches below all Tallowwoods within the road reserve.

The same TSC Act EECs as identified by EcoLogical (2009) were identified during this investigation.

Nambucca Ironbark (*Eucalyptus ancophila*), a Rare or Threatened Australian Plant (ROTAP) listed plant, was detected within the eucalypt forest communities.

## 3.3 Vegetation Communities

Six broad vegetation classes were identified within the study area:

- Moist sclerophyll forest.
- Swamp sclerophyll forest.
- Freshwater wetland.
- Open grassland.
- Exotic species dominated forest.
- Saline wetland.

They comprise of nine vegetation types which are listed in **Table 3.1** and described below. The location of these communities is shown in **Illustration 3.2**. **Table 3.1** also shows the area of vegetation community; condition; a correlation with OEH BioMetrics Vegetation Types and estimate of the percentage of the vegetation cleared within the Northern Rivers Catchment Management Authority (NRCMA); and whether they constitute an EEC.

Table 3.1 Vegetation Types

| Vegetation Type (Vegetation Class) | Biometric Vegetation Type Correlation (Estimated % cleared in NRCMA) | Approximate Area within Study Area (ha) | Condition | Endangered Ecological Community |
|---|---|---|---|---|
| Exotic species dominated open grassland (open grassland) | N/A | 62.44 | Poor – exotic species dominate community | No |
| Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest (moist sclerophyll forest) | Tallowwood – Narrow-leaved White Mahogany open forest of the hinterland ranges of the North Coast (5%); and Tallowwood – Small-fruited Grey Gum dry grassy open forest of the foothills of North Coast (30%) | 7.06 | Varies with location from poor to good | No |
| Blackbutt – Turpentine – Tallowwood open forest (moist sclerophyll forest) | Blackbutt – Turpentine – Tallowwood shrubby open forest of the coastal foothills of the central North Coast (5%) | 1.51 | Moderate to good | No |
| Blackbutt open forest (moist sclerophyll forest) | Blackbutt – Tallowwood dry grassy open forest of the central parts North Coast (55%) | 1.09 | Good | No |
| Freshwater wetland (freshwater wetland) | Coastal floodplain sedgelands, rushlands, and forblands (80%); and Coastal freshwater meadows and forblands of lagoons and wetlands (40%) | 1.23 | Poor – All examples subject to livestock disturbances are likely to have been derived from historic clearing of floodplain forest communities | Yes: Constitutes TSC Act listed EEC: *Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* |
| Broad-leaved Melaleuca / Swamp Mahogany swamp forest (swamp sclerophyll forest) | Paperbark swamp forest of the coastal lowlands of the North Coast (75%) | 3.31 | Good | Yes: Constitutes TSC Act listed EEC: Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions |
| Camphor Laurel forest (exotic species dominated forest) | N/A | 0.79 | Low – Exotic species dominate community | No |
| Radiata Pine forest (exotic species dominated forest) | N/A | 0.53 | Low – Exotic species dominate | No |

| Vegetation Type (Vegetation Class) | Biometric Vegetation Type Correlation (Estimated % cleared in NRCMA) | Approximate Area within Study Area (ha) | Condition | Endangered Ecological Community |
|---|---|---|---|---|
| | | | community | |
| Mangrove Forest (saline wetland) | Mangrove - River Mangrove low closed forest of the NSW Coastal Bioregions (75%) | 0.04 | Low – small and heavily weed infested | No however Mangroves are protected under the FM Act |

### 3.3.1 *Exotic Species Dominated Open Grassland*

*Structure and Floristic Composition*

Emergent – Consists of scattered isolated or small groups of trees and shrubs, comprising of regrowth, ornamental plantings or the occasional remnant tree. Commonly occurring species include Blackwood (*Acacia melanoxylon*), Red Ash (*Alphitonia excelsa*), Camphor Laurel (*Cinnamomum camphora**), Brown Kurrajong (*Commersonia bartramia*), Blackbutt (*Eucalyptus pilularis*), Figs (*Ficus* spp.) and Foambark (*Jagera pseudorhus* var. *pseudorhus*). Tree height ranged between approximately 2 and 25 m, with tree diameter at breast height (DBH) range up to 1.2 m.

Groundcover – Generally mid-dense to dense. Height is generally between 0.1 to 0.3 m due to grazing or slashing. Pastoral grasses and weeds are dominant. Commonly occurring species including Kikuyu Grass (*Pennisetum clandestinum**), Narrow-leaved Carpet Grass (*Axonopus affinis**), Paspalum (*Paspalum dilatatum**), Blady Grass (*Imperata cylindrica* var. *major*), Water Couch (*Paspalum distichum*), Parramatta Grass (*Sporobolus africanus*), South African Pigeon Grass (*Setaria sphacelata**), Cobbler's Pegs (*Bidens pilosa**), Paddy's Lucerne (*Sida rhombifolia**), and White Clover (*Trifolium repens**).

*Distribution and Variation of Community within Study Area*

Occurs across the majority of the study area as mostly cleared pastoral land and around dwellings. Ornamental lawns, gardens and plantings are encompassed within this community.

Species dominance varies with location and is largely associated with varying management regimes (e.g. pastoral improvement practices and recent grazing intensities in grazing areas, disturbed roadside). Species diversity is overall reasonably high as this community intergrades with a diverse range of native communities and supports a large number of exotic pastoral species and weeds.

*Condition of Vegetation*

This community has experienced an extensive disturbance history including clearing, livestock disturbances, pastoral improvement works and rural-residential development. Consequently this community is of poor quality in terms of native biodiversity values.

*Conservation Significance*

The grassland within the study area does not constitute any TSC Act or EPBC Act listed EECs. Overall it is of low conservation significance.

Plate 3.1 Typical view of pastoral grassland

Plate 3.2 Typical view of roadside grassland

### 3.3.2 *Tallowwood – Narrow-leaved White Mahogany – Turpentine Open Forest*

*Structure and Floristic Composition*

Canopy – Cover is typically mid-dense with trees between 15 and 25 m tall, and 0.15 to 1.2 m (typically <0.5 m) DBH. In most areas the canopy is dominated by Narrow-leaved White Mahogany (*Eucalyptus acmenoides*), Tallowwood (*Eucalyptus. microcorys*) and/or Turpentine (*Syncarpia glomulifera*), with common associated species including Ironbark. (Nambucca Ironbark *Eucalyptus ancophila* or Grey Ironbark *Eucalyptus siderophloia*), Small-fruited Grey Gum (*Eucalyptus propinqua*) and Pink Bloodwood (C*orymbia intermedia*). Red Ash, Brown Kurrajong and Foambark are common in the central southern portion of the study area near Shortcut Road, where these species are dominant in small regrowth pockets along drainage lines.

Mid Stratum – Cover is typically mid-dense with shrubs and small trees between 2 and 6 m tall. Includes Banana Bush (*Tabernaemontana pandacaqui*), Brush Muttonwood (*Myrsine howittiana*), Large Mock-olive (*Notelaea longifolia*), Lantana (*Lantana camara**), Cheese Tree (*Glochidion ferdinandi*), Foambark (*Jagera psuedohorus*), Hop Bush (*Dodenea triquetra*), Scrub Turpentine (*Rhodamnia rubescens*), Tree Heath (*Trochocarpa laurina*), Forest Oak (*Allocasuarina torulosa*), Willow Bottlebrush (*Callistemon saligna*), Rose Satinash (*Syzygium crebrinerve*), Camphor Laurel and Sweet Pittosporum (*Pittosporum undulatum*).

Groundcover – Generally mid-dense to dense and up to 0.5 m tall. Approximately 1.2 m tall in a partially cleared area in the central east. Includes Bracken Fern (*Pteridium esculentum*), Basket Grass (*Oplismenus imbecillis*), Spiny-headed Mat-rush (*Lomandra longifolia*), Blady Grass (*Imperata cylindrica* var. *major*), Tall Saw-sedge (*Gahnia clarkei*), Soft Bracken Fern (*Calochlaena dubia*), Gristle Fern (*Blechnum cartilagineum*), Sweet Morinda (*Morinda jasminoides*) and Broad-leaved Paspalum (*Paspalum wettsteinii**).

*Distribution and Variation of Community within Study Area*

Occurs in forested pockets, mainly in the central and eastern portions of the study area. A narrow linear stand occurring in the west directly adjacent to Waterfall Way.

Vegetation structure and species dominance varies across the study area, mainly in response to disturbances (historic clearing and/or logging in most areas, and edge effects). Some stands (particularly in the east directly adjacent to the road corridor) comprise of young regrowth, while others have been reduced to a woodland structure. Trees with senescent features occur mainly in the west.

*Condition of Vegetation*

Varies from poor in the small regrowth and/or narrow linear stands, to good in core areas of the larger intact stands.

*Conservation Significance*

This vegetation community does not constitute any TSC Act or EPBC Act listed EECs. The stands of Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest within the study area are not considered of significant conservation values in terms of a local flora biodiversity conservation perspective as only small portions of this community is estimated to have been cleared under the OEH Biometric system (refer to Table 3.1).

Plate 3.2 Central stand of Tallowwood – Narrow-leaved White Mahogany – Turpentine Open Forest near Cameron's Corner

Plate 3.3 Eastern stand of view of Tallowwood – Narrow-leaved White Mahogany – Turpentine Open Forest south of Waterfall Way

Plate 3.4 Western linear stand of Tallowwood – Narrow-leaved White Mahogany – Turpentine Open Forest along the edge of Waterfall Way

Plate 3.5 Partially cleared Tallowwood – Narrow-leaved White Mahogany – Turpentine Open Forest in the east

### 3.3.3 *Blackbutt – Turpentine – Tallowwood open forest*

*Structure and Floristic Composition*

Canopy – Cover is typically mid-dense with trees up to approximately 25 m tall, and 0.2 to 1.2 m DBH. Dominated by Blackbutt (*Eucalyptus pilularis*) with the occasional Tallowwood, Narrow-leaved White Mahogany, Pink Bloodwood and Turpentine. Other eucalypt species associated with the Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest occur along the ecotonal edges.

Mid Stratum – Varies from sparse in localised under scrubbed areas to mid-dense, and predominantly between 2 to 8 m tall. Commonly occurring species include Forest Oak, Lantana and Tree Heath.

Groundcover – Mid-dense to dense and up to 0.5 m tall. Includes Basket Grass and Soft Bracken Fern as dominant species. Other species include Spiny-headed Mat-rush, Blue Flax Lily (*Dianella caerulea*), Gristle Fern (*Blechnum cartilagineum*), *Gahnia* spp. and Bladey Grass.

*Distribution and Variation of Community within Study Area*

Occurs in the centre of the study area in proximity to Shortcut Road. It covers the upper portion of the hills and grades into Tallowwood – Narrow-leaved White Mahogany – Turpentine on the mid-slopes. Ecotones between these communities are broad and poorly defined.

*Condition of Vegetation*

Varies from moderate in localised under scrubbed or weed infested areas directly adjacent to Shortcut Road, to good in core areas.

*Conservation Significance*

This vegetation community does not constitute any TSC Act or EPBC Act listed EECs. The stands of Blackbutt – Turpentine – Tallowwood open forest within the study area are not considered of significant conservation values from a local flora biodiversity conservation perspective as only small portions of this community is estimated to have been cleared under the OEH Biometric system (refer to Table 3.1).

Plate 3.6 Blackbutt – Turpentine – Tallowwood open forest west of Short Cut Road

Plate 3.7 Blackbutt – Turpentine – Tallowwood open forest east of Short Cut Road

### 3.3.4 *Blackbutt open forest*

*Structure and Floristic Composition*

Canopy – Cover is typically mid-dense with trees around 20 to 25 m tall, and 0.2 to 1 m DBH. Dominated by Blackbutt with the occasional Narrow-leaved White Mahogany and Northern Grey Ironbark.

Mid Stratum – Sparse and dominated by Forest Oak and canopy saplings 4 to 8 m tall.

Groundcover – Dense and up to 0.7 m tall. Dominated by Blady Grass with a common occurrence of Kangaroo Grass (*Themeda australis*), Small-flowered Finger Grass (*Digitaria parviflora*), Wiry Panic (*Entolasia stricta*), Spiny-headed Mat-rush, Bracken Fern and Whiteroot (*Pratia purpurascens*).

*Distribution and Variation of Community within Study Area*

Occurs on a ridge in the eastern portion of the study area. Contains strong floristic similarities to the Blackbutt – Turpentine – Tallowwood open forest, however is likely to have developed under a more regular fire regime, creating a grassy understorey and spare mid-stratum.

*Condition of Vegetation*

Condition is generally good, with low weed occurrence and a number of trees with senescent features such as tree hollows.

*Conservation Significance*

This vegetation community does not constitute any TSC Act or EPBC Act listed EECs. The Blackbutt forest within the study area is not considered of significant conservation values from a local flora biodiversity conservation perspective as it is not considered over-cleared under the OEH Biometric system (refer to Table 3.1).

Plate 3.8 Blackbutt open forest

### 3.3.5 *Freshwater Wetland*

*Structure and Floristic Composition*

Emergent – Isolated emergent Broad-leaved Paperbarks (*Melaleuca quinquenervia*) are located within the wetland near Cameron's Corner, while emergent Swamp Oak (*Casuarina glauca*) occurs in the wetlands in the far western edge of the study area.

Groundcover – Cover varies from dense to mid-dense. Species dominance is highly variable depending on surface water / watertable depth, and includes Water Ribbon (*Triglochin procerum*), *Triglochin striatum*, *Eleocharis equisetina*, Tall Spike Rush (*Eleocharis sphacelata*), Water Couch (*Paspalum distichum*), River Buttercup (*Ranunculus inundatus*), *Juncus usitatus*, Water Primrose (*Ludwigia peploides* subsp. *montevidensis*) and Knotweeds (*Persicaria lapathifolia*, *Persicaria dichotoma*, *Persicaria orientalis** and *Persicaria strigosa*). Salt tolerant species such as Sea Rush (*Juncus kraussii*) and Streaked Arrowgrass (*Triglochin striatum*) occur occasionally in the far western wetland area near Connells Creek, indicating this area experiences occasional saline water influences.

*Distribution and Variation of Community within Study Area*

Occurs in depressions and along drainage lines on the Bellinger River floodplain, mainly in the western portion of the study area. Species composition and structure vary with surface and watertable depth, as well as grazing disturbances.

*Condition of Vegetation*

Condition is generally poor due to historic clearing and disturbances associated with grazing practices (e.g. livestock trampling and grazing, weed invasion, etc).

*Conservation Significance*

This community comprises a poor condition example of the TSC Act listed EEC *Freshwater Wetlands on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner Bioregions*.

