Australian Government

BUILDING OUR FUTURE

NSW GOVERNMENT

Coffs Harbour Bypass

Environmental Impact Statement

September 2019

VOLUME 5

Biodiversity and threatened species management

Appendix H – Biodiversity assessment report

Appendix I – Threatened Species Management Plan



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APPENDIX

H

Appendix H

Biodiversity assessment report

Roads and Maritime Services

Coffs Harbour Bypass
Biodiversity Assessment Report

July 2019

Prepared by Biosis Pty Ltd

Biosis Pty Ltd has completed this assessment in accordance with the relevant federal, state and local legislation and current industry best practice. The company accepts no liability for any damages or loss incurred as a result of reliance placed upon the report content or for any purpose other than that for which it was intended.

Executive summary

Roads and Maritime Services (Roads and Maritime) is seeking approval for the Coffs Harbour Bypass (the Project) located to the west of Coffs Harbour Central Business District (CBD) in northern NSW. The Project is located in the Coffs Harbour local government area (LGA) (Figure 1). Approval is being sought under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as State Significant Infrastructure (SSI).

The Project complements the Pacific Highway upgrade program which, when complete, will provide free flowing dual carriageway conditions for the Pacific Highway between Hexham and the Queensland border. The benefits of the Project include:

- Improved road safety by removing through traffic (light and heavy vehicles) and some local traffic from the existing road network which will reduce conflicts and improve safety for all road users.
- Improved travel time for through and local traffic, reducing through traffic travel times.
- Improved transport efficiency of the existing Pacific Highway through Coffs Harbour, relieving congestion on the wider Coffs Harbour road network and providing an alternative route for some local trips. This improved transport efficiency and the resulting improvements to accessibility and amenity to the Coffs Harbour CBD would likely result in wider economic benefits for the Coffs Harbour region.
- Improved freight efficiency for heavy vehicles by providing a high standard dual carriageway road to complement the National Land Transport Network, Future Transport Strategy 2056 and the recently upgraded Pacific Highway.

The Pacific Highway upgrade program also seeks to create public value and ensure safety of its workers and travelling public.

A concept design (Arup 2019a) has been developed for the Project, which forms the basis of this Biodiversity Assessment Report (BAR). This assessment supports the Environmental Impact Statement (EIS) prepared for the Project.

The study area for the detailed ecological survey focusses on impacts associated with the construction footprint which are being assessed in accordance with the NSW Framework for Biodiversity Assessment (FBA) (OEH [Office of Environment and Heritage] 2014b) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Bilateral Agreement between the Commonwealth and NSW State Government (the Bilateral Agreement).

The Project is to be assessed under the now repealed NSW *Threatened Species Conservation Act 1995* (TSC Act) as it falls within the scope of the Transitional Arrangements prescribed by the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*. However, as this regulation (Clause 31) requires that all saved projects consider any new threatened species and threatened ecological communities (TECs) listings under the NSW *Biodiversity Conservation Act 2016* (BC Act), all listing classifications used throughout this report reference the current legislation.

Numerous biodiversity values listed under the BC Act and EPBC Act were recorded with the study area during the field campaign that spanned from late 2016 to autumn 2018, these include:

- *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* – Endangered BC Act.
- *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions* – Endangered BC Act and Critically Endangered EPBC Act
- Rusty Plum *Niemeyera whitei* – Vulnerable BC Act
- Southern Swamp Orchid *Phaius australis* – Endangered BC Act and EPBC Act
- Coastal Petaltail *Petalura litorea* – Endangered BC Act
- Eastern False Pipistrelle *Falsistrellus tasmaniensis* – Vulnerable BC Act
- Eastern Freetail-bat *Mormopterus norfolkensis* – Vulnerable BC Act
- Giant Barred Frog *Mixophyes iterates* – Endangered BC Act and EPBC Act
- Greater Broad-nosed Bat *Scoteanax reuppellii* – Vulnerable BC Act
- Green-thighed Frog *Litoria brevipalmata* – Vulnerable BC Act

- Grey-headed Flying-fox *Pteropus poliocephalus* - Vulnerable BC Act and EPBC Act
- Koala *Phascolarctos cinereus* – Vulnerable BC Act and EPBC Act
- Little Bentwing-bat *Miniopterus australis* – Vulnerable BC Act
- Olive Whistler *Pachycephala olivacea* – Vulnerable BC Act
- Pale-vented Bush-hen *Amaurornis moluccana* – Vulnerable BC Act
- Southern Myotis *Myotis macropus* – Vulnerable BC Act
- Square-tailed Kite *Lophoictinia isura* – Vulnerable BC Act
- White-bellied Sea-eagle *Haliaeetus leucogaster* – Vulnerable BC Act
- Black-faced Monarch *Monarcha melanopsis* – Migratory EPBC Act
- Rufous Fantail *Rhipidura rufifrons* – Migratory EPBC Act
- Spectacled Monarch *Symposiachrus trivirgatus* – Migratory EPBC Act
- Wanderer Butterfly *Danaus plexippus* – Migratory EPBC Act

Following the inclusion of measures to avoid impacts to biodiversity values undertaken during the concept design stage of the project, likely impacts to the above listed threatened biota include:

- Direct removal of threatened ecological communities comprising a total of 6.08 hectares of vegetation.
- Direct removal of threatened plants, including 57 Rusty Plum and one Southern Swamp Orchid.
- Removal of habitats known and/or predicted to support threatened flora and fauna species comprising 43.37 hectares of native vegetation supporting breeding, foraging and shelter habitats.
- Impacts to habitat connectivity through fragmentation of habitats to the east and west of the study area resulting from construction of the project.
- Potential edge effects, increased fauna mortality and injury, invasion of pests and weeds and impacts associated with noise light and vibration.

Impacts to other biodiversity values include:

- Impacts to the EPBC Act listed migratory species through habitat removal.
- Impacts to instream aquatic ecological values and riparian habitats.
- Impacts to groundwater dependent ecosystems.

Mitigation measures have been proposed to further reduce and minimise unavoidable impacts. These include:

- Maintenance of connectivity through construction of fauna crossings at strategic locations.
- Landscape and revegetation design to incorporate locally occurring flora species and habitat enhancement features.
- Bridging of areas of high quality riparian vegetation providing fauna habitat.
- Pre-clearance surveys to reduce direct impacts to threatened fauna.
- Effective standard construction environmental management practices proven to reduce indirect impacts to the surrounding environment.

Assessments undertaken in accordance with the EPBC Act have determined that the project is likely to result in a significant impact to Koala and Giant Barred Frog. Project impacts are likely to lead to a long-term decrease in the size of local populations and cause disruption to the breeding cycle, reduce the area of occupancy of important populations, fragment existing important populations into two of more populations, adversely affect habitat critical to the survival of a species, and remove habitat that could potentially lead to a decline in the extent of a species. Specific mitigation measures have been provided to reduce the intensity of the impact to EPBC Act listed species.

Assessments were also undertaken for additional EPBC Act listed species and communities, highlighted in the *Pacific Highway Upgrade – Coffs Harbour Bypass referral of proposed action* (DoE 2016), however no significant impact was found. This included assessments for:

- Orara Boronia *Boronia umbellata* – Vulnerable BC Act and EPBC Act
- Southern Swamp Orchid

- *Samadera* sp. Moonee Creek [syn. *Quassia* sp. *Moonee Creek*] – Endangered BC Act and EPBC Act
- Cryptic Forest Twiner *Tylophora woollsii* – Endangered BC Act and EPBC Act
- *Lowland Rainforest of Subtropical Australia*

As a result of the unavoidable impacts of the project, Roads and Maritime will secure offsets in accordance with the FBA (OEH 2014b), the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a), and for significantly impacted EPBC Act listed species under the Commonwealth EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012). Required offsets include the retirement of biodiversity credits in the form of ecosystem credits and species credits.

Ecosystem credits are a measurement of the value of Endangered Ecological Communities (EECs), Critically Endangered Ecological Communities (CEECs) and threatened species habitat listed under the BC Act for species that can be reliably predicted to occur within a Plant Community Type (PCT). Ecosystem credits measure the loss in biodiversity at a development site and the gain in biodiversity values at an offset site (OEH 2014b).

Species credits are the class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates (OEH 2014b).

The following ecosystem credits are required to offset impacts from the project:

- PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion – 926 credits.
- PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion – 616 credits.
- PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion – 365 credits
- PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion – 247 credits.
- PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast - 64 credits.
- PCT1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast – 100 credits.
- PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion – 184 credits.
- PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion – 144 credits.

Note that the ecosystem credits generated for PCT 1302 include PCT 670 Black Booyong – Rosewood – Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion, as this PCT cannot be entered separately in the BioBanking calculator.

The following species credits are required to offset impacts from the project:

- Coastal Petaltail – 192 credits.
- Giant Barred Frog – 253 credits.
- Green-thighed Frog – 23 credits.
- Koala – 954 credits.
- Pale-vented Bush-hen – 64 credits.
- Rusty Plum – 855 credits.
- Southern Myotis – 332 credits.
- Southern Swamp Orchid – 13 credits.

These offsets will be secured in accordance with the Biodiversity Offset Strategy provided in Appendix E and through preparation and implementation of a Biodiversity Offsets Package following approval of the project.