Plate 3.9 Freshwater Wetland near Cameron's Corner

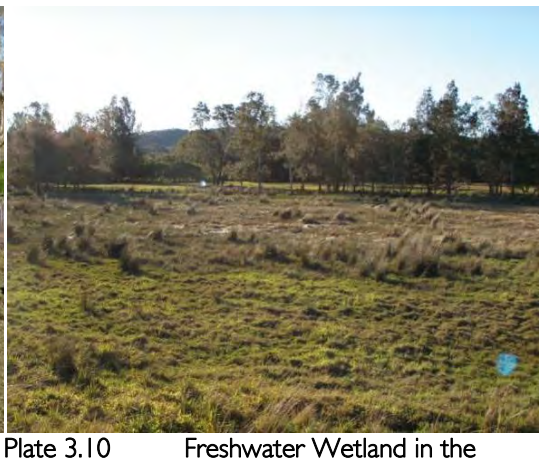


Plate 3.10 Freshwater Wetland in the far western portion of the study area

Plate 3.11 Freshwater Wetland in the western portion of the study area

Plate 3.12 Very poor condition section of Freshwater Wetland north of Cameron's Corner

### 3.3.6 *Broad-leaved Melaleuca / Swamp Mahogany swamp forest*

*Structure and Floristic Composition*

Canopy – Cover is dense with trees around 12 to 16 m tall, and mostly 0.5 to 0.5 m DBH. Broad-leaved Melaleuca is the dominant canopy species, with Swamp Mahogany (*Eucalyptus robusta*) occurring as the main associate species (particularly along the edges).

Mid Stratum –Sparse and up to 6 m tall. Includes Broad-leaved Melaleuca, Snow-in-Summer (*Callistemon salignus*), Creek Sandpaper Fig (*Ficus coronata*), Cheese Tree (*Glochidion ferdinandi*), Foambark and Lantana*.

Groundcover – Mid-dense and up to 1.5 m tall. Dominated by Tall Saw-sedge (*Gahnia clarkei*), Swamp Water Fern (*Blechnum indicum*), with associated species including Soft Bracken Fern, Pennywort (*Centella asiatica*), Tall Sedge (*Carex appressa*) and *Persicaria strigosa*.

*Distribution and Variation of Community within Study Area*

Occurs as a single stand on the southern side of Waterfall Way at Cameron's Corner. Species composition and structure is largely uniform, with minor changes on the edges.

*Condition of Vegetation*

Condition is good, with weeds being largely restricted to the edges.

*Conservation Significance*

This community constitutes the TSC Act listed EEC *Swamp Sclerophyll Forest on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner Bioregions*. This and its good condition make it of particularly high conservation significance.

Plate 3.9 Broad-leaved Melaleuca / Swamp Mahogany swamp forest

### 3.3.7 *Camphor Laurel forest*

*Structure and Floristic Composition*

Canopy – Cover is dense with trees around 18 m tall, and up to 0.5 m DBH. Camphor Laurel is dominant (almost exclusively), with the occasional Flooded Gum (*Eucalyptus grandis*) in the western stands.

Mid Stratum – Mid-dense to open and up to 6 m tall. Includes Camphor Laurel saplings (dominant), *Guioa semiglauca*, Foambark, Small-leaved Privet (*Ligustrum sinense**), Cockspur Thorn (*Maclura cochinchinensis*), Brush Muttonwood (*Rapanea howittiana*) and Rose Satinash.

Groundcover – Mid-dense and up to 1.5 m tall. Species dominant is high variable, with the dominant species including Soft Bracken Fern, Basket Grass and Broad-leaved Paspalum.

*Distribution and Variation of Community within Study Area*

Occurs in small patches, mainly in proximity to drainage lines. Lower strata species vary with location, and are dominated by exotic species in more exposed stands.

*Condition of Vegetation*

Condition is low. Essentially a weed dominated community which has developed following historic clearing.

*Conservation Significance*

This community is of no significant conservation value.

Plate 3.10 Camphor Laurel forest

### 3.3.8 *Radiata Pine forest*

*Structure and Floristic Composition*

Canopy – Comprises dense Radiata Pine (*Pinus radiata**) up to around 12 m tall.

Mid Stratum – Mid-dense with shrubs and small trees 2 to 6 m tall. Includes Radiata Pine saplings, Lantana and a range of predominantly pioneer native saplings such as Blackwood, Snow-in-Summer, Tuckaroo (*Cupaniopsis anacardioides*), Cheese Tree, Sweet Pittosporum and Foambark.

Groundcover – Mid-dense and typically >1.2 m tall. Includes Soft Bracken Fern, Broad-leaved Paspalum, South African Pigeon Grass (*Setaria sphacelata**), Native Raspberry (*Rubus rosifolius*), Sweet Morinda and Climbing Guinea Flower (*Hibbertia scandens*).

*Distribution and Variation of Community within Study Area*

Occurs in a small area north of Shortcut Road. Vegetation composition and structure is uniform.

*Condition of Vegetation*

Condition is low. Essentially an exotic dominated community.

*Conservation Significance*

This community is of no significant conservation value.

Plate 3.11 Radiata Pine forest

### 3.3.9 *Mangrove forest*

*Structure and Floristic Composition*

Canopy – Very poor vegetation form, comprising a line of trees (mostly around 3 to 4 m tall) along Connells Creek, north of Waterfall Way. Dominated by River Mangrove (*Aegicerus corniculatum*), with the occasional Swamp Oak.

Groundcover – Comprise mostly pastoral grass and weeds along the water's edge.

*Distribution and Variation of Community within Study Area*

Occurs in a very narrow and disturbed strip along Connells Creek, north of Waterfall Way. Variation is minimal.

*Condition of Vegetation*

Condition is very poor. Essentially a very small stand of regrowth which is subject to livestock disturbances.

*Conservation Significance*

Mangroves are protected under the FM Act.

### 3.3.10 *Endangered Ecological Communities*

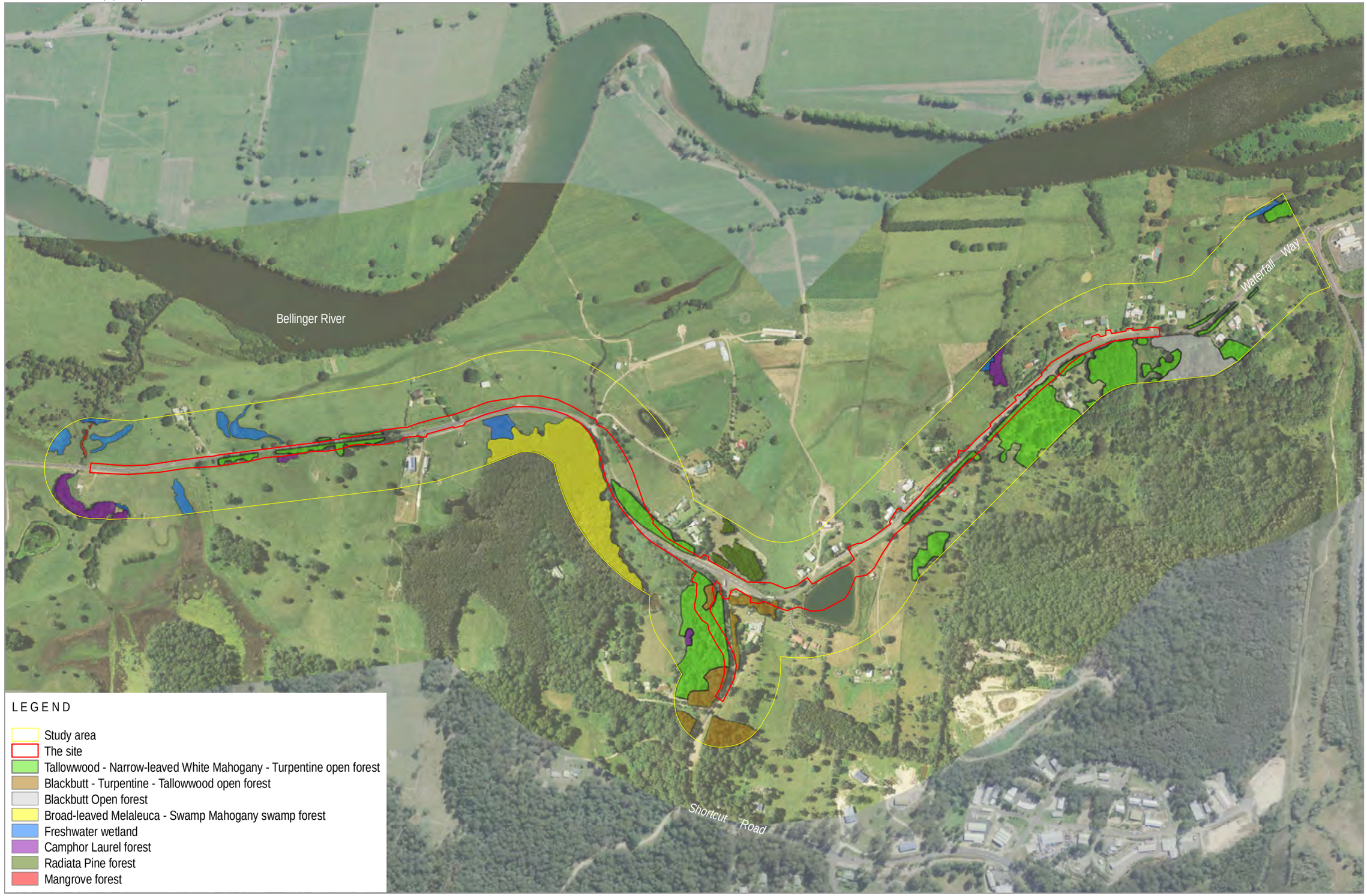
Two TSC Act listed EECs were recorded during the survey:

- *Swamp Sclerophyll Forest on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner Bioregions.*
- *Freshwater Wetlands on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner Bioregions.*

The locations of these communities are shown in Illustration 3.3. No other TSC Act or EPBC Act listed species EECs were recorded.

*Information shown is for illustrative purposes only*

*Drawn by: DSA Checked by: RE Reviewed by: VJS Revised by: DSA Date: May 2012*
*Source of base data: Roads and Maritime Services*




North

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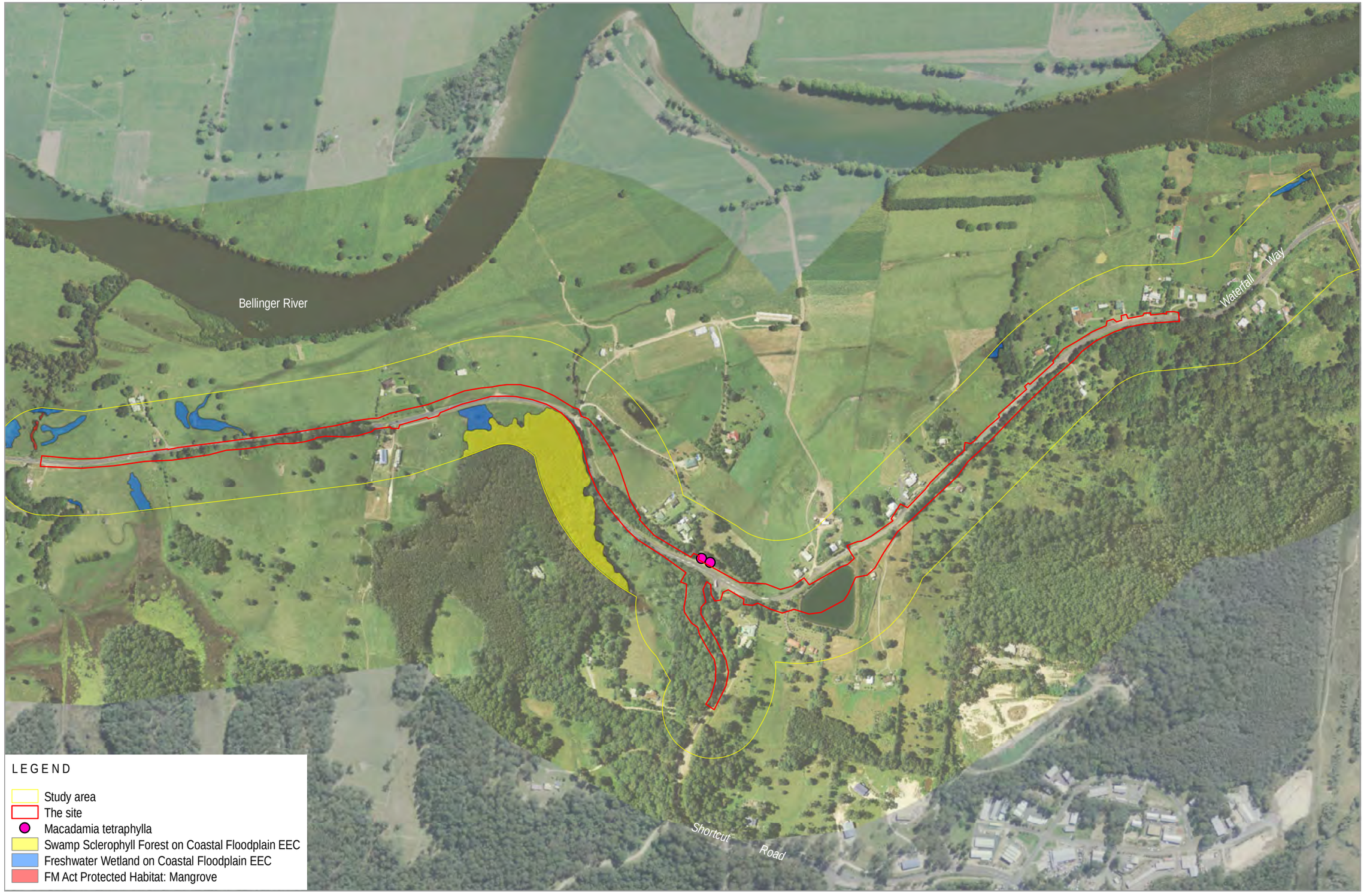
# Vegetation Map

Illustration 3.2

*Information shown is for illustrative purposes only*

*Drawn by: DSA Checked by: RE Reviewed by: VJS Revised by: DSA Date: May 2012*
*Source of base data: Roads and Maritime Services*

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## Legislative Listed Vegetation

Illustration 3.3

## 3.4 Flora Species

A full list of species recorded during the survey is provided in Appendix D. In total, 245 species were recorded (which excludes ornamental plantings), comprising 59 exotic species and 186 native species. An additional five flora species (one exotic and four native) were recorded exclusively during the EcoLogical (2009) investigations within the study area.

### 3.4.1 *Threatened Species*

One threatened species was recorded during the survey: Rough-shelled Bush Nut (*Macadamia tetraphylla*) (refer to Plate 3.12). Two specimens were detected which comprised ornamental plantings near a driveway entrance opposite Shortcut Road (refer to Illustration 3.3). The study area is located well south of this species known natural distribution (i.e. from northern NSW mainly the Richmond and Tweed River, north into south-east Queensland). Consequently no natural local populations are likely to occur locally, and the species is readily cultivated.

A potential occurrence assessment of threatened flora species identified as known or potential occurrences within the locality from the literature review is provided in Appendix C. The study area was considered to provide potential habitat for the following species:

- Clear Milkvine (*Marsdenia longiloba*).
- Rusty Plum (*Niemeyera whitei*).
- Red-flowered King of the Fairies (*Oberonia titania*).
- Milky Silkpod (*Parsonsia dorrigoensis*).
- Minute Orchid (*Taeniophyllum muelleri*).
- Cryptic Forest Twiner (*Tylophora woollsii*).

None of these species were recorded despite targeted surveys.

Plate 3.12 *Macadamia tetraphylla*

### 3.4.2 *RoTAP Species*

One RoTAP listed species was recorded: Nambucca Ironbark (*Eucalyptus ancophila*). It was

recorded primarily within the Tallowwood – Narrow-leaved White Mahogany – Turpentine forest.

No other RoTAP listed species were detected.

### 3.4.3 *NW Act Species*

Five species listed as noxious weeds under the NW Act for the Bellingen LGA were recorded during the survey. These species are listed in Table 3.2.

Table 3.2 NW Act Listed Noxious Weeds within the Study Area

| Species | Class | Legislative Requirement |
|---|---|---|
| Crofton weed (*Ageratina adenophora*) | 4 | The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. |
| Fireweed (*Senecio madagascariensis*) | 4 | The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. |
| Camphor laurel (*Cinnamomum camphora*) | 4 | The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed. |
| Water hyacinth (*Eichhornia crassipes*) | 3 | The plant must be fully and continuously suppressed and destroyed. |
| Lantana (*Lantana species*) | 4 | The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold or knowingly distributed. |

## 3.5 Terrestrial Fauna Species

A full list of species recorded during this and previous surveys within the study area is provided in Appendix E. In total, 104 fauna species have been recorded, including:

- Sixty-nine avifauna (67 native and two feral species).
- Twenty mammals (20 native and two feral species).
- Nine amphibians (all native).
- Six reptiles (all native).

### 3.5.1 *Threatened Species*

Six threatened fauna species have been recorded within the study area:

- Black-necked Stork: An individual was recorded within the Freshwater Wetland, near Cameron's Corner (refer to Plate 3.13 and Illustration 3.4). This species was also recorded during the ERM (2003) survey in this area. The study area provides known foraging habitat. No nests were detected during the survey. Habitats within the footprint of the site are of no significant local foraging values for the Black-necked Stork.
- Koala: Koala scats were detected below two trees (one Tallowwood and one Pink Bloodwood) in the western portion of the site within an isolated area of Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest directly adjacent to Waterfall

Way (refer to Plate 3.14 and Illustration 3.4). The site appears to be subject to low levels (probably transient) Koala usage (acknowledging the limitations on the detectibly of Koala scats during the survey, e.g. leaf litter, dense ground cover in some locations, etc), given the survey results and results of previous systematic surveys which failed to record the Koala or evidence of their occurrence (ERM 2003, EcoLogical 2009, GeoLINK 2011). The nature of the 'Dan Lunney's Community Wildlife Survey 2004 – 2006' record in the central portion of the study area (refer to Illustration 3.4) is unknown (i.e. if the record is of a Koala or a scat; whether the record is of a Koala occupying the area as part of a permanent territory or dispersing, the accuracy of the location, etc).

- Grey-headed Flying-fox: Recorded flying over the study area during nocturnal surveying. The study area provides a relatively small area of opportunistic foraging habitat for this large ranging species. No known roosting habitat occurs within the study area.
- Little Bentwing Bat: The study area provides opportunistic aerial foraging and possible non-breeding roosting habitat for the Little Bentwing Bat.
- Eastern Bentwing Bat: As for the Little Bentwing Bat, the study area provides opportunistic foraging and possible non-breeding roosting habitat.
- Large-footed Myotis: Aquatic foraging habitat within the study area is provided by drainage lines and creeks, farm dams and freshwater wetland areas with open water. Potential roosting habitat is also present (e.g. tree hollows, artificial structures such as culverts, etc).

A *Petaurus* spp. was observed whilst spotlighting in the Tallowwood – Narrow-leaved White Mahogany – Turpentine forest in the centre of the study area, north-west of Shortcut Road, near Cameron's Corner. It was not possible to determine whether the specimen was a Sugar Glider (*Petaurus breviceps*) or the threatened Squirrel Glider. However the Sugar Glider was recorded during the ERM (2003) survey; hence is the most likely species. Notwithstanding, the Squirrel Glider is still considered a potential occurrence (refer to Appendix C).

A potential occurrence assessment of threatened fauna species identified as known or potential occurrences within the locality from the literature review and the habitat within the study area is provided in Appendix C. The following additional species are considered potential occurrences in the study area:

- Regent Honeyeater (*Anthochaera phrygia*): forested portions of the study area with winter flowering food resources provide a small area of potential non-breeding foraging habitat. The site supports a very small part of the Regent Honeyeater's non-breeding foraging range and does not offer habitat of significant value for this species.
- Australasian Bittern (*Botaurus poiciloptilus*): wetland (mainly freshwater, but possibly also saline) areas of the study area provide potential foraging habitat as part of network of potential foraging habitat on the Bellinger River and associated floodplain system. Marginal potential nesting sites may be present in the broader study area, however are absent from the site. No significant potential foraging habitat occurs on the site.
- Curlew Sandpiper (*Calidris ferruginea*): wetland areas of the study area provide potential foraging habitat during non-breeding migratory visits of the Curlew Sandpiper to Australia. The site itself does not provide any significant potential habitat for this species.
- Glossy Black-Cockatoo (*Calyptorhynchus lathami*): the study area offers some localised areas of potential foraging habitat within the moist sclerophyll forest where Forest Oak is present. The site only supports a minor portion of available foraging habitat locally, and no evidence of Glossy Black-Cockatoo foraging was detected during site visits and surveys. No potential nesting sites (i.e. large hollow-bearing trees) occur on site.
- Barred Cuckoo-shrike (*Coracina lineata*): the study area provides potential foraging habitat during fruiting periods of local fruit resources (e.g. Camphor Laurel and Ficus sp.), though provides only marginal quality nesting habitat. The site comprises only a minor portion of

foraging resources available to the local population and does not support any significant potential nesting habitat.

- Varied Sittella (*Daphoenositta chrysoptera*): moist sclerophyll forest areas within the study area provide potential foraging and nesting habitat for the Varied Sittella, as part of a larger area of potential habitat within the locality that may support the local population. The site provides only a minor portion of the habitat available locally.
- Little Lorikeet (*Glossopsitta pusilla*): nectar and pollen resources from sclerophyll forest, gardens and paddock trees within the study area may provide potential seasonal opportunistic foraging resources for the Little Lorikeet, as part of a larger area of potential foraging habitat within the locality. Tree hollows may also provide some nesting opportunities, though this species typically prefers dry habitats. The site provides only a minor portion of the potential habitat available locally for the Little Lorikeet.
- Little Eagle (*Hieraaetus morphnoides*): the study area provides a small area of foraging habitat for the Little Eagle as part of a larger area of similar habitat for this species in the locality. No nesting sites are known within the study area.
- Black Bittern (*Ixobrychus flavicollis*): aquatic wetland areas of the study area provide potential foraging habitat as part of a network of potential foraging habitat on the Bellinger River floodplain. Marginal potential nesting sites may be present in the broader study area, however are absent from the site. No significant potential foraging habitat occurs on the site.
- Swift Parrot (*Lathamus discolour*): forested portions of the study area with winter flowering food resources provide a small area of potential non-breeding foraging habitat. The site provides a minute fraction of the Swift Parrots non-breeding foraging range and does not offer significant habitat for this species.
- Mangrove Honeyeater (*Lichenostomus fasciogularis*): nectar and pollen resources from mangrove forest, sclerophyll forest, gardens and paddock trees may provide seasonal opportunistic foraging resources for the Mangrove Honeyeater. The mangrove forest may also provide marginal potential nesting habitat. Given the extent of better quality habitat along the Bellinger River and the scarcity of records in the locality, the likelihood of this species nesting on the site is low.
- Square-tailed Kite (*Lophoictinia isura*): the study area provides a small area of foraging and potential nesting habitat for the Square-tailed Kite as part of a larger area of habitat of similar value for this species in the locality. No nests are known within the study area.
- Powerful Owl (*Ninox strenua*): the sclerophyll forest areas of the study area provide potential foraging habitat, forming a fraction of a larger foraging territory. No suitable nesting trees (large hollow-bearing trees) are present. Moist gullies within the moist sclerophyll forest may also provide opportunistic roosting habitat.
- Eastern Osprey (*Pandion cristatus*): the Eastern Osprey is known to utilise the local section of the Bellinger River to the north. Ospreys may fly over the study area on occasions; however the study area lacks any significant potential foraging habitat. There are no known nest sites within the study area.
- Masked Owl (*Tyto novaehollandiae*): the moist sclerophyll forest and interface with adjacent pastoral land provide potential foraging habitat, potentially forming a fraction of a larger foraging territory. No suitable nesting trees (large hollow-bearing trees) are present.
- Sooty Owl (*Tyto tenebricosa*): the moist sclerophyll forest provide potential foraging habitat, potentially forming a fraction of a larger foraging territory. No suitable nesting trees (large hollow-bearing trees) are present.
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*): the study area may form the outer fringes of a local population range which would be expected to be based in the extensive forest areas to the south, however does not comprise any significant potential foraging, sheltering or denning habitat. Any occurrences would be opportunistic during movements

of animals over a broader territory.

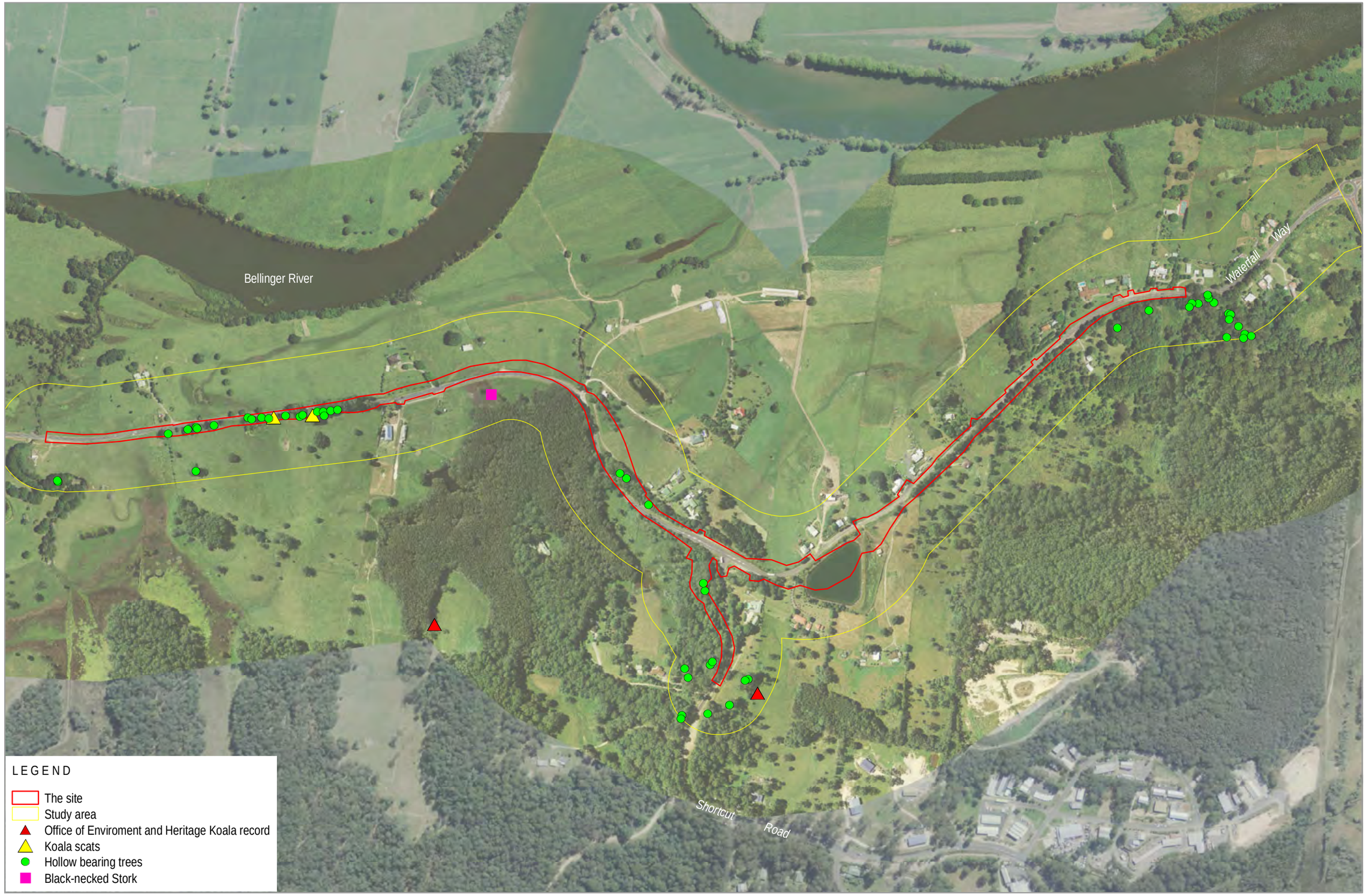
- Eastern Freetail-bat (*Mormopterus norfolkensis*): the study area provides potential foraging habitat for the Eastern Freetail-bat. Potential roosting opportunities are provided by tree hollows (possibly also for breeding) as well as artificial structures (e.g. roof cavities). The study area forms a fraction of potential habitat available within the locality for this species.
- Eastern Long-eared Bat (*Nyctophilus bifax*): the forested portions of the study area provides potential foraging habitat for the Eastern Freetail-bat. Potential roosting opportunities are provided by tree hollows (possibly for breeding roosting) as well as areas of dense vegetation and decorticating park (e.g. swamp sclerophyll forest). This species preference for rainforest, wet sclerophyll forest and swamp sclerophyll forest types suggest the site provides marginal potential habitat.
- Squirrel Glider (*Petaurus norfolcensis*): the sclerophyll forests in the central and eastern portions of the study area, and paddock trees within an achievable glide distance (up to approximately 50 m depending on tree height) provide potential foraging habitat for the Squirrel Glider. Hollow-bearing trees in these areas may also provide potential den sites. The study area may support at least part of the range of a number of social groups of a population centred in the more extensive forest areas to the south. The moist sclerophyll forest in the far western portion of the study area offers limited potential in terms of being able to support the Squirrel Glider as this vegetation appears to have regrown following historic clearing and is not interconnected to any tracts of forest to allow for potential re-colonisation of this vegetation.
- Brush-tailed Phascogale (*Phascogale tapoatafa*): the sclerophyll forests in the central and eastern portions of the study area provide potential foraging and denning habitat for the Brush-tailed Phascogale. These habitats essentially form the northern fringes of a large area of potential interconnected habitat which extends to the south / south-west. The site only has potential to support a fraction of the local populations range.
- Greater Broad-nosed Bat (*Scoteanax rueppellii*): generally as for Eastern Freetail-bat.
- Common Blossom-bat (*Syconycteris australis*): the swamp sclerophyll forest within the study area provides potential seasonal foraging habitat. No significant potential roosting habitat is present. The site does not support any significant potential habitat for the Common Blossom-bat.
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*): generally as for Eastern Freetail-bat.
- Wallum Froglet (*Crinia tinnula*): the swamp sclerophyll forest within the study area provides potential breeding habitat for the Wallum Froglet, with adjacent sclerophyll forest providing potential non-breeding foraging habitat. No significant potential habitat occurs on the site.