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Glossary of terms for this template

Definitions	
Assessment circles	Two circles (the inner and outer assessment circle) in which the percent native vegetation cover in the landscape is assessed, taking into account both cover and condition of vegetation (OEH 2014)
Biodiversity credit report	The report produced by the Credit Calculator that sets out the number and type of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site, or sets out the number and type of biodiversity credits that are created at an offset site (OEH 2014).
Construction footprint	The area directly affected by the project.
Controlled action	A proposed action that is likely to have a significant impact on: a matter of national environmental significance; the environment of Commonwealth land (even if taken outside Commonwealth land); or the environment anywhere in the world (if the action is undertaken by the Commonwealth).
Controlling provision	The matters of national environmental significance under the EPBC Act which the proposed action may have a significant impact on.
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to the project Secretary's Environmental Assessment Requirements (SEARs) for cumulative impact assessment requirements.
Direct impact	Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter (ref http://www.environment.gov.au/system/files/resources/0b0cfb1e-6e28-4b23-9a97-fdadda0f111c/files/environment-assessment-manual.pdf).
Ecosystem credit	A measurement of the value of Endangered Ecological Communities (EECs), Critically Endangered Ecological Communities (CEECs) and threatened species habitat for species that can be reliably predicted to occur with a Plant Community Type (PCT). Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site (OEH 2014b)
Ecosystem credit species	A species identified as requiring ecosystem credits as per Section 6.3 of the NSW Framework for Biodiversity Assessment(OEH 2014b)
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (OEH 2014).
Indirect impact	Where an event or circumstance is a direct consequence of the action (ref http://www.environment.gov.au/system/files/resources/0b0cfb1e-6e28-4b23-9a97-fdadda0f111c/files/environment-assessment-manual.pdf).
Matters for further consideration	Impacts that are considered to be complicated or severe that will require further consideration by the consent authority (OEH 2014). The assessment is based on thresholds detailed in Section 9 of the FBA. These can also be included as part of the project SEARs.
Landscape buffer area	A 550 metre area surrounding the construction footprint used to calculate the project's Landscape Score in accordance with the FBA.
MNES	A matter of national environmental significance (MNES) protected by a provision of Part 3 of the EPBC Act.
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (OEH 2014).

Mitigation	Action to reduce the severity of an impact (OEH 2014).
Mitigation measure	Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality.
Plant Community Type	NSW classification system used to assess vegetation based on the inherent attributes and characteristics including structure, growth form and plant species.
Population	All the individuals that interbreed within a given area.
Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates (OEH 2014b)
Species credit species	Threatened species and populations that are assessed according to Section 6.4 of the FBA (OEH 2014).
Study area	The area directly affected by the development and any additional areas likely to be affected by the development, either directly or indirectly (OEH 2014).
Target species	A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.

Abbreviations

BAR	Biodiversity Assessment Report
BBAM	BioBanking Assessment Methodology
BBCC	BioBanking Credit Calculator
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BVT	Biometric Vegetation Type
CBD	Central Business District
CEECs	Critically Endangered Ecological Communities
CEMP	Construction Environmental Management Plan
DP&E	Department of Planning and Environment (NSW)
DPI	Department of Primary Industries
DoEE	Department of the Environment and Energy
EECs	Endangered Ecological Communities
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Federal).
ESD	*Ecologically Sustainable Development*
FBA	Framework for Biodiversity Assessment
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater dependent ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia
KTP	Key Threatening Process
LGA	Local Government Area
MNES	Matters of National Environmental Significance
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
OEH	Office of Environment and Heritage
PCT	Plant Community Type
SAT	Spot Assessment Technique
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSI	State Significant Infrastructure
TECs	Threatened Ecological Communities
TSPD	Threatened Species Profile Database
TSC Act	*Threatened Species Conservation Act 1995* (NSW).
VIS	Vegetation Information System

1 Introduction

1.1 Overview

Roads and Maritime is seeking approval for the Coffs Harbour Bypass (the Project) located to the west of the Coffs Harbour urban area in northern NSW.

The Coffs Harbour Bypass forms part of the Pacific Highway upgrade program which, when complete, will provide free flowing dual carriageway conditions for the Pacific Highway between Hexham and the Queensland border. The principal objectives of the Pacific Highway upgrade program are to:

- Improve traffic safety
- Reduce travel times and freight costs
- Engage the community and consider their issues
- Support economic development
- Support Ecologically Sustainable Development (ESD) principles
- Provide a safe workplace
- Achieve value for money

The Pacific Highway upgrade program also seeks to create public value and ensure safety of its workers and travelling public. A concept design (Arup 2019a) has been developed for the project, which forms the basis of this assessment. This assessment supports the EIS prepared for the project.

1.2 The proposed project

Roads and Maritime is seeking approval under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as Critical State Significant Infrastructure (CSSI).

The Project includes a 12 kilometre bypass of Coffs Harbour from south of Englands Road to Korora Hill in the north and a 2 kilometre upgrade of the existing highway between Korora Hill and Sapphire. The Project would provide a four-lane divided highway that bypasses Coffs Harbour, passing through the North Boambee Valley, Roberts Hill and then traversing the foothills of the Coffs Harbour basin to the west and north to Korora Hill.

The key features of the Project include:

- Four-lane divided highway from south of Englands Road roundabout to the dual carriageway highway at Sapphire
- Bypass of the Coffs Harbour urban area from south of Englands Road intersection to Korora Hill
- Upgrade of the existing Pacific Highway between Korora Hill and the dual carriageway highway at Sapphire
- Grade-separated interchanges at Englands Road, Coramba Road and Korora Hill
- A one-way local access road along the western side of the project between the southern tie-in and Englands Road, connecting properties to the road network via Englands Road
- A new service road, located east of the project, connecting Solitary Islands Way with James Small Drive and the existing Pacific Highway near Bruxner Park Road
- Three tunnels through ridges at Roberts Hill (around 190 m long), Shephards Lane (around 360 m long), and Gatelys Road (around 450 m long)
- Structures to pass over local roads and creeks as well as a bridge over the North Coast Railway
- A series of cuttings and embankments along the alignment
- Tie-ins and modifications to the local road network to enable local road connections across and around the alignment
- Pedestrian and cycling facilities, including a shared path along the service road tying into the existing shared path on Solitary Islands Way, and a new pedestrian bridge to replace the existing Luke Bowen footbridge with the name being retained
- Relocation of the Kororo Public School bus interchange

- Noise attenuation, including low noise pavement, noise barriers and at-property treatments as required
- Fauna crossing structures including glider poles, underpasses and fencing
- Ancillary work to facilitate construction and operation of the project, including:
  - Adjustment, relocation and/or protection of utilities and services
  - New or adjusted property accesses as required
  - Operational water quality measures and retention basins
  - Temporary construction facilities and work including compound and stockpile sites, concrete/asphalt batching plant, sedimentation basins and access roads (if required).



COFFS HARBOUR LGA

Solitary Islands Marine Park

Legend

- Study area
- Local Government Area
- Solitary Islands Marine Park

Figure 1: Location of the study area, Coffs Harbour NSW

Biosis Pty Ltd

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

Acknowledgements: Imagery (c) Arup 2018
Topo (c) NSW Land and Planning Information (2012)

Matter: 22156
Date: 23 May 2019,
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Metres
Scale 1:50,000 @ A3
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1.3 Purpose of this report

This Biodiversity Assessment Report (BAR) has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the Coffs Harbour Bypass for the purpose of seeking project approval under Division 5.2 of the EP&A Act. Table 1.1 outlines the requirements relevant to this assessment and where they are addressed in the report.

Table 1.1 SEARs relevant to biodiversity

SEARs No.	Secretary's requirement	Where addressed in this report
General 1(2)	*The project will impact on matters of national environmental significance (MNES) protected under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act and will be assessed in accordance with the NSW Bilateral Agreement (2015). The Proponent must assess impacts to MNES protected under the EPBC Act. The assessment must be in accordance with the requirements listed in Attachment A* (of the SEARs)	Section 8.3
Key Issues 4(1)	*The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA and be carried out by a person accredited in accordance with section 142B(1)(c) of the Threatened Species Conservation Act, 1995.*	Section 1.7 and throughout.
Key Issues 4(2)	*The Proponent must survey and assess any impacts on biodiversity values not covered by the FBA, as specified in section 2.3, including but not limited to aquatic species, riparian vegetation, instream macrophytes and habitat condition.*	Chapters 3, 4 and 8
Key Issues 4(3)	*The Proponent must assess impacts on EECs, threatened species and/or populations and provide the information specified in section 9.2 of the FBA.*	Chapters 3, 4 and 8
Key Issues 4(4)	*The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the Threatened Species Conservation Act 1995 (TSC Act), Fisheries Management Act 1994 (FM Act) and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).*	Sections 8.1.4 and 8.5
Key Issues 11(1)	*The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the FBA.*	Section 8.4.3
Key Issues 11(1)	*The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:* *(b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement;*	Sections 3.3 and 8.4.2

SEARs No.	Secretary's requirement	Where addressed in this report
Attachment A	*The project will be assessed in accordance with the NSW Assessment Bilateral Agreement 2015 (the Agreement) and as such is required to be assessed in the manner specified in Schedule 1 to that Agreement.* *Assessment documentation prepared for the purposes of approval under the EPBC Act must, in addition to providing sufficient information for a decision in accordance with the Agreement, address the matters outlined in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth). The requirements are intended such that there is sufficient information in the assessment report relevant to MNES such that the Commonwealth decision-maker may make a determination on whether or not to approve the action. The proponent must undertake an assessment of all the protected matters that may be impacted by the development under the controlling provision identified in paragraph 1* (threatened species and communities (section 18 and section 18A)). *A list of protected matters that are considered likely to be significantly impacted is provided at Annexure 1 to these* SEARs.	Chapter 5, Section 8.3 and Appendix F

1.4 The study area

The study area for the BAR is defined as the area that will be impacted by construction of the project through native vegetation clearing, temporary soil disturbance, waterway/wetland crossings and ancillary works or facilities.

The study area (Figure 2) includes the construction footprint, which comprises the roadway and infrastructure, associated areas of cut and fill, a number of ancillary areas required for construction of the Project, and the areas above the three tunnels. The study area comprises an area of approximately 307 hectares consisting of a 14 kilometre largely linear footprint extending from Sapphire in the north to Boambee in the south, and additional areas adjacent to the construction footprint assessed for their value to local biodiversity.

Land in the study area supports mixed uses including agricultural production, general industry, residential areas, existing roads, and other infrastructure. Remnant native vegetation occurs in the study area, interspersed with modified non-native pasture, and exotic weed dominated vegetation patches. Multiple watercourses are present in the study area providing habitat and connectivity for terrestrial and aquatic biodiversity.

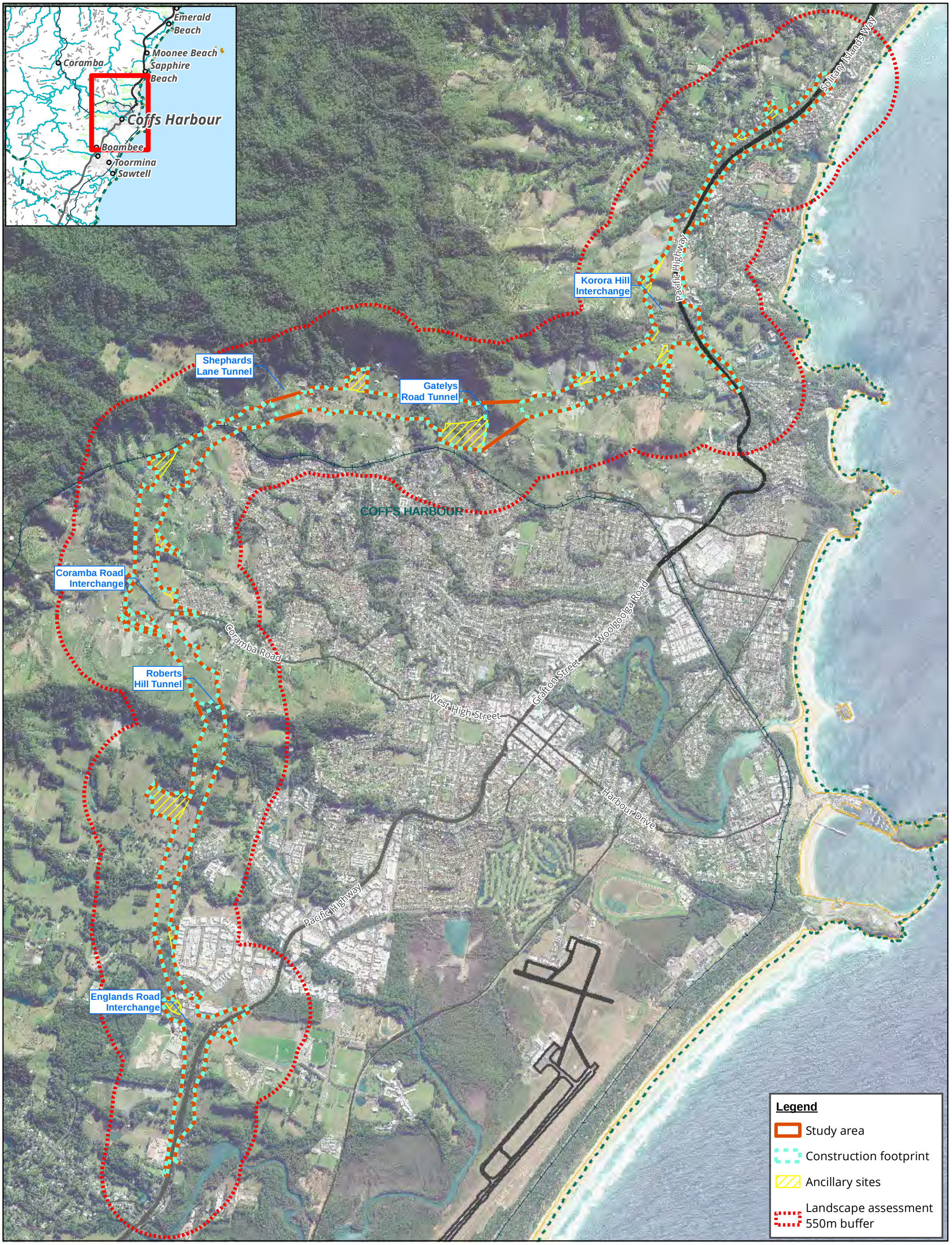


Figure 2: Study area

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

Matter: 22156
Date: 23 May 2019,
Checked by: CW, Drawn by: SSK, Last edited by: lharley
Location:P:\22100s\22156\Mapping\
22156_F2_StudyArea

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Metres
Scale 1:30,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

1.5 Legislative context

The project has been determined to be SSI and approval is being sought under Division 5.2 of the NSW EP&A Act. An EIS is a requirement of the approval process. SEARs were issued by the NSW Department of Planning and Environment (DPE) in June 2016, and were updated in October 2017, and state that biodiversity impacts must be assessed and documented in accordance with the Framework for Biodiversity Assessment (OEH 2014a) and the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014b).

The project has also been referred under the EPBC Act (2017/8005) and deemed to be a controlled action assessed under the Bilateral Agreement made under section 45 of the EPBC Act relating to environmental assessment between the Commonwealth of Australia and the State of New South Wales. The bilateral agreement endorses the FBA and the NSW Biodiversity Offsets Policy as accredited processes. Guidelines for preparing the EIS under the Bilateral Agreement have been provided by the Australian Government Department of the Environment and Energy (DoEE).

There have been recent changes to environmental and biodiversity assessment regulations in NSW. Under Clause 27(1)(a) of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* (BC Regulation (Savings & Transitional)), this project is a pending planning application. Clause 28 of the BC Regulation (Savings & Transitional) states that the former planning provisions continue to apply (and Part 7 of the BC Act does not apply) to the determination of a pending or interim planning application.

The Secretary of the DPE has issued environmental assessment requirements for the Project and the biodiversity assessment commenced in mid-2016. Given these transitional arrangements, the biodiversity assessment undertaken for this project is in accordance with the issued environmental assessment requirements, the FBA and the NSW Biodiversity Offsets Policy for Major Projects. As all threatened species, communities and their habitat are now listed under the BC Act, this biodiversity assessment and report makes reference to the listings under the current legislation. However, assessment has been undertaken as per the requirements laid out in the SEARs (ie. under the TSC Act).

1.6 Project scope

The biodiversity impact assessment was undertaken across several phases. Initial field inspections commenced in August 2016. These initial assessments focussed on gathering contemporary background data, validating existing information sources such as government vegetation mapping products, devising survey strategies and collecting site specific information to inform impact avoidance and minimisation before the alignment was finalised for the project EIS. The detailed field survey phase was conducted between late 2016, autumn and spring 2017, and was completed in autumn 2018. The aim was to gather sufficient information on the extent of native vegetation removal, impacts on threatened species and communities, and impacts on aquatic habitats during the optimal seasonal survey periods.

Specifically the scope of this assessment included:

- Preparing vegetation mapping (PCTs and vegetation zones) through refinement of regional vegetation mapping products produced by OEH.
- Collecting vegetation plot and transect data to characterise vegetation condition, document the potential scale of vegetation removal, and assist in calculating biodiversity offsets.
- Mapping and characterisation, where possible, of the extent and condition of listed TECs to determine the significance of potential impacts and calculate appropriate biodiversity offsets.
- Targeted surveys at seasonally appropriate times for threatened flora and terrestrial and aquatic fauna to determine the extent of habitat and the significance of potential impacts and calculate appropriate biodiversity offsets.
- Considering impacts associated with all aspects of the project.
- Providing recommendations for impact mitigation and site rehabilitation during the project construction and operation phases.
- Consulting with regulatory authorities on survey methods, species and communities knowledge and information sources to inform the biodiversity impact assessment.
- Documenting the findings of the surveys and assessments into a BAR using the FBA method that would be suitable for submission with the Project EIS.

- Documenting the significance of potential impacts on MNES listed under the EPBC Act, particularly threatened species and ecological communities.

Table 1.2 identifies the various items required as part of the biodiversity assessment, the controlling requirements, and the sections within the report where each is addressed.

Table 1.2 Commonwealth and NSW Assessment requirements

Biodiversity assessment	Required by	Section addressed
Inventory		
Identification of the terrestrial biodiversity values, including NSW listed threatened species and endangered ecological communities, in the area proposed for development.	Framework for Biodiversity Assessment	Section 2 Landscape features Section 3 Native vegetation Section 4 Threatened species
Identification of aquatic biodiversity values in the area proposed for development.	Policy and guidelines for fish habitat conservation and management	Section 4.3
Identification of nationally listed threatened species, endangered ecological communities and migratory species in the area proposed for development.	EPBC Act Bilateral Agreement	Section 5 Matters of National Environmental Significance
Impact assessment		
Description of the direct (related to vegetation clearance) impacts of the project on biodiversity.	Framework for Biodiversity Assessment	Section 8.1
Description of the full range of impacts of the project on biodiversity.	Secretary's Environmental Assessment Requirements	Section 8 Impact assessment
Description on the likely significance of impacts of the project on each nationally listed species, EECs and migratory species.	EPBC Act Bilateral Agreement	Section 8.3
Mitigation measures		
Description of the mitigation measures to be applied.	Framework for Biodiversity Assessment	Section 7 Avoid and minimise impacts
Description of the specific mitigation measures to be applied on each nationally listed species, EEC and migratory species.	EPBC Act Bilateral Agreement	Section 9 Mitigation
Offset requirements		
Quantification and description of biodiversity offsets required for the unavoidable direct impacts of the project on threatened species and EECs.	Framework for Biodiversity Assessment	Section 10 Offsetting required
Quantification and description of biodiversity offsets required for all direct and indirect significant residual impacts on nationally listed species, EEC and migratory species.	EPBC Act Bilateral Agreement	Section 10 Offsetting required
Offset proposals		

Biodiversity assessment	Required by	Section addressed
Details of how offsets provided meet expected loss.	Framework for Biodiversity Assessment	Refer to Appendix E – Biodiversity Offset Strategy
Demonstrate offsets for MNES are like-for-like, consistent with the EPBC Act Bilateral Agreement.	EPBC Act Bilateral Agreement	Refer to Appendix E – Biodiversity Offset Strategy

1.7 Biosis BioBanking Accredited Assessors

Current and former Biosis Biobanking Accredited Assessors involved in the Project include:

- Lead – Callan Wharfe (Assessor No. 173)
- Support – Rebecca Dwyer (Assessor No. 95)
- Support – Renae Baker (Assessor No. 102)
- Support – Jane Raithby-Veall (Assessor No. 115)
- Former lead – Samuel Luccitti (Assessor No. 237) (no longer employed at Biosis)
- Former lead – Nathan Garvey (Assessor No. 103) (no longer employed at Biosis)

2 Landscape features

Landscape features relevant to the project have been identified within a 550 metre buffer of the study area as required for linear assessments undertaken in accordance with the FBA (OEH 2914a).