Plate 3.13 Black-necked Stork


Plate 3.14 Koala Scats

*Information shown is for illustrative purposes only*

*Drawn by: DSA Checked by: RE Reviewed by: VJS Date: Mayr 2011*
*Source of base data: Roads and Maritime Services and Office of Enviroment and Heritage Koala*

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## Threatened Fauna Recordings and Hollows - bearing Trees

Illustration 3.4

### 3.5.2 *Habitat Assessment*

The study area was assessed to determine its value for native fauna species. The assessment focused on identifying habitat features known to be associated with listed threatened and migratory species. These features are components of the environment that, if present, would support fauna communities or indicate that fauna may be present. The habitat assessment was used to help determine the occurrence potential of threatened fauna species in Appendix E.

Table 3.3 Habitat Features

| *Habitat Feature* | *Indicator* | *Score* | *Comment* |
|---|---|---|---|
| Claw Marks on Trees | Claw marks on trees indicate the presence of arboreal mammals such as Possums, Gliders and Koalas and reptiles such as the Lace Monitor | 2 | Evidence of arboreal fauna activity within the moist sclerophyll forest communities was indicated by claw marks on Small-fruited Grey Gums and tracks up rough barked species (refer to Plate 3.15). These were typically on larger trees (>0.35 m DBH). Discernable scratches detected were of Lace Monitors (*Varanus varius*) and Common Brushtail Possums (*Trichosurus vulpecular*). |
| Scats | A range of animal faeces may be recorded indicating the presence of certain animals | 1 | Detected scats were of the Common Brushtail Possum, macropods and Koala (refer to Section 3.5.1). |
| *Allocasuarina* spp. | *Allocasuarina* spp. provide key foraging sources for the Glossy Black-Cockatoo | 2 | Forest Oak was an occasional to common mid-stratum species within the moist sclerophyll forest communities in the central and eastern portions of the study area. Hence the study area provides potential foraging habitat for the threatened Glossy Black-Cockatoo (*Calyptorhynchus lathami*). No chewed cones suggestive of Glossy Black Cockatoo foraging was detected.<br><br>Elsewhere the occurrence of *Allocasuarina* spp. was negligible. |
| Tracks | A range of animal tracks in the soil may be recorded indicating the presence of certain animals | 1 | None domestic tracks were uncommon and comprised the occasional macropod track, as well as tracks of waterfowl around dams and the freshwater wetlands. |
| Tree Hollows and Stags | Tree hollows and stags provide shelter and roosting areas for a variety of birds, reptiles and arboreal | 1 | Searches for hollow-bearing trees were undertaken throughout the study area excluding the swamp sclerophyll forest which is outside the Proposal footprint and reported to support no significant tree hollows (EcoLogical 2009). Fifty-two hollow-bearing trees were detected, located primarily within the moist sclerophyll forest in the western and eastern portions of the study area, with a few also in proximity to Shortcut Road (refer to Illustration 3.4). Most trees supported only small hollows (openings <100 mm |

| *Habitat Feature* | *Indicator* | *Score* | *Comment* |
|---|---|---|---|
| | mammals | | diameter) that did not appear particularly deep. Medium (openings 100 to 200 mm diameter) and large (openings +200 mm diameter) hollows occurred at low densities (refer to Plate 3.16). |
| Rocky Outcrops | Rocky outcrops are preferred by certain fauna | 0 | No rocky outcrops or similar rock features occur within the study area. |
| Animal Diggings | A range of animal diggings in the soil may be recorded indicating the presence of certain animals | 1 | Bandicoot diggings were encountered at low densities within the forested vegetation within the study area. It was not possible to discern which Bandicoot species was the culprit (i.e. Long-nosed Bandicoot *Perameles nasuta* or Northern Brown Bandicoot *Isoodon macrourus*), though the Long-nosed Bandicoot was recorded during the ERM 2003 survey. |
| Burrows | Fauna can be identified by the types of burrows present | 0 | No burrows were encountered during the survey. |
| Leaf Litter | Large amounts of leaf litter often indicates ample invertebrate activity and shelter for small animals | 1 | Good leaf litter accumulations were present within the larger stands of moist sclerophyll forest and swamp sclerophyll forest in the central and eastern portions of the study area. |
| Aquatic Habitat | Fauna are often attracted to water bodies to drink, spawn or forage | 2 | The main aquatic habitats within the study area included:<br>• Freshwater wetlands: Vary in depth, size and aquatic vegetation cover (refer to Plate 3.17). Collectively provide opportunistic habitat for a range of waterfowl including foraging habitat for the Black-necked Stork. Also provides habitat for common frogs, and some structurally suitable habitat for the threatened Green and Golden Bell-frog provided by the wetlands with permanent water. Areas with open surface water also provide potential Large-footed Myotis foraging habitat.<br>• Farm dams: Vary in depth, size and aquatic vegetation cover (refer to Plate 3.18). Habitat values generally as for freshwater wetland.<br>• Swamp sclerophyll forest: Pools of semi-permanent surface water occur throughout. Provides habitat for a range of frogs, including the threatened Wallum Froglet. Interface with the freshwater wetlands may also provide roosting habitat for waterfowl.<br>• Connells Creek and the unnamed creek from Cameron's Corner north to the Bellinger River: support areas with open surface water along the main creek channel. Generally provide low quality habitat for common frogs and waterfowl, and may be subject to |

| *Habitat Feature* | *Indicator* | *Score* | *Comment* |
|---|---|---|---|
| | | | opportunistic foraging by the Black-necked Stork. Areas with open surface water may also provide potential Large-footed Myotis foraging habitat.<br>• Raleigh dam: Large size however supports a synthetic liner and lacks any aquatic vegetation (refer to **Plate 3.19**). Overall of no significant habitat value.<br><br>Other drainage lines are very minor as aquatic habitat. |
| Fallen Timber and Hollow Logs | Fallen timber and hollow logs often provide shelter for a variety of fauna, as well as provide prey (including invertebrate prey) habitat | 1 | The occurrence of well rotted or hollow fallen timbers within the study area was low, and restricted to swamp and moist sclerophyll forests. |
| Extent of Well Developed Vegetation Structure | An area with a large extent of well developed vegetation structure will encourage fauna | 1 | The habitats within the study area form a mosaic with pastoral and rural-residential land along the edge of the Bellinger River floodplain. While the central and eastern forest areas are interconnected with larger stands of forest habitats to the south, the study area has been subject to obvious historic disturbances and edge effects. |
| Sap Sources | Specific Angophoras, Eucalypt and Corymbia species may provide potential sap sources for *Petaurus* spp. (Van Dyck and Strahan 2008) | 1 | The main species which provide potential sap sources for *Petaurus* spp. is Pink Bloodwood. No discernible *Petaurus* spp. sap incisions were detected. |
| Diversity of Flora Species | A broad flora species diversity provides a large range of food sources and habitat available for fauna | 2 | The study area supports a medium to high diversity of species, which is attributed to the varying habitat types and historic / ongoing disturbance regime. The diversity of canopy nectar and pollen food sources provides almost a year round reliable food source, though limited numbers of some species may reduce seasonal reliability.<br><br>The study area supports a range of predominantly pioneer fruit sources from rainforest species and weeds (e.g. Camphor Laurel). While this allows for foraging by common fructivorous species, these resources are unlikely to be significant enough to attract the threatened fruit doves for regular foraging (at best only rare opportunistic usage). |
| Understorey, | Dense | 2 | The forested areas of the study area typically support a mi- |

| *Habitat Feature* | *Indicator* | *Score* | *Comment* |
|---|---|---|---|
| Shrub Layer and Ground Cover | understorey or ground cover such as thick grass provides shelter for a range of fauna | | dense to dense understorey, which provides shelter for a range of passerine birds (refer to Plate 3.20). Areas with significant dense groundcovers for were localised, and unlikely to support threatened fauna dependant on this habitat component (e.g. Common Planigale) due to historic disturbances and fragmentation across the study area. |
| Connectivity and Corridors | Areas that are connected to other areas of vegetation provide a corridor for movement and can accommodate large numbers of fauna | 2 | The study area is located along the southern edge of the Bellinger River floodplain. It comprises a mosaic of different habitat areas amongst pastoral and rural-residential land. The aquatic floodplain habitats form part of a larger area of similar mostly cleared floodplain east and west along the Bellinger River. This is likely mainly to support highly mobile or habitat generalist species capable of inhabiting a pastoral environment.<br><br>The larger forest stands in the central and eastern portions of the study area are on the northern edge of a larger rolling hills landscape. They are interconnected with an extensive area of forest between the Bellinger and Kalang Rivers, which includes Tarakeeth State Forest. |
| Koala Browse Species | Koalas are known to have a preference for specific food trees | 2 | Swamp Mahogany (confined to the swamp sclerophyll forest) and Tallowwood (scattered throughout the moist sclerophyll forest) are primary Koala browse species within the study area. Small-fruited Grey-Gum is also locally considered a secondary browse species. The occurrence of these species and local records, indicate the study area provides potential habitat for this species. While no Koalas were directly recorded during this or previous systematic field surveys within the study area, evidence of a low level of usage was detected through the presence of Koala scats in the western moist sclerophyll forest (refer to Section 3.5.1). |
| Raptor Roost and/or Nest Trees | Most raptors are very selective in choosing both the type of tree and the location used for roosting or building of nests (e.g. Ospreys typically utilise large dead trees near coastal waterways) | 1 | The site supports a number large (>1 m DBH) eucalypt species with semi-emergent or habitat interface characteristics (e.g. between forest / pastoral land) which provide potential nesting habitat or vantage points for raptors. No raptor nests were detected.<br><br>Denser vegetated areas along minor drainage lines within the moist sclerophyll forest were structurally suitable for roosting by species such as the Powerful Owl. |
| Artificial Structures | Various artificial structures are known to support important habitat | 1 | The main artificial structures of interest within the study area comprise Connells Creek Bridge and road culverts. These structures may provide potential microbat roost sites, although no roosting microbats were detected during the survey. The potential for Connells Creek Bridge to support roosting by breeding threatened microbats may be reduced by the high exposure and limited number cavities within the |

| *Habitat Feature* | *Indicator* | *Score* | *Comment* |
|---|---|---|---|
| | features for some threatened species (e.g. Osprey nests on bridges) | | bridge. While dwellings and sheds may provide habitat for a number of animals (e.g. microbats, pythons and possums) none occur within the site, hence these feature remain unaffected by the Proposal. |

*0* *Nil*
*1* *Low Occurrence*
*2* *Medium Occurrence*
*3* *High Occurrence*

Plate 3.15 Scratches

Plate 3.16 Hollow-bearing Flooded Gum

Plate 3.17 Freshwater wetland

Plate 3.18 Farm Dam

Plate 3.19 Raleigh Dam

Plate 3.20 Area of dense undergrowth in the sclerophyll forest

### 3.5.3 *EPBC Act Migratory Species*

Four EPBC Act listed migratory species have been recorded within the study area:

- Great Egret (*Ardea alba*).
- Cattle Egret (*Ardea ibis*).
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*).
- White-throated Needletail (*Hirundapus caudacutus*).

Of the other migratory species identified on the EPBC Act Protected Matters Search Tool database results (refer to Appendix B), the study area provides potential habitat for the following additional species:

- Fork-tailed Swift (*Apus pacificus*).
- Rainbow Bee-eater (*Merops ornatus*).
- Black-faced Monarch (*Monarcha melanopsis*).
- Spectacled Monarch (*Monarcha trivirgatus*).
- Satin Flycatcher (*Myiagra cyanoleuca*).
- Rufous Fantail (*Rhipidura rufifrons*).
- Regent Honeyeater (*Xanthomyza Phrygia*).
- Latham's Snipe (*Gallinago hardwickii*).
- Little Curlew (*Numenius minutes*).

## 3.6 FM Act Listed Species and Habitats

No habitat for threatened species, populations or EECs, or protected fauna species listed under the FM Act occurs within the study area. As mentioned previously, Mangroves are protected under the FM Act, and occur along Connell's Creek, north of Waterfall Way.

# 4 Conclusion

The study area comprised of a rural / rural-residential landscape on the southern edge of the Bellinger River floodplain. It supports a mosaic of forest and wetland habitat amongst the cleared/development land. While the entire study area shows signs of historic disturbances, it still retains known and potential habitat values for a range of threatened species and communities, and migratory species. The impacts of the Waterfall Way upgrade on these legislative listed species and communities would need to be assessed in the Ecological Assessment (Part B).

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# Appendix A

## Survey Weather Conditions

# Survey Weather Conditions

Table A.1 Meteorological Data for Coffs Harbour During Survey

| *Date* | *Min temp (°C)* | *Max temp (°C)* | *Rainfall (mm)* | *Direction of maximum wind gust* | *Speed of maximum wind gust (km/h)* | *9am Temperature (°C)* | *3pm Temperature (°C)* |
|---|---|---|---|---|---|---|---|
| 5/07/2011 | 11.0 | 20.6 | 0 | WNW | 41 | 17.3 | 20.3 |
| 6/07/2011 | 3.3 | 17.0 | 0 | WNW | 33 | 14.1 | 16.5 |
| 28/08/2011 | 12.2 | 20.9 | 25.0 | SSW | 35 | 17.3 | 20.0 |
| 7/11/2011 | 19.5 | 27.5 | 0 | NE | 44 | 23.3 | 24.6 |
| 8/11/2011 | 17.7 | 27.1 | 0 | NE | 56 | 24.5 | 25.5 |
| 9/11/2011 | 18.9 | 28.8 | 0 | NNE | 46 | 24.4 | 26.0 |
| 10/11/2011 | 18.3 | 31.5 | 0 | NE | 33 | 28.7 | 25.6 |
| 11/11/2011 | 18.7 | 23.7 | 0 | SSW | 41 | 22.0 | 22.0 |
| 12/11/2011 | 18.4 | 24.7 | 0 | N | 43 | 21.3 | 21.7 |

Source: Bureau of Meteorology website: http://www.bom.gov.au/climate/dwo/IDCJDW2030.latest.shtml (accessed 14/11/2011)