2.1 Identified features

Land through which the study area and 550 metre landscape assessment buffer occurs generally supports mixed uses including agricultural production, general industry, residential areas, existing roads, and other infrastructure. Remnant native vegetation occurs throughout the study area, interspersed with modified non-native pasture, and exotic weed dominated vegetation patches.

Native vegetation within the study area is characterised by an overlap in distribution of more tropical-influenced communities in the north and temperate communities in the south. Nine PCTs were recorded within the study area covering 43.37 hectares.

The study area and 550 metre buffer includes land reserved under the *National Parks and Wildlife Act 1974* (NPW Act) including Kororo Nature Reserve and Ulidarra National Park in the north. Kororo Nature Reserve provides an important Koala refuge and habitat corridor linking remnant vegetation within the study area. Similarly, vegetation further south on the proposed alignment connecting to Boambee State Forest in the west provides important Koala dispersal habitat. This habitat includes primary and secondary feed trees as well as shelter trees and corridors. Koala habitat and connectivity are discussed at greater length in Section 4.2.

Smaller remnant patches of native vegetation occur closer towards the Coffs Harbour CBD and provide connectivity to larger areas of vegetation on the eastern side of the existing highway for a suite of local fauna.

Six named watercourses and their tributaries intersect the study area at various locations along the linear footprint. These watercourses include Coffs Creek, Jordans Creek, Newports Creek, Boambee Creek, Pine Brush Creek and Treefern Creek. Aquatic values of the study area are discussed further in Section 4.3. (Figure 3)

2.1.1 IBRA Bioregions and subregions

The study area and 550 metre buffer occur within the North Coast Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and the Coffs Coast and Escarpment IBRA subregion, the Bellinger River Catchment and within the Coffs Harbour LGA.

The Coffs Coast and Escarpment IBRA subregion covers the entire study area and is the subregion used in this assessment. The study area, including the 550 metre assessment buffer surrounding the linear footprint (Figure 3) is located entirely within this subregion.

The study area occurs within the former Northern Rivers major catchment area (now the North Coast Local Land Services region) (Figure 3).

2.1.2 NSW Landscape Regions (Mitchell landscapes)

The study area and 550 metre buffer occur across four soil landscapes (Mitchell 2002) (Figure 3), listed in order of greatest area covered:

- Brooms Head - Kempsey Coastal Ramp.
- Manning - Macleay Coastal Alluvial Plain.
- Nymboida Great Escarpment.
- Manning - Macleay Barriers and Beaches.

Brooms Head - Kempsey Coastal Ramp soil landscape covers approximately 60% of the study area and buffer and is characterised by thin, stony gradational loam and sandy loam on the slopes grading to yellow-brown texture-contrast soils on lower slopes and in valleys. Typical vegetation associated with this soil landscape is Dry Hardwood Forest dominated by the following species: Blackbutt *Eucalyptus pilularis*, Sydney Blue Gum *Eucalyptus saligna*, and Large-fruited Blackbutt *Eucalyptus pyrocarpa*.

Manning - Macleay Coastal Alluvial Plain, the second-most prominent soil landscape within the study area occupies channels, floodplains, terraces and swamps of the Manning and Macleay Rivers. Soils are characterised dark organic loams and silty clay and support vegetation tolerant of being inundated such as Flooded Gum *Eucalyptus grandis,* River Oak *Casuarina cunninghamiana*, as well as common wetland species including Common Reed *Phragmites australis* and Spike Rush *Eleocharis* spp.

Nymboida Great Escarpment soil landscape occurs on ranges and along steep escarpments with high waterfalls and deep gorges on main streams at elevations between 400 and 1400 metres above sea level. Soils vary from shallow gritty sandy loam through red and yellow earthy gradational profiles to deep siliceous sands and loams on valley floors. The predominant underlying geology is Permian/Carboniferous granite and sandstone. Vegetation within this soil landscape varies considerably with elevation, aspect and soil quality. Vegetation communities include Cool Temperate Forests, Open Tall Forests and Subtropical Forests.

Manning - Macleay Barriers and Beaches soil landscape, the least common landscape within the study area occurs on beaches, dunes, swamps and lagoons on Quaternary coastal sands at elevations up to 25 metres above sea level. Species typically occurring in this soil landscape include: Spinifex Coast Wattle *Acacia sophorae*, Coast Tea-tree *Leptospermum laevigatum*, Old Man Banksia *Banksia serrata* and Red Bloodwood *Corymbia gummifera*. (Figure 3)

2.1.3 Rivers and Streams

The study area and 550 metre buffer are located within the Bellinger River Catchment on the mid north coast of NSW. A number of perennial and non-perennial watercourses and their tributaries intersect the study area (Figure 3). None of these watercourses feed directly into the Bellinger River but instead flow out directly to the coast. Waterways within the study area have been classified based on stream order (Strahler 1952). They include:

- Boambee Creek (second order) and adjoining first order tributaries.
- Coffs Creek (third order). Adjoining tributaries feed into Coffs Creek inlet outside of the study area to the east; a designated Habitat Protection Zone (DPI [Department of Primary Industries] Fisheries 2018).
- Jordans Creek (third order) and several adjoining first and second order tributaries.
- Newports Creek (fifth order) and several adjoining first, second and third order tributaries.
- Pine Brush Creek (fifth order) and several adjoining first order tributaries.
- Treefern Creek (third order) and several adjoining first and second order tributaries.

Overall, the majority of the waterways and associated riparian zones within the study area consist of first order streams (approximately 35% or total riparian zone by area) with higher order watercourses less frequent (fifth order streams make up 3% of riparian zones). (Figure 3)

No mapped Key Fish Habitats occur within the study area (DPI Fisheries 2007).

Solitary Islands Marine Park extends north from Coffs Harbour to Sandon River along about 75 kilometres of coastline (Figure 1). Marine parks are declared and managed under the *Marine Estate Management Act 2014* by NSW DPI. The Reserve is approximately 710 square kilometres in area, reaching from the mean high water mark to three nautical miles offshore, and including estuaries to their tidal limit (DPI 2018).

The Solitary Islands Marine Park (Commonwealth Waters) adjoins the State marine park and extends further seaward to the 50 metre depth contour. The Australian Marine Park protects large complex subtidal reefs, including Pimpernel Rock, a unique underwater pinnacle with high conservation value.

The project receiving environments of Pine Brush Creek, Jordans Creek, Treefern Creek, and Coffs Creek flow into the Habitat Protection Zone of the Solitary Islands Marine Park.

2.1.4 Wetlands

No Ramsar Wetlands or Nationally Important Wetlands have been mapped within the study area or 550 metre buffer area (Commonwealth of Australia 2015). The closest Ramsar Wetland; Myall Lakes, is located approximately 300 kilometres south of Coffs Harbour.

A number of wetlands mapped by OEH on the NSW Wetlands 2006 spatial layer (OEH 2006) occur to the east, west and south of the study area, including at Pine Brush Creek, Boambee Creek and Cordwells Creek (Figure 3). During field investigations, no wetlands were identified in the study area

due to a lack of hydrological and vegetative features such as regular standing water, large areas dominated by macrophytes and a lack of typical wetland PCTs.

2.1.5 State or Regionally Significant Biodiversity Links

An assessment of the biodiversity connecting links as described in the FBA for linear shaped developments is provided in Table 2.1 below, relative to the study area (OEH 2014a).

Table 2.1 Assessment of the biodiversity connecting links as described in the FBA for linear shaped developments

Connecting link category	FBA definitions/criteria (Table 17, OEH 2014)	Present	Rationale for presence/absence
State significant biodiversity link	An area identified by the assessor as being part of a state significant biodiversity link and in a plan approved by the Chief Executive, OEH **OR** A riparian buffer 50 m either side of a 6th order stream or higher OR A riparian buffer 50 m around an important wetland	No	No plans regarding ecological values within the study area have been approved by the Chief Executive of OEH to date. Thus, the study area does not support any current state significant biodiversity links.
Regionally significant biodiversity link	An area identified by the assessor as being part of a regionally significant biodiversity link and in a plan approved by the Chief Executive, OEH **OR** A riparian buffer 20 m either side of a 4th or 5th order stream **OR** A riparian buffer 30 m around a regionally significant wetland.	Yes	The study area supports a regionally significant biodiversity link in the form of a fourth order waterway riparian buffer zone of the southern tributary of Newports Creek (Figure 3). Pine Brush Creek is not considered a connecting link due to the presence of the existing Pacific Highway.
Local area biodiversity link	Links areas of native vegetation in moderate to good condition that are ≥250 ha in total, or areas greater than 1000 ha in total **AND** Width of vegetation in moderate to good condition that is connecting the area is >30 metres and <100 metres.	Yes	Several 'local area biodiversity links' are present along the linear footprint (Figure 3), including: • Riparian vegetation associated with Jordans Creek and tributaries which connect vegetation of the coastal plain with that of the escarpment in the north of the study area. • Vegetation running south east from Shephards Lane and following the North Coast Railway. • Vegetation connecting vegetation of the escarpment foothills along Roberts Hill to vegetation of the coastal plain in the vicinity of Halls Road, North Boambee Valley (Figure 3). • Riparian vegetation of Newports Creek in the North Boambee Valley.