# Appendix B

## EPBC Act Protected Matter Search Tool, OEH BioNet and DPI Records Viewer Database Results

Table B1 BioNet Threatened Species Database Search Results (8/05/2012)

| Kingdom | Class | Scientific Name | Common Name | Legal Status | Records |
|---|---|---|---|---|---|
| Fauna | Amphibia | *^Mixophyes iteratus* | Giant Barred Frog | E1 | 17 |
| Fauna | Amphibia | *Crinia tinnula* | Wallum Froglet | V | 24 |
| Fauna | Amphibia | *Litoria aurea* | Green and Golden Bell Frog | E1 | 1 |
| Fauna | Amphibia | *Litoria brevipalmata* | Green-thighed Frog | V | 2 |
| Fauna | Reptilia | *Caretta caretta* | Loggerhead Turtle | E1 | 1 |
| Fauna | Reptilia | *Chelonia mydas* | Green Turtle | V | 3 |
| Fauna | Reptilia | *Hoplocephalus stephensii* | Stephens' Banded Snake | V | 1 |
| Fauna | Aves | *Oxyura australis* | Blue-billed Duck | V | 1 |
| Fauna | Aves | *Ptilinopus magnificus* | Wompoo Fruit-Dove | V | 49 |
| Fauna | Aves | *Ptilinopus regina* | Rose-crowned Fruit-Dove | V | 31 |
| Fauna | Aves | *Ptilinopus superbus* | Superb Fruit-Dove | V | 1 |
| Fauna | Aves | *Ephippiorhynchus asiaticus* | Black-necked Stork | E1 | 81 |
| Fauna | Aves | *Botaurus poiciloptilus* | Australasian Bittern | E1 | 1 |
| Fauna | Aves | *Ixobrychus flavicollis* | Black Bittern | V | 8 |

| Kingdom | Class | Scientific Name | Common Name | Legal Status | Records |
|---|---|---|---|---|---|
| Fauna | Aves | *^^Lophoictinia isura* | Square-tailed Kite | V | 20 |
| Fauna | Aves | *Hieraaetus morphnoides* | Little Eagle | V | 2 |
| Fauna | Aves | *Pandion cristatus* | Eastern Osprey | V | 56 |
| Fauna | Aves | *Esacus magnirostris* | Beach Stone-curlew | E4A | 5 |
| Fauna | Aves | *Haematopus fuliginosus* | Sooty Oystercatcher | V | 10 |
| Fauna | Aves | *Haematopus longirostris* | Pied Oystercatcher | E1 | 21 |
| Fauna | Aves | *Charadrius leschenaultii* | Greater Sand-plover | V | 1 |
| Fauna | Aves | *Irediparra gallinacea* | Comb-crested Jacana | V | 4 |
| Fauna | Aves | *Calidris ferruginea* | Curlew Sandpiper | E1 | 1 |
| Fauna | Aves | *Sternula albifrons* | Little Tern | E1 | 16 |
| Fauna | Aves | *^Calyptorhynchus lathami* | Glossy Black-Cockatoo | V | 141 |
| Fauna | Aves | *Glossopsitta pusilla* | Little Lorikeet | V | 20 |
| Fauna | Aves | *^^Ninox strenua* | Powerful Owl | V | 23 |
| Fauna | Aves | *^^Tyto novaehollandiae* | Masked Owl | V | 12 |
| Fauna | Aves | *^^Tyto tenebricosa* | Sooty Owl | V | 4 |
| Fauna | Aves | *Tyto longimembris* | Eastern Grass Owl | V | 1 |
| Fauna | Aves | *Anthochaera phrygia* | Regent Honeyeater | E4A | 2 |

| Kingdom | Class | Scientific Name | Common Name | Legal Status | Records |
|---|---|---|---|---|---|
| Fauna | Aves | *Lichenostomus fasciogularis* | Mangrove Honeyeater | V | 1 |
| Fauna | Aves | *Pomatostomus temporalis temporalis* | Grey-crowned Babbler (eastern subspecies) | V | 2 |
| Fauna | Aves | *Daphoenositta chrysoptera* | Varied Sittella | V | 7 |
| Fauna | Aves | *Coracina lineata* | Barred Cuckoo-shrike | V | 11 |
| Fauna | Aves | *Stagonopleura guttata* | Diamond Firetail | V | 1 |
| Fauna | Mammalia | *Dasyurus maculatus* | Spotted-tailed Quoll | V | 26 |
| Fauna | Mammalia | *Phascogale tapoatafa* | Brush-tailed Phascogale | V | 17 |
| Fauna | Mammalia | *Phascolarctos cinereus* | Koala | V | 823 |
| Fauna | Mammalia | *Petaurus australis* | Yellow-bellied Glider | V | 22 |
| Fauna | Mammalia | *Petaurus norfolcensis* | Squirrel Glider | V | 3 |
| Fauna | Mammalia | *Pteropus poliocephalus* | Grey-headed Flying-fox | V | 75 |
| Fauna | Mammalia | *Syconycteris australis* | Common Blossom-bat | V | 2 |
| Fauna | Mammalia | *Mormopterus norfolkensis* | Eastern Freetail-bat | V | 9 |
| Fauna | Mammalia | *Kerivoula papuensis* | Golden-tipped Bat | V | 1 |

| Kingdom | Class | Scientific Name | Common Name | Legal Status | Records |
|---|---|---|---|---|---|
| Fauna | Mammalia | *Miniopterus australis* | Little Bentwing-bat | V | 41 |
| Fauna | Mammalia | *Miniopterus schreibersii oceanensis* | Eastern Bentwing-bat | V | 22 |
| Fauna | Mammalia | *Myotis macropus* | Southern Myotis | V | 5 |
| Fauna | Mammalia | *Nyctophilus bifax* | Eastern Long-eared Bat | V | 2 |
| Fauna | Mammalia | *Scoteanax rueppellii* | Greater Broad-nosed Bat | V | 4 |
| Fauna | Mammalia | *Vespadelus troughtoni* | Eastern Cave Bat | V | 1 |
| Fauna | Mammalia | *Arctocephalus forsteri* | New Zealand Fur-seal | V | 3 |
| Fauna | Mammalia | *Arctocephalus pusillus doriferus* | Australian Fur-seal | V | 2 |
| Fauna | Insecta | *Ocybadistes knightorum* | Black Grass-dart Butterfly | E1 | 130 |
| Fauna | Insecta | *Petalura litorea* | Coastal Petaltail | E1 | 3 |
| Flora | Flora | *Marsdenia longiloba* | Slender Marsdenia | E1 | 32 |
| Flora | Flora | *Parsonsia dorrigoensis* | Milky Silkpod | V | 22 |
| Flora | Flora | *Tylophora woollsii* | Cryptic Forest Twiner | E1 | 2 |
| Flora | Flora | *Chamaesyce psammogeton* | Sand Spurge | E1 | 1 |
| Flora | Flora | *Acacia chrysotricha* | Newry Golden Wattle | E1 | 93 |

| Kingdom | Class | Scientific Name | Common Name | Legal Status | Records |
|---|---|---|---|---|---|
| Flora | Flora | *Tinospora tinosporoides* | Arrow-head Vine | V | 3 |
| Flora | Flora | *Syzygium paniculatum* | Magenta Lilly Pilly | E1 | 1 |
| Flora | Flora | *^Dendrobium melaleucaphilum* | Spider orchid | E1 | 5 |
| Flora | Flora | *^Diuris sp. aff. chrysantha* | Byron Bay Diuris | E1 | 1 |
| Flora | Flora | *^Oberonia titania* | Red-flowered King of the Fairies | V | 1 |
| Flora | Flora | *^Peristeranthus hillii* | Brown Fairy-chain Orchid | V | 4 |
| Flora | Flora | *Alexfloydia repens* | Floyd's Grass | E1 | 17 |
| Flora | Flora | *Hicksbeachia pinnatifolia* | Red Boppel Nut | V | 2 |
| Flora | Flora | *Macadamia integrifolia* | Macadamia Nut | | 1 |
| Flora | Flora | *Acronychia littoralis* | Scented Acronychia | E1 | 16 |
| Flora | Flora | *Niemeyera whitei* | Rusty Plum, Plum Boxwood | V | 95 |

# Appendix C

## Threatened Species Potential Occurrence Assessment

Table C.1 Threatened Flora Potential Occurrence Assessment

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| *Acacia chrysotricha* | Newry Golden Wattle | E | - | Restricted to an area south of Bellingen on the NSW north coast. An understorey species on rainforest edges and in wet or dry eucalypt forest in steep narrow gullies on quartzite soils. | Low – Marginally suitable in broad habitat terms, however restricted to moist gullies on quartzite substrate. | Low |
| *Acronychia littoralis* | Scented Acronychia | E | E | Littoral rainforest on sand. | Low | Unlikely |
| *Alexfloydia repens* | Floyd's Grass | E | - | Understorey of *Casuarina glauca* forest and along the uppermost fringe of mangroves. | Marginal within Mangrove forest | Low – potential habitat within the study area is highly degraded. Not recorded during survey. |
| *Allocasuarina defungens* | Dwarf Heath Casuarina | E | E | Tall heath on sand, also on clay and sandstone. | Low | Unlikely |
| *Arthraxon hispidus* | Hairy-joint grass | V | V | Moist shady places in or on the edges of rainforest and wet eucalypt forest, often near creeks or swamps. | Moderate in broad habitat terms | Low not recorded during survey or within locality. |
| *Chamaesyce psammogeton* | Sand Spurge | E | - | Coastal sand dunes and exposed sites on headlands. | Low | Unlikely |
| *Cynanchum elegans* | White-flowered Wax Plant | E | E | Dry, littoral or subtropical rainforest, and occasionally in scrub or woodland. | Low | Low |
| *Dendrobium melaleucaphilum* | Spider Orchid | E | - | Grows frequently on *Melaleuca styphelioides*, less commonly on rainforest trees or on rocks in coastal districts. | Low | Low |
| *Diuris* sp. *aff. chrysantha* | Byron Bay Diuris | E | - | Only known at a single location in Byron Bay, 20 plants recorded. | Low | Unlikely |
| *Hicksbeachia pinnatifolia* | Red Boppel Nut | V | V | Subtropical rainforest, moist eucalypt forest and Brush Box forest. | Low | Unlikely |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| *Macadamia integrifolia* | Macadamia Nut | - | V | Remnant rainforest. | Low | Unlikely |
| *Marsdenia longiloba* | Clear Milkvine | E | V | Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops. | Moderate | Possible |
| *Niemeyera whitei* | Rusty Plum | V | - | Rainforest and the adjacent understorey of moist eucalypt forest. | Moderate | Possible however targeted surveys failed to detect this conspicuous species |
| *Oberonia titania* | Red-flowered King of the Fairies | V | - | Occurs in littoral and subtropical rainforest and paperbark swamps, but it can also occur in eucalypt-forested gorges and in mangroves. | Moderate | Possible |
| *Parsonsia dorrigoensis* | Milky Silkpod | V | E | Subtropical and warm temperate rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils | Moderate | Possible |
| *Peristeranthus hillii* | Brown Fairy-chain Orchid | V | - | Restricted to coastal and near-coastal environments, particularly Littoral Rainforest and Lowland Rainforest on Floodplain. The species is an epiphyte, growing in clumps on tree trunks and thick vines. | Low | Low |
| *Syzygium paniculatum* | Magenta Lilly Pilly | E | V | Occurs in lowland and littoral rainforest. | Low | Unlikely |
| *Taeniophyllum muelleri* | Minute Orchid | - | V | Grows on outer branches and branchlets of rainforest trees; coast and coastal ranges. | Moderate | Possible |
| *Thesium austral* | Austral Toadflax | V | V | Grassland or grassy eucalypt woodland where *Themeda australis* is predominant, on grassy headlands. | Low | Unlikely |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| *Tinospora tinosporoides* | Arrow-head Vine | V | V | Wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils. | Low | Unlikely |
| *Tylophora woollsii* | Cryptic Forest Twiner | E | E | Moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins. | Moderate | Possible |
| *Zieria prostrata* | Headland Zieria | E | E | Low grassy heath on exposed sites and wind-pruned open to sparse shrubland in more sheltered aspects. | Low | Unlikely |