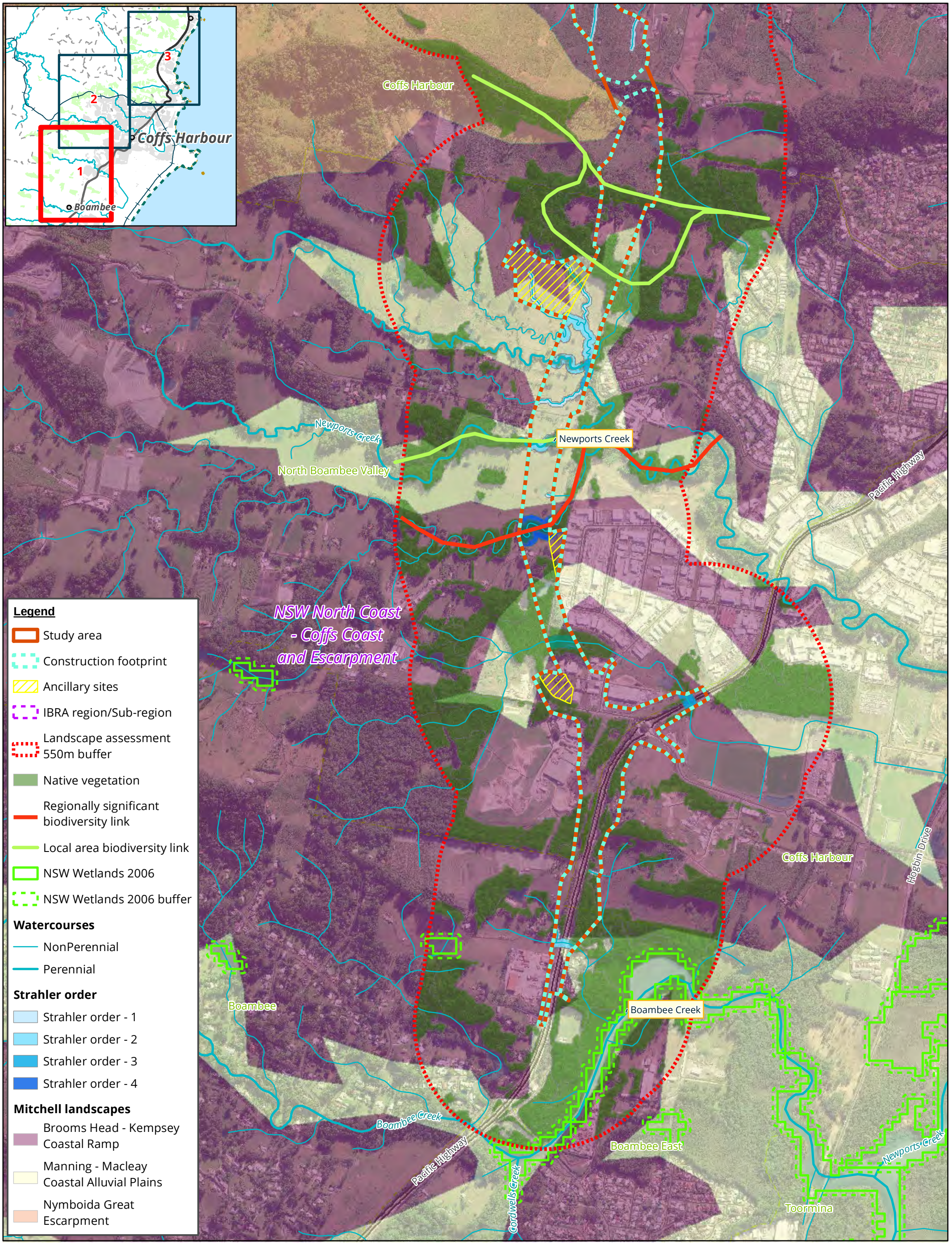


Figure 3.1: Landscape features

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Acknowledgements:Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

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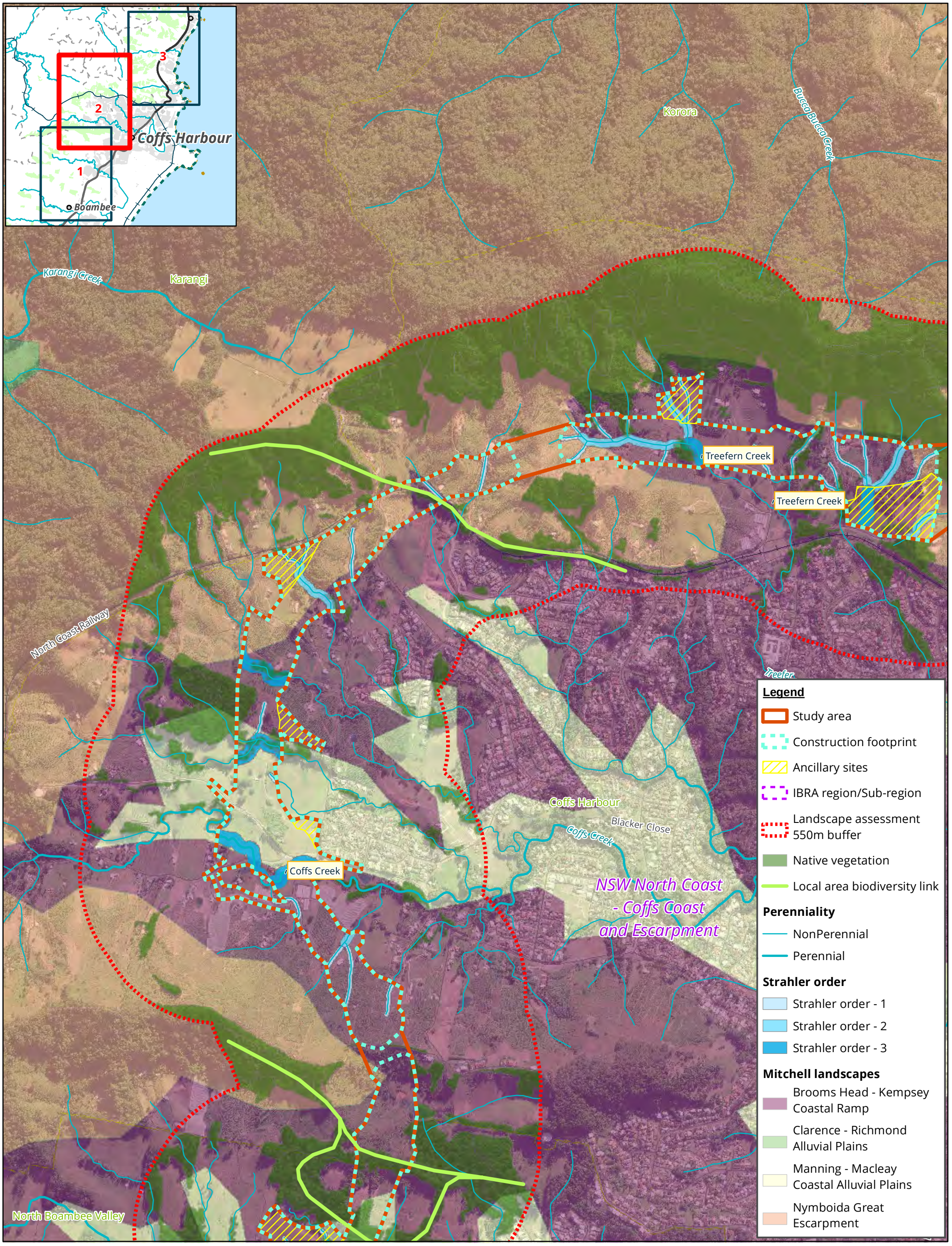


Figure 3.2: Landscape features

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Acknowledgements:Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

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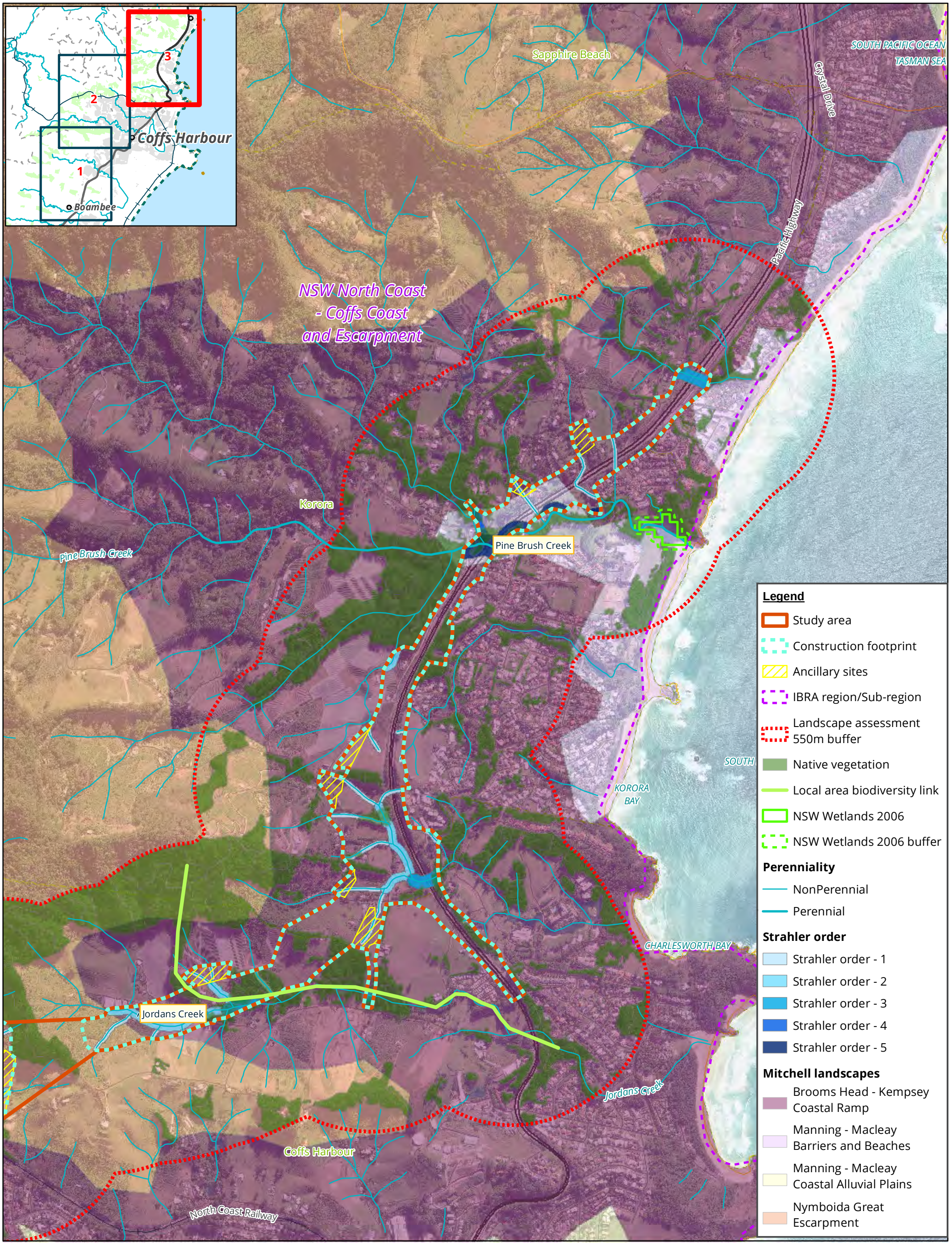


Figure 3.3: Landscape features

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Newcastle, Sydney, Wangaratta & Wollongong

Acknowledgements:Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

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22156_F3.2-3_LandscapeFeatures

0 150 300 450 600 750
Metres
Scale 1:15,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

2.2 Landscape values

Landscape value has been calculated using the method for linear shaped developments, outlined in Appendix 5 of the FBA (OEH 2014a).

A 550 metre buffer surrounding the centre line of the project alignment was applied using a GIS in order to identify the buffer area surrounding the construction footprint. The buffer area was calculated as approximately 2226.5 hectares.

2.2.1 Native vegetation assessment

The extent of native vegetation cover before development within the buffer area was determined as the sum of areas of all native vegetation polygons mapped by Biosis within the study area and as detailed in the OEH mapping project *Development of a Fine-Scale Vegetation Map for the Coffs Harbour Local Government Area* (OEH 2012) for those areas outside the current study area.

To determine the extent of native vegetation cover after development, the extent of vegetation required for removal is subtracted from the extent of native vegetation cover before development. Table 2.2 provides a summary of the extent of native vegetation cover within the buffer area before development and after development based on the Concept Design for the Project.

Table 2.2 Extent of native vegetation cover before and after development

Assessment circle (area)	Before development		After development		Percent native vegetation cover score
	Native vegetation cover (ha)	Cover (%)	Native vegetation cover (ha)	Cover (%)	
550 m buffer (2226.5 ha)	619.5	27.8%	576.1	25.9%	1.9%

2.2.2 Connectivity value

The following categories of connecting links are present within the study area (as detailed in Table 2.1 above):

- One ‘regionally significant biodiversity link’ in the form of fifth order waterway riparian buffer zone associated with Newports Creek.
- One ‘large area biodiversity link’ connecting Roberts Hill in the west to remnant native vegetation of North Boambee Valley near Eyre.

Several ‘local area biodiversity links’, including:

- Riparian vegetation associated with Jordans Creek and tributaries which connect vegetation of the coastal plain with that of the escarpment in the north of the study area.
- Vegetation running south east from Shephards Lane and following the North Coast Railway.
- Vegetation connecting vegetation of the escarpment foothills along Roberts Hill to vegetation of the coastal plain of North Boambee Valley.
- Riparian vegetation of Newports Creek in the North Boambee Valley (Figure 3).

A connectivity value score of 10 was therefore determined in accordance with Table 17 of the FBA, on the basis that one or more regionally significant biodiversity links may be impacted.

2.2.3 Patch size

Patch size was assessed in accordance with the FBA (OEH 2014) using a select process in ArcGIS. Within each NSW Landscape, all vegetation not defined as low condition and separated by a distance of less than 100 metres (woody vegetation types) and 30 metres (non-woody vegetation types) was mapped sequentially using Biosis and OEH (2012) data. Using this method, the patch size class and patch size score for each NSW Landscape was determined and is presented in Table 2.3.

Table 2.3 Patch size

NSW Landscape	Percentage cleared (%)	Patch size class	Patch size score
Brooms Head - Kempsey Coastal Ramp.	26	Extra large (>1000 ha)	12.5
Manning - Macleay Barriers and Beaches	24	Extra large (>1000 ha)	12.5
Manning - Macleay Coastal Alluvial Plain	57	Extra large (>1000 ha)	12.5
Nymboida Great Escarpment	18	Extra large (>1000 ha)	12.5

2.2.4 Area to perimeter ratio

An assessment was undertaken for defining the change in area to perimeter ratio of patch size areas impacted by the Project. A GIS process has been used to calculate the total area and perimeter of all of patches of vegetation present within the construction footprint which extend to the 550 metre buffer either side of the alignment before and after vegetation removal associated with the project. Steps undertaken in this process are detailed in Appendix 5 of the FBA.

The area to perimeter ratio calculated before and after vegetation removal, and the associated score, is provided in Table 2.4.

Table 2.4 Area to perimeter ratio

Before Development	After Development	Proportional change in ratio (%)	Score
Area to perimeter ratio			
25	27	0*	0

*It should be noted that the score for proportional change in area/perimeter ratio returned by the BioBanking Calculator is 0 (rather than 3, as expected above). The score of 0 cannot be edited in the BioBanking Calculator and as such has been used to calculate the Landscape Value score, and present in the table above.

2.2.5 Landscape value score

In undertaking the above calculations in accordance with Section 4 and Appendix 5 of the FBA, the landscape value score for the Concept Design of Project has been determined to be 23.75.

3 Native vegetation

The extent of native vegetation within the study area was determined using Section 5 of the FBA with the method used to develop the project's native vegetation map outlined below.

3.1 Method

3.1.1 Background research

In order to provide a context for the study area, information about flora and fauna from within a 10 kilometre radius of the study area (the 'locality') was obtained from relevant public databases. Records from the following databases were collated and reviewed:

- Commonwealth DoEE Protected Matters Search Tool for matters protected by the EPBC Act.
- NSW OEH BioNet - the database for the Atlas of NSW Wildlife for records of threatened populations, species and ecological communities (biota).
- The NSW Plant Community Types, as held within the Vegetation Information System (VIS) Classification 2.1 database.
- PlantNET (The Royal Botanic Gardens and Domain Trust) for records of locally occurring flora species including Rare or Threatened Australian Plants (RoTAP).
- Australian Government's Bureau of Meteorology Groundwater Dependent Ecosystems (GDE) Atlas.
- DoEE Directory of Important Wetlands in Australia (DIWA).
- NSW DPE's *State Environmental Planning Policy (Coastal Management) 2018* (SEPP (Coastal Management)) wetlands spatial data.
- NSW DPI Fisheries predicted distribution maps of threatened species and fish communities for items listed under the NSW FM Act.
- BirdLife Australia, the New Atlas of Australian Birds 1998-2015.

Other sources of biodiversity information reviewed:

- Fine-Scale Vegetation Map for the Coffs Harbour Local Government Area (OEH 2012).
- Commonwealth listing advice for EPBC listed communities.
- Approved conservation advice for EPBC listed communities.
- BC Act Threatened Species Scientific Committee final determinations.

The following reports were also reviewed:

- Coffs Harbour Bypass: Biodiversity Constraints Report (Biosis 2016).
- Coffs Harbour City Koala Plan of Management (Lunney et al. 1999).
- NSW Scientific Committee final determinations for threatened biota, including (but not limited to):
- Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (NSW Scientific Committee 2004a).
- Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion (NSW Scientific Committee 2004b).
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004c).
- Commonwealth Listing Advice on Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (TSSC 2008).
- Commonwealth Species Profiles (SPRAT Profiles).
- OEH Threatened Species Profiles.
- Recovery plans for EPBC and TSC Act listed communities where available.
- Guides to the identification, assessment and management of nationally threatened ecological communities.

3.1.2 Vegetation surveys

PCT confirmation and condition assessments

Confirmation and further assessment of desktop vegetation mapping of the study area was undertaken by Biosis in August 2016. The purpose of this assessment was to undertake detailed vegetation mapping of PCTs (review and update of the initial desktop draft PCT map), and a preliminary assessment of vegetation condition of all vegetation in accordance with the requirements of the FBA. This initial survey included 70 person hours of vegetation confirmation surveys.

Detailed mapping of vegetation communities was conducted using tablet computers (Samsung Galaxy Tab 3) running the ArcGIS Collector application and aerial photo interpretation. Areas of native vegetation for which a PCT could validly be assigned were identified and delineated in the field, and their condition determined. Identification of PCTs within the study area was confirmed with reference to the community profile descriptors (and diagnostic species tests) held within the OEH (2012) mapping project and NSW VIS: Classification Version 2.1 (now the BioNet Vegetation Classification).

General classification of native vegetation in NSW used in this report is based on the classification system in Keith (2004) which uses three groupings of vegetation: vegetation formation, vegetation class and vegetation type (PCT), with vegetation type the finest grouping. The grouping referred to in this report is PCT.