Table C.2 Threatened Fauna Potential Occurrence Assessment

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| *Aves* | | | | | | |
| *Anthochaera phrygia* | Regent Honeyeater | E | E | Dry open forest and woodland with an abundance of nectar-producing eucalypts, particularly box-ironbark woodland, swamp mahogany forests, and riverine sheoak woodlands. | Moderate | Possible as rare non-breeding forager. |
| *Botaurus poiciloptilus* | Australasian Bittern | V | - | Permanent freshwater wetlands with tall dense vegetation, particularly bullrushes and spikerushes. | Moderate | Possible |
| *Calidris ferruginea* | Curlew Sandpiper | Preliminary Endangered. | - | Occupies littoral and estuarine habitats, mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland. | Moderate as secondary non-breeding foraging habitat | Possible |
| *Calyptorhynchus lathami* | Glossy Black-Cockatoo | V | - | Sheoaks in coastal forests and woodlands, timbered watercourses, and moist and dry eucalypt forests of the coast and the Great Divide up to 1,000 m. | Moderate | Possible |
| *Charadrius leschenaultii* | Greater Sand Plover | V | - | Wide sandy beaches, mangroves, saltmarsh, mudflats and exposed reefs. | Low | Low |
| *Coracina lineata* | Barred Cuckoo-shrike | V | - | Rainforest, eucalypt woodlands, swamp woodlands and timber along watercourses. | Moderate | Possible |
| *Daphoenositta chrysoptera* | Varied Sittella | V | - | Inhabits eucalypt forests and woodlands, especially rough- | Moderate | Possible |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| | | | | barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. | | |
| *Ephippiorhynchus asiaticus* | Black-necked Stork | E | - | Warm temperate terrestrial wetlands, mangroves, mudflats, dry floodplains. | High | Recorded |
| *Esacus neglectus* | Beach Stone-curlew | CE | - | Tidal flats at the mouth of estuaries or on open beaches. | Low | Unlikely |
| *Glossopsitta pusilla* | Little Lorikeet | V | - | Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. | Moderate | Possible |
| *Haematopus fuliginosus* | Sooty Oystercatcher | V | - | Intertidal rocky and coral reefs, mostly ocean shores. | Low | Unlikely |
| *Haematopus longirostris* | Pied Oystercatcher | V | - | Open beaches, intertidal flats, sandbanks and occasionally rocky headlands. | Low | Unlikely |
| *Hieraaetus morphnoides* | Little Eagle | V | - | Open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. | Moderate | Possible |
| *Irediparra gallinacea* | Comb-crested Jacana | V | - | Among vegetation floating on slow-moving rivers and permanent lagoons, swamps, lakes and dams. | Low | Unlikely |
| *Ixobrychus flavicollis* | Black Bittern | V | - | Dense vegetation fringing and in streams, swamps, tidal creeks and mudflats, particularly amongst swamp | Moderate | Possible |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| | | | | sheoaks and mangroves. | | |
| *Lathamus discolor* | Swift Parrot | E | E | Forests, woodlands, plantations, and banksias. | Moderate | Possible |
| *Lichenostomus fasciogularis* | Mangrove Honeyeater | V | - | Mangrove forest, also near coastal forests and woodlands including casuarina and paperbark swamps. | Low to moderate | Possible |
| *Lophoictinia isura* | Square-tailed Kite | V | - | Dry woodland and open forest, particularly along major rivers and belts of trees in urban or semi-urban areas. Home range can extend over at least 100 $km^2$. | Moderate | Possible |
| *Ninox strenua* | Powerful Owl | V | - | Woodland and open forest to tall moist forest and rainforest, common along drainage lines. | Moderate | Possible |
| *Oxyura australis* | Blue-billed Duck | V | - | Aquatic (large, deep, open fresh-water dams and lakes), sewage ponds, large rivers and saline bodies seldom on land. | Low | Low |
| *Pandion cristatus (*formerly *Pandion haliaetus)* | Eastern Osprey | V | - | Forage for fish in fresh, brackish or saline waters of rivers, lakes, estuaries with suitable nesting sites nearby. | Moderate | Possible |
| *Pomatostomus temporalis temporalis* | Grey-crowned Babbler | V | - | Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. | Low | Low |
| *Ptilinopus magnificus* | Wompoo Fruit-dove | V | - | Rainforests, low-elevation moist eucalypt forest, and Brush Box forests. | Low | Low – possibly only as rare foraging visitor. |
| *Ptilinopus regina* | Rose-crowned Fruit-dove | V | - | Subtropical and dry rainforest, moist eucalypt forest and swamp forest. | Low | Low – possibly only as rare foraging visitor. |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| *Ptilinopus superbus* | Superb Fruit-dove | V | - | Subtropical and dry rainforest, moist eucalypt forest and swamp forest. | Low | Low – possibly only as rare foraging visitor. |
| *Rostratula benghalensis australis* | Australian Painted Snipe | E | V | Well-vegetated shallows and margins of wetlands, dams, sewage ponds, wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub, and open timber. | Low | Low |
| *Stagonopleura guttata* | Diamond Firetail | V | - | Found in grassy eucalypt woodlands, in open forest, mallee, Natural Temperate Grassland, and Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. | Low | Unlikely |
| *Sterna albifrons* | Little Tern | E | - | Coastal waters, bays, shallow inlets, salt or brackish lakes. | Low | Unlikely |
| *Tyto capensis* | Eastern Grass Owl | V | - | Areas of tall grass, including tussocks in swampy areas, grassy plains, swampy heath, cane grass, sedges on flood plains. | Low | Low |
| *Tyto novaehollandiae* | Masked Owl | V | - | Dry eucalypt forest and woodlands. | Moderate | Possible |
| *Tyto tenebricosa* | Sooty Owl | V | - | Dry, subtropical and warm temperate rainforests and wet eucalypt forests. Nest in large tree hollows. | Low to moderate | (Marginally) Possible |
| *Mammalia* | | | | | | |
| *Chalinolobus dwyeri* | Large-eared Pied Bat | V | V | Near cave entrances and crevices in cliffs. | Low | Low |
| *Dasyurus maculatus maculatus* | Spotted-tailed Quoll | V | E | Dry and moist eucalypt forests and rainforests, fallen hollow logs, large rocky outcrops. | Moderate | Possible |
| *Kerivoula papuensis* | Golden-tipped | V | - | Rainforest and | Low | Unlikely |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| | Bat | | | adjacent sclerophyll forest. Roost in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests. | | |
| *Mormopterus norfolkensis* | Eastern Freetail-bat | V | - | Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts in tree hollows. | Moderate | Possible |
| *Miniopterus australis* | Little Bentwing-bat | V | - | Moist eucalypt forest, rainforest and dense coastal scrub. | Moderate | Possible |
| *Miniopterus schreibersii oceanensis* | Eastern Bentwing-bat | V | - | Forest or woodland, roost in caves, old mines and stormwater channels. | Moderate | Possible |
| *Myotis macropus* | Large-footed Myotis | V | - | Bodies of water, rainforest streams, large lakes, reservoirs. | Moderate | Possible |
| *Nyctophilus bifax* | Eastern Long-eared Bat | V | - | Lowland subtropical rainforest and wet and swamp eucalypt forest, extending to adjacent moist eucalypt forest. | Moderate | Possible |
| *Petaurus australis* | Yellow-bellied Glider | V | - | Tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Dens in tree hollows of large trees, often in family groups. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. | Low | Low |
| *Petaurus norfolcensis* | Squirrel Glider | V | - | Blackbutt, bloodwood and ironbark eucalypt forest with heath | Moderate | Possible |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| | | | | understorey in coastal areas, and box-ironbark woodlands and River Red Gum forest inland. | | |
| *Phascogale tapoatafa* | Brush-tailed Phascogale | V | - | Drier forests and woodlands with hollow-bearing trees and sparse ground cover. | Moderate | Possible |
| *Phascolarctos cinereus* | Koala | V | V | Appropriate food trees in forests and woodlands, and treed urban areas. | High | Recorded |
| *Potorous tridactylus tridactylus* | Long-nosed Potoroo | V | V | Cool temperate rainforest, moist and dry forests, and wet heathland, inhabiting dense layers of grass, ferns, vines and shrubs. | Low | Unlikely |
| *Pseudomys novaehollandiae* | New Holland Mouse | - | V | Occurs in open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. | Low | Unlikely |
| *Pteropus poliocephalus* | Grey-headed Flying-fox | V | V | Subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. | High | Known |
| *Saccolaimus flaviventris* | Yellow-bellied Sheathtail-bat | V | - | Forages in a variety of habitats, roosts in tree hollows and buildings. | Moderate | Possible |
| *Scoteanax rueppellii* | Greater Broad-nosed Bat | V | | woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. | Moderate | Possible |
| *Syconycteris australis* | Common Blossom-bat | V | - | Littoral rainforest and feed on flowers in adjacent heathland and paperbark swamps. | Moderate | Possible |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| *Vespadelus troughtoni* | Eastern Cave Bat | V | - | Cave roosting species found in dry open forest and woodland near cliffs and rocky overhangs. | Low | Low |
| *Amphibia* | | | | | | |
| *Crinia tinnula* | Wallum Froglet | V | - | Acid paperbark and sedge swamps known as 'wallum', this is a banksia-dominated lowland heath ecosystem characterised by acidic waterbodies. | Moderate | Possible |
| *Litoria aurea* | Green and Golden Bell Frog | E | V | Amongst vegetation in and around permanent swamps, lagoons, farm dams and on flood-prone river flats, particularly where there are bullrushes or spikerushes. | Low | Low |
| *Litoria booroolongensis* | Booroolong Frog | E | E | Permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. | Low | Unlikely |
| *Litoria brevipalmata* | Green-thighed Frog | V | - | Rainforest, moist to dry eucalypt forest and heath, typically where surface water gathers after rain. | Low – moderate typically associated with large intact stands of habitat | Low |
| *Mixophyes balbus* | Stuttering Frog | V | V | Cool rainforest, moist eucalypt forest and occasionally along creeks in dry eucalypt forest. | Low | Unlikely |
| *Mixophyes iteratus* | Southern Barred Frog | E | E | Deep, damp leaf litter in rainforests, moist eucalypt forest and near dry eucalypt forest. | Low | Low |
| *Reptilia* | | | | | | |
| *Emydura macquarii signata* | Bellinger River Emydura | - | V | Long, deep pools in broad reaches of the upper Bellinger River. | Low | Unlikely |
| *Hoplocephalus* | Stephens' | V | - | Rainforest and | Low | Low |

| *Scientific Name* | *Common Name* | *Status* | | *Habitat Requirement* *Source: OEH undated* | *Suitability of Study Area Habitat* | *Potential Occurrence* |
|---|---|---|---|---|---|---|
| | | *TSC Act* | *EPBC Act* | | | |
| *stephensii* | Banded Snake | | | eucalypt forests and rocky areas up to 950 m. | | |
| *Insecta* | | | | | | |
| *Ocybadistes knightorum* | Black Grass-dart Butterfly | E | - | Confined to coastal stands of Swamp Oak and Paperbark where Floyd's Grass grows edging the upper tidal areas of mangroves. | Low | Unlikely |
| *Petalura litorea* | Giant Dragonfly | E | - | Permanent wetlands, swamps and bogs with some free water and open vegetation. | Low | Low |