Following completion of preliminary field PCT and vegetation condition mapping, PCTs were stratified into vegetation zones in accordance with Section 5.2 of the FBA. The FBA defines vegetation zones as a relatively homogenous area of native vegetation on a development site that is the same PCT and broad condition state (OEH 2014a), the areas of which were then used to inform the requirements for full floristics surveys as per Section 5.3 of the FBA (OEH 2014a).

Full floristic surveys

Following stratification of vegetation zones, site value was assessed using data obtained via a series of plots and transects, implementing the NSW BioBanking Assessment Methodology (BBAM) (OEH 2014c), as described in Section 5.3 of the FBA (OEH 2014a). Plot and transect data was collected over a number of field mobilisations:

- November 2016 – 40 person hours.
- April 2017 – 89 person hours.
- May 2018 – 32 person hours.

Each survey was undertaken in accordance with the BBAM and the FBA (refer Section 1.5) and included plot/transects consisting of:

- A 20 metre x 50 metre quadrat and 50 metre transect for assessment of site attributes.
- A 20 metre x 20 metre quadrat, nested within the quadrat outlined above, for full floristic survey to determine native plant species richness and cover.

The minimum number of plot/transects per vegetation zone was determined using Table 3 of the FBA (Table 3.1). A total of 41 plot/transects were completed within the study area over the course of the field assessments. Plot locations are shown on Figure 5. The details of the number of plot/transects completed within each vegetation zone are outlined in Table 3.1, along with a comparison to the minimum requirement in accordance with Table 3 of the FBA (OEH 2014a).

Table 3.1 Comparison of number of transects/plots required and completed per zone area

Vegetation Zone	Vegetation Zone Area (ha)	FBA plot requirements	No. plots completed
1	0.51	1	1
2	11.27	3	3
3	3.39	2	2
5	6.26	3	5 (1)
6	0.74	1	1
8	0.94	1	1
9	2.48	2	3
10	0.89	1	1
11	1.15	1	1
12	1.23	1	1(1)
13	0.15	1	1
14	4.07	3	3
15	0.73	1	1
16	0.38	1	1
17	1.91	1	3
100	0.89	1	1
101	1.42	1	2
102	3.35	2	5
103	1.61	1	2 (1)

Numbers in brackets in the table above, represent initial BBAM plot/transects undertaken in vegetation which at the time occurred inside the study area (Section 1.4), that now occurs outside the current study area. Floristic data collected at these locations has been used to supplement the data collected within the study area, as each plot occurs immediately adjacent to, and in a vegetation patch contiguous with, vegetation in the current study area. All plots (including those outside of the construction footprint) have been included in the BBAM calculator.

Plant identification and nomenclature

All vascular flora recorded during vegetation surveys were identified to species level where possible. Species that could not be identified in the field were recorded to the nearest possible family or genus and collected for later identification. Where they could not be identified confidently, specimens were lodged with the NSW Herbarium for identification.

Nomenclature, including common names, follows Harden (1990-1993, and revised editions 2000-2002). Recent taxonomic revisions were identified using the PlantNET website, developed by the Royal Botanic Gardens (n.d.).

A list of flora species, with cover and abundance was compiled for each vegetation type, and is provided in Appendix A. Records of all flora species will be submitted to OEH for incorporation into the Atlas of NSW Wildlife.

3.1.3 Limitations

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

Due to the degraded or cleared nature of some properties, for example banana plantations or properties in more developed areas cleared of native vegetation, some properties were not accessed directly and detailed walkovers were not undertaken. However, all these properties were able to be clearly viewed from adjoining properties or public roads/footpaths, sufficient to determine the absence of native vegetation communities within. A small number of properties were not able to be accessed as part of the field component of the project. Aerial photo interpretation was undertaken to assess the presence of native vegetation on these properties. All other properties were accessed for assessment. Biosis is confident that the assessment is adequate for the purpose of identifying areas of native vegetation and threatened species habitat. The assessment was completed through implementation of the BBAM and in accordance with the FBA.

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

3.1.4 PCT descriptions

The study area supports 43.37 hectares of native vegetation, across nine separate PCTs with varying levels of disturbance and condition, stratified into 19 vegetation zones (Figure 5). Native vegetation within the study area generally comprises isolated patches of vegetation in an agricultural, residential and industrial land-use matrix. The condition of these patches ranges from poor, with heavy weed infested supporting little native species richness or diversity, good condition high native species floristic and structural diversity and low weed infestation. Zones in lower condition also show high levels of modification and fragmentation.

Poor condition vegetation zones are characterised by a canopy of mature and semi mature native trees over an understorey dominated by woody weeds and exotic vines, herbs and grasses. Resilience in the understory in these zones was seen to be low, with a low cover and abundance of native species. Higher condition vegetation condition zones are characterised by complex vegetation structure with a high diversity and abundance of native species within each strata.

Four vegetation formations (Keith 2004) were recorded as present within the study area, these included (in order of abundance):

- Wet Sclerophyll Forest (Shrubby sub-formation) – 35.68 hectares.
- Forested Wetlands – 3.65 hectares.
- Rainforest – 2.43 hectares.
- Wet Sclerophyll Forest (Grass sub-formation) – 1.62 hectares.

These vegetation formations comprise four vegetation classes (Keith 2004) and nine PCTs, which are described in detail below.

Table 3.2 Vegetation zones

Vegetation zone	Vegetation zone code	Plant community type (PCT)	Threatened ecological community	Site value score	Study area (ha)
1	Moderate/good	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion (NR111)*	Yes – BC Act	82.67	0.51
2	Moderate/good – Good	PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (NR120)	No	81.33	11.27
3	Moderate/good – Poor	PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (NR120)	No	45.56	3.39
5	Moderate/good – Good	PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (NR122)	No	85.33	6.26
6	Moderate/good – Medium	PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (NR120)	No	57.33	0.74
8	Moderate/good – Good	PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast (NR258)	No	82.67	0.94
9	Moderate/good – Poor	PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion (NR138)	No	72	2.48
10	Moderate/good – Good	PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (NR217)	Yes - BC Act	84	0.89
11	Moderate/good – Medium	PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (NR217)	Yes – BC Act	85.33	1.15
12	Moderate/good – Poor	PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (NR217)	Yes – BC Act	78	1.23
13	Moderate/good – Medium	PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (NR122)	No	89.33	0.15
14	Moderate/good – Poor	PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (NR122)	No	46.67	4.07
15	Moderate/good – Good	PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast (NR263)	No	71.33	0.73

Vegetation zone	Vegetation zone code	Plant community type (PCT)	Threatened ecological community	Site value score	Study area (ha)
16	Moderate/good – Other	PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (NR217)	Yes – BC Act	87.33	0.38
17	Moderate/good – Medium	PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion (NR280)	Yes – BC Act	68	1.91
100	Moderate/good – Other	PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast (NR263)	No	77.33	0.89
101	Moderate/good – Poor	PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion (NR274)	No	74	1.42
102	Moderate/good – Good	PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion (NR138)	No	78	3.35
103	Moderate/good	PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion (NR274)	No	72.67	1.61
TOTAL					43.37

*** Note that PCT 670 Black Booyong – Rosewood – Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion, cannot be entered into the BioBanking calculator, and as such credit calculations have been attributed to PCT1302, further detailed below.**

PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion

Vegetation formation: Rainforest

Vegetation class: Subtropical Rainforest

PCT: 670

BVT: NR111

Conservation status: Commonwealth EPBC Act: Not listed. This PCT can conform to the EPBC Act listing for Lowland Rainforest of Subtropical Australia however the vegetation within the study area does not meet the listing requirements for Key Diagnostic Characteristics and Condition Class requirements (TSSC 2011a, b) as outlined in Section 3.2.1. NSW BC Act: Endangered Ecological Community (refer Section 3.2).

Estimate of percent cleared: 75%

Condition:

- VZ1: Moderate/good – Medium

Extent in the study area: 0.51 hectares of this PCT was recorded and mapped as an isolated patch on an east facing slope north of Mackays Lane (Figure 3).

Plots completed in vegetation zone:

- VZ1: One plot/transect (PT_34) (Figure 5).

Table 3.3 PCT 670 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	10-50	1-15	Hairy Rosewood *Dysoxylum rufum,* Green Bolly Gum *Neolitsea australiensis,* Yellow Carabeen *Sloanea woollsii*
Small trees & shrubs	1-30	0.25-2.5	Native Tamarind *Diploglottis australis,* Hairy-leaved Firewheel Tree *Stenocarpus sinuatus* Hard Corkwood *Endiandra sieberi*, Creek Sandpaper Fig *Ficus coronate,* Prickly Supplejack *Ripogonum discolor*
Ground covers	0.1-1	0.1-10	Rough Maidenhair *Adiantum hispidulum,* Naked Shield Fern *Lastreopsis munita,* Gristle Fern *Blechnum cartilagineum,* Rainbow Fern *Calochlaena dubia.*
Vines & climbers	0.1 - 30	0.5 - 5	Water Vine *Cissus antarctica*

Description: The canopy is dominated by Hairy Rosewood *Dysoxylum rufum*, Green Bolly Gum *Neolitsea australiensis* and Yellow Carabeen *Sloanea woollsii*. The midstorey and shrub layer consist of Native Tamarind *Diploglottis australis* and Green Bolly Gum *Neolitsea australiensis*, Hairy-leaved Firewheel Tree *Stenocarpus sinuatus*, Water Vine *Cissus antarctica*, Hard Corkwood *Endiandra sieberi*, Creek Sandpaper Fig *Ficus coronate* and Prickly Supplejack *Ripogonum discolor*. The ground is dominated by Rough Maidenhair *Adiantum hispidulum*, Naked Shield Fern *Lastreopsis munita*, Gristle Fern *Blechnum cartilagineum* and Rainbow Fern *Calochlaena dubia* (Plate 1).