# Appendix D

## Flora Species List

Table D.1 Flora Species List

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adiantaceae | *Adiantum hispidulum* | Rough Maidenhair | | | | | | | | | | | | | |
| Altingiaceae | *Liquidambar sp.** | Liquid Amber | | | | | | | | | | | | | |
| Amaryllidaceae | *Crinum pedunculatum* | Swamp Lily | | | | | | | | | | | | | |
| Anacardiaceae | *Mangifera sp.** | Mango | | | | | | | | | | | | | |
| Aneilema | *Pollia crispata* | - | | | | | | | | | | | | | |
| Apiaceae | *Centella asiatica* | Pennywort | 2 | 1 | 2 | | 3 | | 3 | 1 | | | | 2 | |
| Apiaceae | *Daucus carota** | Wild Carrot | | | | | | | | 2 | 1 | | | | |
| Apiaceae | *Daucus glochidiatus* | Native Carrot | | | | | | | | | | | | | |
| Apiaceae | *Hydrocotyle bonariensis** | A Pennywort | | | | | | | | | | | | | |
| Apocynaceae | *Araujia sericifera** | Moth Vine | | | | | | | | | | | | | |
| Apocynaceae | *Gomphocarpus fruticosus** | Narrow-leaved Cotton Bush | | | | | | | | | | | | | |
| Apocynaceae | *Gomphocarpus physocarpus** | Balloon Cotton Bush | | | | | | | | | 1 | | | | |
| Apocynaceae | *Marsdenia lloydii* | Corky Marsdenia | | | | | | | | | | | | | |
| Apocynaceae | *Marsdenia rostrata* | Common Milk Vine | | | | | | | | | | | | 1 | |
| Apocynaceae | *Parsonsia straminea* | Common Silkpod | | | | 2 | 2 | | 2 | | | | | | 1 |
| Apocynaceae | *Tabernaemontana pandacaqui* | Banana Bush | | | 1 | | | | 3 | | | | | 1 | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Araceae | *Gymnostachys anceps* | Settler's Flax | 1 | | | | | | 2 | | | | | | |
| Araliaceae | *Polyscias sambucifolia* | Elderberry Panax | | | | | | | 3 | | | | | | |
| Araucariaceae | *Araucaria heterophylla* | Norfolk Island Pine | | | | | | | | | | | | | |
| Arecaceae | *Archontophoenix cunninghamiana* | Bangalow Palm | | | | | | | | | | | | | 1 |
| Arecaceae | *Syagrus romanzoffiana** | Cocos Palm | | | | | | | | | | | | | |
| Asparagaceae | *Asparagus aethiopicus** | Asparagus Fern | | | | | | | | | | | | | |
| Aspleniaceae | *Asplenium australasicum f. australasicum* | Birds Nest Fern | | | | | | | | | | | | | |
| Asteliaceae | *Cordyline petiolaris* | Broad-leaved Palm Lily | | | | | | | | | | | | | |
| Asteliaceae | *Cordyline stricta* | Narrow-leaved Palm Lily | | | | | | | | | | | | | |
| Asteraceae | *Ageratina adenophora** | Crofton Weed | 1 | 1 | | | | | | | | | | 2 | |
| Asteraceae | *Ageratum houstonianum** | Blue Billygoat Weed | | | | | | | | | | | | | |
| Asteraceae | *Bidens pilosa** | Cobbler's Pegs | | | | | | | | | | | | | |
| Asteraceae | *Conyza parva** | A Fleabane | | | | | | | | | | | | | |
| Asteraceae | *Conyza sp.** | A Fleabane | | | | | | | | | 1 | | | | |
| Asteraceae | *Cotula coronopifolia* | Waterbuttons | | | | | | | | | | | 3 | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Asteraceae | *Gamochaeta americana** | Cudweed | | | | | | | | 2 | | | | | |
| Asteraceae | *Hypochaeris radicata** | Catsear | | | | | | | | | | | | | |
| Asteraceae | *Onopordum acanthium subsp. acanthium** | Scotch Thistle | | | | | | | | 1 | 2 | | | | |
| Asteraceae | *Senecio madagascariensis** | Fireweed | | | | | | | | 1 | | | | | |
| Asteraceae | *Tagetes minuta** | Stinking Roger | | | | | | | | | | | | | |
| Asteraceae | *Taraxacum officinale** | Dandelion | | | | | | | | | 1 | | | | |
| Azollaceae | *Azolla filiculoides var. rubra* | Azolla | | | | | | | | | | | | | |
| Bignoniaceae | *Jacaranda mimosaefolia* | Jacaranda | | | | | | | | | | | | | |
| Blechnaceae | *Blechnum cartilagineum* | Gristle Fern | | | 1 | | | | 3 | | | | | | |
| Blechnaceae | *Blechnum indicum* | Swamp Water Fern | | | | | | | | | | | | | |
| Brassicaceae | *Cardamine hirsuta* | Common Bittercress | | | | | | | | | | | | | |
| Cannaceae | *Canna indica** | Canna Lily | | | | | | | | | | | | | |
| Casuarinaceae | *Allocasuarina torulosa* | Forest Oak | 2 | 3 | 1 | | | | 3 | | | | | | |
| Casuarinaceae | *Casuarina glauca* | Swamp Oak | | | | | | | | | | | | | |
| Commelinaceae | *Commelina cyanea* | Native Wandering Jew | | | | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commelinaceae | *Tradescantia fluminensis** | Wandering Jew | | | | | | | | | | | | | |
| Convolvulaceae | *Ipomoea cairica** | Coast Morning Glory | | | | | | | | | | | | | |
| Cunoniaceae | *Callicoma serratifolia* | Black Wattle | | | | | | | | | | | | | |
| Cunoniaceae | *Ceratopetalum gummiferum* | NSW Christmas Bush | | | | | | | | | | | | | |
| Cyatheaceae | *Cyathea cooperi* | Straw Treefern | | | | | | | | | | | | | 2 |
| Cyperaceae | *Carex appressa* | Tall Sedge | | | | | 2 | | | | | | | | |
| Cyperaceae | *Carex fasciularis* | Tassel Sedge | | | | | | | | | | | | | |
| Cyperaceae | *Cyperus brevifolius** | | | | | | | | | | | | | | |
| Cyperaceae | *Cyperus eragrostis** | Umbrella Sedge | | 1 | | | | | | | 1 | | | | |
| Cyperaceae | *Cyperus lucidus^* | - | | | | | | | | | | | | | |
| Cyperaceae | *Cyperus sp.* | - | | | | | 1 | | | | | | | | |
| Cyperaceae | *Eleocharis equisetina* | A Spikerush | | | | | | | | | | | | | |
| Cyperaceae | *Eleocharis sphacelata* | Tall Spike Rush | | | | | | | | | | | | | |
| Cyperaceae | *Fimbristylis dichotoma* | Common Fringe-sedge | | | | | | | | 1 | 1 | | 5 | | |
| Cyperaceae | *Gahnia aspera* | Rough Saw-sedge | | | | | | | 2 | | | | | 1 | |
| Cyperaceae | *Gahnia clarkei* | Tall Saw-sedge | 4 | | 3 | 4 | 5 | | | | | | | | |
| Cyperaceae | *Schoenoplectus mucronatus* | - | | | | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dennstaedtiaceae | *Histiopteris incisa* | Bat's Wing Fern | | | | | | | | | | | | | |
| Dennstaedtiaceae | *Hypolepis muelleri* | Harsh Ground Fern | | | | | | | | | | | | | |
| Dennstaedtiaceae | *Pteridium esculentum* | Bracken | 4 | 3 | | | | | | | | | | | |
| Dicksoniaceae | *Calochlaena dubia* | Soft Bracken Fern | | | 1 | 2 | 2 | | 4 | | | 2 | | 3 | 2 |
| Dicksoniaceae | *Dicksonia antarctia* | Soft Treefern | | | | | | | | | | | | | |
| Dilleniaceae | *Hibbertia aspera* | Rough Guinea Flower | | | | | | | | | | | | | |
| Dilleniaceae | *Hibbertia obtusifolia* | - | | | | | | | | | | | | | |
| Dilleniaceae | *Hibbertia scandens* | Climbing Guinea Flower | 2 | 1 | 2 | | | | 3 | | | | | | 2 |
| Dioscoreaceae | *Dioscorea transversa* | Native Yam | | | | | | | | | | | | | |
| Elaeocarpaceae | *Elaeocarpus obovatus* | Hard Quandong | | | | | | | | | | | | | |
| Elaeocarpaceae | *Elaeocarpus reticulatus* | Blueberry Ash | | | | | | | | | | | | | |
| Ericaceae | *Trochocarpa laurina* | Tree Heath | | | | | | | | | | | | 2 | |
| Euphorbiaceae | *Breynia oblongifolia* | Coffee Bush | | | | | | | | | | | | | |
| Euphorbiaceae | *Claoxylon australe* | Brittlewood | | | 1 | | | | | | | | | | |
| Euphorbiaceae | *Croton verreauxii* | Green Native Cascarilla | | | | | | | 2 | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Euphorbiaceae | *Glochidion ferdinandi var. ferdinandi* | Cheese Tree | | | 1 | | 1 | | 3 | | | | | | 2 |
| Euphorbiaceae | *Glochidion sumatranum* | Umbrella Cheese Tree | | | | | | | | | | | | | |
| Fabaceae (Caesalpinioideae) | *Senna floribunda** | - | | | | | | | | | | | | | |
| Fabaceae (Caesalpinioideae) | *Senna pendula var. glabrata** | - | | | 1 | | | | 2 | | | | | 2 | 2 |
| Fabaceae (Faboideae) | *Callerya australis* | Blunt Wisteria | | | | | | | | | | 1 | | | |
| Fabaceae (Faboideae) | *Derris involuta* | Native Derris | | | | | | | 1 | | | | | | |
| Fabaceae (Faboideae) | *Desmodium uncinatum** | Silver-leaf Desmodium | | | | | | | | | | | | | |
| Fabaceae (Faboideae) | *Erythrina sykesii** | Coral Tree | | | | | | | | | | | | | |
| Fabaceae (Faboideae) | *Glycine clandestina* | - | | 2 | | | | | | | | | | | |
| Fabaceae (Faboideae) | *Hardenbergia violacea* | False Sarsaparilla | | 1 | | | | | | | | | | | |
| Fabaceae (Faboideae) | *Jacksonia scoparia* | Dogwood | | | | | | | | | | | | | |
| Fabaceae (Faboideae) | *Kennedia rubicunda* | Dusky Coral-pea | | 1 | | | | | | | | | | | |
| Fabaceae (Faboideae) | *Trifolium repens** | White Clover | | | | | | | | | | | | | |
| Fabaceae (Mimosoideae) | *Acacia disparrima var. disparimma* | Brush Ironbark Wattle | | | | | | | | | | | | | |
| Fabaceae (Mimosoideae) | *Acacia fimbriata* | Fringed Wattle | | | | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fabaceae (Mimosoideae) | *Acacia longissima* | Long-leaf Wattle | | | 1 | | | | | | | | | 1 | |
| Fabaceae (Mimosoideae) | *Acacia maidenii* | Maiden's Wattle | | | | | | | | | | | | | |
| Fabaceae (Mimosoideae) | *Acacia melanoxylon* | Blackwood | | | | | | | | | | | | | 2 |
| Fabaceae (Mimosoideae) | *Acacia podalyriifolia* | Queensland Silver Wattle | | | | | | | | | | | | | |
| Fabaceae (Mimosoideae) | *Acacia sp.* | Non-endemic Wattle | | | | | | | | | | | | | |
| Fabaceae / Caesalpiniaceae | *Caesalpinia ferrea* | Leopard Tree | | | | | | | | | | | | | |
| Flagellariaceae | *Flagellaria indica* | Whip Vine | | | | | | | | | | | | | |
| Geraniaceae | *Geranium solanderi* | Cutleaf Cranesbill | | | | | | | | | | | | | |
| Gleicheniaceae | *Gleichenia dicarpa* | Pouched Coral Fern | | | | | | | | | | | | | |
| Haloragaceae | *Gonocarpus micranthus* | - | 1 | 1 | | | | | | | | | | | |
| Haloragaceae | *Gonocarpus sp.* | - | | | | | | | | | | | | | |
| Juncaceae | *Juncus kraussii* | Sea Rush | | | | | | | | | | | 2 | | |
| Juncaceae | *Juncus prismatocarpus* | Branching Rush | | | | | | | | | | | 1 | | |
| Juncaceae | *Juncus usitatus* | - | | | | | | | | | | | | | |
| Juncaginaceae | *Triglochin procerum* | Water Ribbon | | | | | | 6 | | | | | 2 | | |
| Juncaginaceae | *Triglochin striatum* | - | | | | | | 6 | | | | | 3 | | |
| Juncaginaceae | *Triglochin striatum* | Streaked Arrowgrass | | | | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lamiaceae | *Prostanthera inceana* | Cut-leaved Mint-bush | | | 1 | | | | | | | | | 2 | |
| Lauraceae | *Cinnamomum camphora** | Camphor Laurel | | | 1 | | | | 2 | 1 | | 5 | | 1 | 2 |
| Lauraceae | *Cryptocarya microneura ^* | Murrogun | | | | | | | | | | | | | |
| Lemnaceae | *Lemna trisulca*^* | - | | | | | | | | | | | | | |
| Lobeliaceae | *Pratia purpurascens* | Whiteroot | | 3 | | | | | | 1 | 1 | | | 2 | |
| Lomandraceae | *Lomandra hystrix* | - | | | | | | | | | | | | | |
| Lomandraceae | *Lomandra longifolia* | Spiny-headed Mat-rush | 2 | 3 | 2 | | | | | | | | | 1 | |
| Lomandraceae | *Lomandra multiflora* | Many-flowered Mat-rush | | | | | | | 2 | | | | | | |
| Luzuriagaceae | *Eustrephus latifolius* | Wombat Berry | | | | | | | | | | | | | |
| Luzuriagaceae | *Geitonoplesium cymosum* | Scrambling Lily | | | | | | | 3 | | | | | 1 | 2 |
| Lycopodiaceae | *Lycopodium cernua* | Slender Clubmoss | | | | | | | | | | | | | |
| Malvaceae | *Sida rhombifolia** | Paddy's Lucerne | 1 | | | | | | | 1 | | | | | |
| Meliaceae | *Synoum glandulosum subsp. glandulosum* | Scentless Rosewood | | | 2 | | | | | | | | | 2 | 2 |
| Menispermaceae | *Sarcopetalum harveyanum* | Pearl Vine | | | | | | | | | | | | | |
| Menispermaceae | *Stephania japonica var. discolor* | Snake Vine | | | 1 | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 3: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monimiaceae | *Wilkiea huegeliana* | Veiny Wilkiea | | | | | | | | | | | | | |
| Moraceae | *Ficus coronata* | Creek Sandpaper Fig | | | | | 1 | | | | | | | | 1 |
| Moraceae | *Ficus obliqua* | Small-leaved Fig | | | | | | | | | | | | | |
| Moraceae | *Ficus rubiginosa* | Port Jackson Fig | | | | | | | | | | | | | |
| Moraceae | *Ficus sp.* | Small-leaved Fig | | | | | | | | | | | | | |
| Moraceae | *Ficus superb^* | Deciduous Fig | | | | | | | | | | | | | |
| Moraceae | *Ficus watkinsiana* | Strangling Fig | | | | | 1 | | | | | | | | |
| Moraceae | *Maclura cochinchinensis* | Cockspur Thorn | | | | | | | 2 | | | 2 | | | |
| Moraceae | *Trophis scandens subsp. scandens* | Burny Vine | | | | | | | | | | | | | |
| Myrsinaceae | *Aegicerus corniculatum* | River Mangrove | | | | | | | | | | | | | |
| Myrsinaceae | *Myrsine howittiana* | Brush Muttonwood | | | | | | | | | | 3 | | | |
| Myrsinaceae | *Rapanea howittiana* | Brush Muttonwood | | | | | | | | | | 2 | | | |
| Myrtaceae | *Acmena smithii* | Lilly Pilly | | | | | | | | | | | | | |
| Myrtaceae | *Backhousia citriodora* | Lemon Myrtle | | | | | | | | | | | | | |
| Myrtaceae | *Callistemon salignus* | Willow Bottlebrush | | | | 2 | | | | | | | | | 2 |
| Myrtaceae | *Corymbia intermedia* | Pink Bloodwood | | | | | | | 3 | | | | | 3 | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Myrtaceae | *Corymbia maculata* | Spotted Gum | | | | | | | | | | | | | |
| Myrtaceae | *Eucalyptus acmenoides* | White Mahogany | 3 | 3 | | | | | 4 | | | | | | |
| Myrtaceae | *Eucalyptus ancophila#* | Grey Ironbark | | | | | | | 1 | | | | | | |
| Myrtaceae | *Eucalyptus grandis* | Flooded Gum | | | | | | | | | | 3 | | | |
| Myrtaceae | *Eucalyptus microcorys* | Tallowwood | | | | | | | 3 | | | | | | |
| Myrtaceae | *Eucalyptus pilularis* | Blackbutt | 3 | 4 | | | | | | | | | | 3 | |
| Myrtaceae | *Eucalyptus propinqua* | Small-fruited Grey Gum | | | | | | | 3 | | | | | | |
| Myrtaceae | *Eucalyptus robusta* | Swamp Mahogany | | | | 2 | 2 | | | | | | | | |
| Myrtaceae | *Eucalyptus siderophloia* | Northern Grey Ironbark | 1 | 1 | | | | | | | | | | | |
| Myrtaceae | *Eucalyptus torelliana* | Cadaghi | | | | | | | | | | | | | |
| Myrtaceae | *Lophostemon confertus* | Brush Box | | | 1 | | | | | | | | | | |
| Myrtaceae | *Lophostemon suaveolens* | Swamp Turpentine | 2 | | | | | | | | | | | 1 | |
| Myrtaceae | *Melaleuca armillaria* | - | | | | | | | | | | | | | |
| Myrtaceae | *Melaleuca quinquenervia* | Broad-leaved Paperbark | | | | 5 | 5 | 2 | | | | | | | |
| Myrtaceae | *Melaleuca styphelioides* | Prickly-leaved Tea Tree | | | | | | | | | | | | | |
| Myrtaceae | *Rhodamnia rubescens* | Scrub Turpentine | | | 1 | | | | | | | | | 1 | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Myrtaceae | *Rhodomyrtus psidioides* | Native Guava | | | | | | | | | | | | | |
| Myrtaceae | *Syncarpia glomulifera* | Turpentine | | | | | | | | | | | | | |
| Myrtaceae | *Syzygium crebrinerve* | Rose Satinash | | | 1 | | | | | | | 2 | | | |
| Myrtaceae | *Syzygium sp.* | - | 1 | | 1 | | | | | | | | | | |
| Nymphaeaceae | *Nymphaea caerulea* subsp. *Zanzibarensis** | Cape Waterlily | | | | | | | | | | | | | |
| Ochnaceae | *Ochna serrulata** | Mickey Mouse Plant | | | | | | | | | | | | | |
| Oleaceae | *Ligustrum lucidum** | Large-leaved Privet | | | | | | | | | | | | | |
| Oleaceae | *Ligustrum sinense** | Small-leaved Privet | | | 1 | | | | | | | 3 | | | 2 |
| Oleaceae | *Notelaea longifolia* | Large Mock-olive | | | 1 | | | | 3 | | | | | 1 | |
| Onagraceae | *Ludwigia peploides subsp. montevidensis* | Water Primrose | | | | | | 3 | | | | | | | |
| Orchidaceae | *Cymbidium suave* | Snake Orchid | | | | | | | | | | | | | |
| Oxalidaceae | *Oxalis articulata** | Shamrock Oxalis | | | | | | | | | | | | | |
| Oxalidaceae | *Oxalis sp.* | - | | | | | | | | 1 | | | | | |
| Passifloraceae | *Passiflora subpeltata** | White Passionflower | | | | | | | | | | | | | 1 |
| Philydraceae | *Philydrum lanuginosum* | Frogsmouth | | | | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phormiaceae | *Dianella caerulea* | Blue Flax lily | | | 1 | | | | 3 | | | | | 2 | |
| Phyllanthaceae | *Bridelia sp.* | - | | | | | | | | | | | | | |
| Phyllanthaceae | *Phyllanthus sp.** | - | | | | | | | | | | | | | |
| Pinaceae | *Pinus elliottii** | Slash Pine | | | | | | | | | | | | | |
| Pinaceae | *Pinus radiata** | Radiata Pine | | | | | | | | | | | | | 6 |
| Pittosporaceae | *Bursaria spinosa var. spinosa* | Native Blackthorn | | | | | | | 3 | | | | | | |
| Pittosporaceae | *Pittosporum multiflorum* | Orange Thorn | | | 2 | | | | | | | | | | |
| Pittosporaceae | *Pittosporum undulatum* | Sweet Pittosporum | | | 1 | | | | 2 | | | | | | 2 |
| Plantaginaceae | *Plantago lanceolata** | Lamb's Tongues | | | | | | | | | 1 | | | | |
| Platanaceae | *Platanus sp.** | Planetree | | | | | | | | | | | | | |
| Poaceae | *Andropogon virginicus** | Whisky Grass | | 2 | | | | | | 2 | | | | | |
| Poaceae | *Axonopus affinis** | Narrow-leaved Carpet Grass | | | | | | | | 4 | | | | | |
| Poaceae | *Briza minor** | Quaking Grass | | | | | | | | | | | | | |
| Poaceae | *Capillipedium spicigerum* | Scented-top Grass | | | | | | | | | | | | | |
| Poaceae | *Chloris gayana** | Rhodes Grass | | | | | | | | | | | | | |
| Poaceae | *Cynodon dactylon* | Common Couch | | | | | | | | 3 | | | | | |
| Poaceae | *Digitaria parviflora* | Small-flowered Finger Grass | 3 | 3 | | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Poaceae | *Echinopogon ovatus* | Forest Hedgehog Grass | | | | | | | | | | | | | |
| Poaceae | *Entolasia stricta* | Wiry Panic | 3 | 3 | 1 | | | | 4 | | | | | 1 | |
| Poaceae | *Eragrostis pilosa** | Soft Lovegrass | | | | | | | | | | | | | |
| Poaceae | *Imperata cylindrica var. major* | Blady Grass | 4 | 5 | | | | | | | 5 | | | 2 | |
| Poaceae | *Melinis repens** | Red Natal Grass | | | | | | | | | | | | | |
| Poaceae | *Oplismenus imbecillis* | - | 3 | | 3 | | | | 3 | | | 2 | | | |
| Poaceae | *Paspalum distichum* | Water Couch | | | | | | | | | | | 5 | | |
| Poaceae | *Paspalum urvillei** | Vasey Grass | | | | | | | | | | | | | |
| Poaceae | *Paspalum wettsteinii** | Broad-leaved Paspalum | | | 4 | | | | 3 | 2 | | 2 | | 2 | 2 |
| Poaceae | *Pennisetum clandestinum** | Kikuyu Grass | | | | | | | | | | | | | |
| Poaceae | *Phragmites australis* | Common Reed | | | | | | | | | | | | | |
| Poaceae | *Setaria sphacelata** | South African Pigeon Grass | | | | | | | | | | | | | |
| Poaceae | *Sporobolus africanus** | Parramatta Grass | | | | | | | | 4 | 2 | | | | |
| Poaceae | *Sporobolus creber* | Slender Rat's Tail Grass | | | | | | | | | | | | | |
| Poaceae | *Themeda australis* | Kangaroo Grass | | 3 | | | | | | | | | | 2 | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 3: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Podocarpaceae | *Podocarpus elatus* | Plum Pine | | | | | | | | | | | | | |
| Polygonaceae | *Persicaria dichotoma* | A Smartweed | | | | | 1 | | | | | | | | |
| Polygonaceae | *Persicaria lapathifolia* | Pale Knotweed | | | | | | | | | | | | | |
| Polygonaceae | *Persicaria orientalis** | - | | | | | | | | | | | | | |
| Polygonaceae | *Persicaria strigosa* | A Smartweed | | | | | 1 | 2 | | | | | | | |
| Polygonaceae | *Rumex crispus** | Curled Dock | | | | | | | | | | | | | |
| Polypodiaceae | *Platycerium bifurcatum* | Elkhorn | | | 1 | | | | | | | 1 | | | |
| Polypodiaceae | *Pyrrosia confluens* | Robber Fern | | | | | | | | | | | | | |
| Pontederiaceae | *Eichhornia crassipes** | Water Hyacinth | | | | | | | | | | | | | |
| Proteaceae | *Banksia integrifolia* | Coastal Banksia | | | | | | | | | | | | | |
| Proteaceae | *Grevillea robusta* | Silky Oak | | | | | | | | | | | | | |
| Proteaceae | *Hakea salicifolia* | Willow-leaved Hakea | | | | | | | | | | | | | |
| **Proteaceae** | ***Macadamia tetraphylla*** | **Rough-shelled Bush Nut** | | | | | | | | | | | | | |
| Proteaceae | *Persoonia conjuncta* | - | | | | | | | | | | | | 1 | |
| Proteaceae | *Persoonia media^* | - | | | | | | | | | | | | | |
| Ranunculaceae | *Ranunculus inundatus* | River Buttercup | | | | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rhamnaceae | *Alphitonia excelsa* | Red Ash | | | | | 1 | | | | | | | | |
| Ripogonaceae | *Ripogonum brevifilum* | Small-leaved Supplejack | | | | | | | | | | | | | |
| Rosaceae | *Rubus parvifolius* | Native Raspberry | | | | | | | | | | | | | |
| Rosaceae | *Rubus rosifolius* | Native Raspberry | | | | | | | | | | | | | 2 |
| Rubiaceae | *Morinda jasminoides* | Sweet Morinda | | | 3 | 2 | | | | | | 1 | | | 2 |
| Rubiaceae | *Pomax umbellata* | Pomax | 1 | 2 | | | | | | | | | | | |
| Rutaceae | *Acronychia oblongifolia* | Common Acronychia | | | | | | | | | | | | | |
| Rutaceae | *Citrus x limon** | Lemon | | | | | | | | | | | | | |
| Rutaceae | *Murraya paniculata** | Murraya | | | | | | | | | | | | | |
| Rutaceae | *Zieria smithii* | Sandfly Zieria | | | | | | | 2 | | | | | | |
| Sapindaceae | *Cardiospermum halicacabum** | Balloon Vine | | | | | | | | | | | | | |
| Sapindaceae | *Cupaniopsis anacardioides* | Tuckeroo | | | | | | | 3 | | | | | | 2 |
| Sapindaceae | *Dodonaea triquetra* | Large-leaf Hop-bush | | | | | | | | | | | | | |
| Sapindaceae | *Guioa semiglauca* | - | | | 1 | | | | | | | 1 | | | |
| Sapindaceae | *Jagera pseudorhus var. pseudorhus* | Foambark Tree | | | 1 | | 1 | | 4 | | | 2 | | | 2 |
| Smilacaceae | *Smilax glyciphylla* | Sweet Sarsparilla | | 1 | 2 | | | | | | | | | | |
| Solanaceae | *Duboisia myoporoides* | Corkwood | | | | | | | | | | | | | |

| *Family* | *Scientific Name* | *Common Name* | *Quadrat 1: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 2: Blackbutt open forest* | *Quadrat 2: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 4:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 5:* Broad-leaved Melaleuca / Swamp Mahogany swamp forest | *Quadrat 6: Freshwater Wetland* | *Quadrat 7: Tallowwood – Narrow-leaved White Mahogany – Turpentine open forest* | *Quadrat 8: Grassland* | *Quadrat 9: Grassland* | *Quadrat 10: Camphor Laurel Forest* | *Quadrat 11: Freshwater Wetland* | *Quadrat 12: Blackbutt – Turpentine – Tallowwood open forest* | *Quadrat 13: Radiata Pine Forest* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solanaceae | *Solanum mauritianum** | Wild Tobacco Bush | | | | | | | | | | | | | 1 |
| Solanaceae | *Solanum seaforthianum** | Climbing Nightshade | | | | | | | | | | | | | |
| Solanaceae | *Solanum sp.* | - | 1 | | | | | | | | | | | | |
| Sterculiaceae | *Commersonia bartramia* | Brown Kurrajong | | | | | | | | | | | | | |
| Thymelaeaceae | *Pimelea linifolia subsp. linifolia* | Slender Rice-flower | | | | | | | | | | | | | |
| Ulmaceae | *Trema tomentosa var. viridis* | Native Peach | | | | | | | | | | | | | |
| Uvulariaceae | *Tripladenia cunninghamii* | Bush Lily | | | 1 | | | | 2 | | | | | | |
| Verbenaceae | *Lantana camara** | Lantana | | 1 | 3 | 2 | 1 | | 2 | | | | | 3 | 5 |
| Verbenaceae | *Verbena bonariensis** | Purpletop | | | | | | | | | | | | | |
| Violaceae | *Viola hederacea* | Ivy-leaved Violet | | | | | | | | | | | | | |
| Vitaceae | *Cissus antarctica* | Water Vine | | | | | | | | | | | | | |
| Vitaceae | *Cissus hypoglauca* | Giant Water Vine | | | | | | | | | | | | | |
| Vitaceae | *Tetrastigma nitens* | - | | | | | | | | | | | | | |

Key:

**Bold** denotes TSC Act and EPBC Act listed Vulnerable Species

* denotes exotic species

# denotes RoTAP listed species

^ denotes species only recorded during the Ecological (2009) survey

Quadrat Score =Braun-Blanquet (% cover)

| | |
|---|---|
| 1 | <5% uncommon |
| 2 | <5% common |
| 3 | 5-25% |
| 4 | 26-50% |
| 5 | 51-75% |
| 6 | 76-100% |

# Appendix E

## Fauna Species List

Table E.1 Fauna Species List

| *Common Name* | *Scientific Name* | *Recording Type* |
|---|---|---|
| | *Aves* | |
| Yellow Thornbill | *Acanthiza nana* | Observation |
| Eastern Spinebill | *Acanthorhynchus tenuirostris* | Observation |
| Collared Sparrowhawk | *Accipiter cirrhocephalus* | EMR (2003) only recording |
| Common Myna | *Acridotheres tristis** | Observation |
| Chestnut Teal | *Anas castanea* | Observation |
| Pacific Black Duck | *Anas superciliosa* | Observation |
| Red Wattlebird | *Anthochaera carunculata* | Observation and call identification |
| Great Egret | *Ardea alba^* | Observation |
| Cattle Egret | *Ardea ibis^* | Observation |
| Pacific Heron | *Ardea pacifica* | EMR (2003) only recording |
| Yellow-Tailed Black Cockatoo | *Calyptorhynchus funereus* | Observation and call identification |
| Pheasant Coucal | *Centropus phasianinus* | Observation and call identification |
| Australian Wood Duck | *Chenonetta jubata* | Observation |
| Grey Shrike-Thrush | *Colluricincla harmonica* | EMR (2003) only recording |
| White-Headed Pigeon | *Columba leucomela* | Observation |
| Black-faced Cuckoo-Shrike | Coracina novaehollandiae | Observation |
| White-throated Treecreeper | *Cormobates leucophaeus* | Observation |
| Torresian Crow | *Corvus orru* | Observation and call identification |
| Brown Quail | *Coturnix ypsilophora* | Observation |
| Pied Butcherbird | *Cracticus nigrogularis* | Observation and call identification |
| Laughing Kookaburra | *Dacelo novaeguineae* | Observation and call identification |
| Mistletoebird | *Dicaeum hirundinaceum* | EMR (2003) only recording |
| Spangled Drongo | *Dicrurus bracteatus* | Observation |
| White-faced Heron | *Egretta novaehollandiae* | Observation |
| Black-Shouldered Kite | *Elanus axillaris* | Observation |
| Blue-faced Honeyeater | *Entomyzon cyanotis* | Observation and call identification |
| Eastern Yellow Robin | *Eopsaltrica australis* | Observation |
| Black-necked Stork | *Ephippiorhynchus asiaticus* | Observation |
| Common Koel | *Eudynamys scolopacea* | Call identification |
| Dollarbird | *Eurystomus orientalis* | Observation |
| Magpie Lark | *Grallina cyanoleuca* | Observation and call identification |
| Australian Magpie | *Gymnorhina tibicen* | Observation and call identification |
| White-bellied Sea-Eagle | *Haliaeetus leucogaster^* | Observation |

| *Common Name* | *Scientific Name* | *Recording Type* |
|---|---|---|
| Whistling Kite | *Haliastur sphenurus* | Observation and call identification |
| White-throated Needletail | *Hirundapus caudacutus^* | EMR (2003) only recording |
| Wonga Pigeon | *Leucosarcia melanoleuca* | Observation and call identification |
| Yellow-faced Honeyeater | *Lichenostomus chrysops* | Observation |
| Brown Cuckoo-dove | *Macropygia amboinensis* | Observation |
| Superb Fairy-wren | *Malurus cyaneus* | EMR (2003) only recording |
| Variegated Fairy-wren | *Malurus lamberti* | Observation |
| Noisy Minor | *Manorina melanocephala* | Observation and call identification |
| Scarlet Honeyeater | *Myzomela sanguinolenta* | EMR (2003) only recording |
| Red-browed Finch | *Neochmia temporalis* | Observation |
| Crested Pigeon | *Ocyphaps lophotes* | Observation and call identification |
| Olive-backed Oriole | *Oriolus sagittatus* | Observation and call identification |
| Golden Whistler | *Pachycephala pectoralis* | Observation |
| Striated Pardalote | *Pardalotus striatus* | Observation |
| Rose Robin | *Petroica rosea* | Observation |
| Brush Bronzewing | *Phaps elegans* | EMR (2003) only recording |
| Noisy Friarbird | *Philemon corniculatus* | Observation and call identification |
| Royal Spoonbill | *Platalea regia* | EMR (2003) only recording |
| Tawny Frogmouth | *Podargus strigoides* | Observation |
| Purple Swamphen | *Porphyrio porphyrio* | Observation |
| Eastern Whipbird | *Psophodes olivaceus* | Observation and call identification |
| Satin Bowerbird | *Ptilonorhynchus violaceus* | Observation |
| Grey Fantail | *Rhipidura fuliginosa* | Observation and call identification |
| Willie Wagtail | *Rhipidura leucophrys* | Observation and call identification |
| Large-billed Scrubwren | *Sericornis magnirostris* | Observation |
| Figbird | *Sphecotheres viridis* | Observation |
| Pied Currawong | *Strepera graculina* | Observation |
| Spotted Turtledove | *Streptopelia chinensis** | Observation |
| Sacred Ibis | *Threskiornis aethiopica* | EMR (2003) only recording |
| Australian White Ibis | *Threskiornis molucca* | Observation |
| Straw-necked Ibis | *Threskiornis spinicollis* | Observation |
| Scaly-breasted Lorikeet | *Trichoglossus chloroepidotus* | Observation |
| Rainbow Lorikeet | *Trichoglossus haematodus* | Observation and call identification |

| *Common Name* | *Scientific Name* | *Recording Type* |
|---|---|---|
| Barn Owl | *Tyto alba* | EMR (2003) only recording |
| Masked Lapwing | *Vanellus miles* | Observation and call identification |
| Silvereye | *Zosterops lateralis* | Observation |
| | ***Mammals*** | |
| Brown Antechinus | *Antechinus stuartii* | One Elliott A capture |
| White-striped Freetail Bat | *Austronomus australis* | EMR (2003) only recording |
| Gould's Wattled Bat | *Chalinolobus gouldii* | '*Probable*' anabat recording |
| Northern Brown Bandicoot | *Isoodon macrourus* | EMR (2003) only recording |
| Brown Hare | *Lepus capensis** | Observation |
| Red-necked Wallaby | *Macropus rufogriseus* | Observation |
| **Little Bentwing Bat** | ***Miniopterus australis*** | '*Definite*' anabat recording |
| **Eastern Bentwing Bat** | ***Miniopterus schreibersii oceanensis*** | EMR (2003) only recording |
| **Large-footed Myotis** | ***Myotis macropus*** | '*Probable*' anabat recording |
| Sugar Glider | *Petaurus breviceps* | Spotlighting observation |
| **Koala** | ***Phascolarctos cinereus#*** | Scat identification |
| Common Ringtail Possum | *Pseudocheirus peregrines* | EMR (2003) only recording |
| **Grey-headed Flying-fox** | ***Pteropus poliocephalus#*** | Spotlighting observation |
| Bush Rat | *Rattus fuscipes* | Thirteen Elliott A captures |
| Black Rat | *Rattus rattus** | One Elliott A capture |
| Eastern Broad-nosed Bat | *Scotorepens orion* | '*Definite*' anabat recording |
| Common Brushtail Possum | *Trichosurus vulpecula* | Spotlighting observation; Two Elliott B captures |
| Large Forest Bat | *Vespadelus darlingtoni* | '*Definite*' anabat recording |
| Eastern Forest Bat | *Vespadelus pumilus* | '*Definite*' anabat recording |
| Swamp Wallaby | *Wallabia bicolor* | Observation |
| | ***Amphibians*** | |
| Tusked Frog | *Adelotus brevis* | Call identification |
| Common Eastern Froglet | *Crinia signifera* | Call identification |
| Striped Marsh Frog | *Limnodynastes peronii* | Call identification |
| Bleating Tree Frog | *Litoria dentata* | Call identification |
| Eastern Dwarf Tree Frog | *Litoria fallax* | Call identification |
| Jervis Bay Tree Frog | *Litoria jervisiensis* | EMR (2003) only recording |
| Peron's Tree Frog | *Litoria peronii* | Call identification |
| Tyler's Tree Frog | *Litoria tyleri* | Observation and call identification |

| *Common Name* | *Scientific Name* | *Recording Type* |
|---|---|---|
| Red-back Toadlet | *Pseudophryne coriacea* | Call identification |
| | ***Reptiles*** | |
| Striped Skink | *Ctenotus robustus* | EMR (2003) only recording |
| Land Mullet | *Egernia major* | Observation |
| Barred-sided Skink | *Eulamprus tenuis* | Observation |
| Grass Skink | *Lampropholis delicata* | Observation |
| Eastern Water Dragon | *Physignathus lesueurii ssp. Lesueurii* | Observation |
| Lace Monitor | *Varanus varius* | Scratch identification |

Key:
**Bold** denotes TSC Act listed species
# denotes EPBC Act listed threatened species
^ denotes EPBC Act listed migratory species
* denotes exotic species