It should be noted that PCT670 / NR111 is not available in the BioBanking Calculator. This is in-spite of the BioNet Vegetation Classificaton listing the PCT status as “Approved”, and as occurring in the Coffs Coast and Escarpment Bioregion. The PCT is also associated with the Northern Rivers CMA in the archived BioBanking data (from 21 August 2017) available on the OEH website.

As a result of the unavailability of the PCT in the BioBanking Calculator, the PCT for Vegetation Zone 1 has been entered as PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion. This PCT has the same benchmark values, the same value for CMA percent cleared and represents the same vegetation formation (Rainforest) and class (Subtropical Rainforest) as PCT 670. As such, the offsetting calculations will result in the same requirement and offsetting options, but with a different baseline PCT.



Plate 1 PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion

PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion

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

Vegetation class: North Coast Wet Sclerophyll Forest

PCT: 692

BVT: NR120

Conservation status: Commonwealth EPBC Act: Not Listed. PCT not associated with any EPBC Act listed TECs. NSW BC Act: Not Listed. PCT not associated with any BC Act listed TECs (refer Section 3.2).

Estimate of percent cleared: 15%

Condition:

- VZ2: Moderate/good – Good
- VZ3: Moderate/good – Poor
- VZ6: Moderate/good – Medium

Extent in the study area: 15.40 hectares of this PCT was recorded and mapped in a number of patches of varying size and condition along the North Boambee Valley, Korora and the Pacific Highway (Figure 4).

Plots completed in vegetation zone:

- VZ2: Three plot/transects (PT_16, PT_017, PT_20).
- VZ3: Two plot/transects (PT_40, PT_41).
- VZ6: One Plot/Transect (PT_21) (Figure 5).

Table 3.4 PCT 692 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	10-40	2.5-40	Tallowwood *Eucalyptus microcorys*, Blackbutt *Eucalyptus pilularis*
Small trees & shrubs	1-30	0.1-10	Tree Heath *Trochocarpa laurina,* Forest Oak, *Allocasuarina torulosa*, Blueberry Ash *Elaeocarpus reticulatus,* Forest Maple *Cryptocarya rigida*
Ground covers	0.1-1	0.1-45	Rainbow Fern *Calochlaena dubia*, Gristle Fern *Blechnum cartilagineum*, Prickly Rasp Fern *Doodia aspera*, Blady Grass *Imperata cylindrica,* Needle Mat-rush *Lomandra cylindrical*, Creeping Beard Grass *Oplismenus imbecillis*
Vines & climbers	N/A	N/A	

Description: The canopy is mainly dominated by Tallowwood *Eucalyptus microcorys* and Blackbutt *Eucalyptus pilularis* with Smooth-barked Apple *Angophora costata*, Hard-leaved Scribbly Gum *Eucalyptus sclerophylla* and Pink Bloodwood *Corymbia intermedia* also present at lower abundance. The midstorey and shrub layer consists of Tree Heath *Trochocarpa laurina*, Forest Oak, *Allocasuarina torulosa*, Forest Maple *Cryptocarya rigida*, and Blueberry Ash *Elaeocarpus reticulatus*. Exotic species are frequently present in the midstorey and include Camphor Laurel *Cinnamomum camphora*, Lantana *Lantana camara* and Ester Cassia *Senna pendula var. glabrata*. The groundcover is dominated by Rainbow Fern *Calochlaena dubia*, Gristle Fern *Blechnum cartilagineum*, Prickly Rasp Fern *Doodia aspera*, Blady Grass *Imperata cylindrica,* Needle Mat-rush *Lomandra cylindrica* and Creeping Beard Grass *Oplismenus imbecillis* (Plate 2).



Plate 2 PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion

PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion

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

Vegetation class: North Coast Wet Sclerophyll Forest

PCT: 695

BVT: NR122

Conservation status: Commonwealth EPBC Act: Not Listed. PCT not associated with any EPBC Act listed TECs. NSW BC Act: Not Listed. PCT not associated with any BC Act listed TECs (refer Section 3.2).

Estimate of percent cleared: 5 %

Condition:

- VZ5: Moderate/good – Good: This vegetation zone maintains a complex vegetation structure with a high native species diversity and abundance in all strata. However, some areas shows light to moderate levels of Lantana *Lantana camara* infestation.
- VZ13: Moderate/good – Medium: This vegetation zone maintains a less complex vegetation structure with a moderate native species diversity and abundance in all strata and low levels of modification, fragmentation and weed infestation (Camphor Laurel *Cinnamomum camphora*, Lantana *Lantana camara* and Small-leaved Privet *Ligustrum sinense*).
- VZ14: Moderate/good – Poor: This vegetation zone shows very high levels of modification and disturbance, with low levels of native canopy, shrub and ground cover mostly dominated by Lantana *Lantana camara*.

Extent in the study area: 10.47 hectares of this PCT was recorded and mapped in a number of patches of varying size and condition located along the northern half of the study area within Upper Orara, Coffs Harbour and Korora (Figure 4).

Plots completed in vegetation zone:

- VZ5: Six plot/transects (PT_06, PT_07, PT_08, PT_23, PT_24, PT_29).
- VZ13: One plot/transect (PT_28).
- VZ14: Three plot/transects (PT_04, PT_05, PT_42) (Figure 5).

Table 3.5 PCT 695 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	20 – 55	2 – 30	Pink Bloodwood *Corymbia intermedia*, Tallowwood *Eucalyptus microcorys*, Blackbutt *Eucalyptus pilularis*, Brush Box *Lophostemon confertus*, Turpentine *Syncarpia glomulifera*, Flooded Gum *Eucalyptus grandis*, Small-fruited Grey Gum *Eucalyptus propinqua*, Red Mahogany *Eucalyptus resinifera*
Small trees & shrubs	0.1 – 18	0.1 – 35	White Apple *Endiandra virens*, Scrub Ironwood *Austromyrtus acmenoides,* Rose Myrtle *Archirhodomyrtus beckleri,* Jackwood *Cryptocarya glaucescens*, Bolwarra *Eupomatia laurina,* Murrogun *Cryptocarya microneura,* Banana Bush *Tabernaemontana pandacaqui,* Veiny Wilkiea *Wilkiea huegeliana,* Rusty Plum *Niemeyera whitei,* Hairy-leaved Bolly Gum *Neolitsea dealbata,* Narrow-leaved Palm Lily *Cordyline stricta*
Ground covers	0.1 – 1.5	0.1 – 60	Gristle Fern *Blechnum cartilagineum*, Creeping Beard Grass *Oplismenus imbecillis*, Prickly Rasp Fern *Doodia aspera*, Native Ginger *Alpinia caerulea,* Small Supplejack *Ripogonum fawcettianum*
Vines & climbers	N/A	0.1 – 10	Sweet Morinda *Morinda jasminoides*

Description: The canopy is mainly dominated by Pink Bloodwood *Corymbia intermedia*, Tallowwood *Eucalyptus microcorys*, Blackbutt *Eucalyptus pilularis*, Brush Box *Lophostemon confertus* and Turpentine *Syncarpia glomulifera* with Flooded Gum *Eucalyptus grandis*, Small-fruited Grey Gum *Eucalyptus propinqua* and Red Mahogany *Eucalyptus resinifera* present in less abundance. The midstorey and shrub layer is dominated by White Apple *Endiandra virens*, Scrub Ironwood *Austromyrtus acmenoides*, Rose Myrtle *Archirhodomyrtus beckleri*, Jackwood *Cryptocarya glaucescens*, Bolwarra *Eupomatia laurina*, Murrogun *Cryptocarya microneura*, Sweet Morinda *Morinda jasminoides*, Hairy-leaved Bolly Gum *Neolitsea dealbata*, Narrow-leaved Palm Lily *Cordyline stricta,* Banana Bush *Tabernaemontana pandacaqui*, Veiny Wilkiea *Wilkiea huegeliana* and threatened species Rusty Plum *Niemeyera whitei*. Exotic species in this layer include Small-leaved Privet *Ligustrum sinense*, Lantana *Lantana camara*, Mickey Mouse Plant *Ochna serrulata,* and Easter Cassia *Senna pendula var. glabrata*. The groundcover is dominated by Gristle Fern *Blechnum cartilagineum*, Creeping Beard Grass *Oplismenus imbecillis*, Prickly Rasp Fern *Doodia aspera*, Native Ginger *Alpinia caerulea* and Small Supplejack *Ripogonum fawcettianum* (Plate 3).



Plate 3 PCT 695 Blackbutt – Turpentine – Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion

PCT 747 Brush Box – Tallowwood – Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion

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

Vegetation class: North Coast Wet Sclerophyll Forest

PCT: 747

BVT: NR138

Conservation status: Commonwealth EPBC Act: Not Listed. PCT not associated with any EPBC Act listed TECs. NSW BC Act: Not Listed. PCT not associated with any BC Act listed TECs (refer Section 3.2.

Estimate of percent cleared: 30 %

Condition:

- VZ9: Moderate/good – Poor: This vegetation zone maintains a vegetation structure with moderate native species diversity and low richness in all strata and moderate to high levels of weed infestation (Camphor Laurel *Cinnamomum camphora*, Lantana *Lantana camara* and Small-leaved Privet *Ligustrum sinense*).
- VZ102: Moderate/good – Good: This vegetation zone maintains a complex vegetation structure with a high native species diversity and cover in all strata.

Extent in the study area: 5.82 hectares of this PCT was recorded and mapped across patches of varying size and condition scattered along the study area (Figure 4).

Plots completed in vegetation zone:

- VZ9: Three plot/transects (PT_26, PT_27, PT_33).
- VZ102: Five plot/transects (PT_22, PT_32, PT_35, PT_39, PT_43) (Figure 5).

Table 3.6 PCT 747 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	5 - 35	0.5 - 40	Brush Box *Lophostemon confertus*, Sydney Blue Gum *Eucalyptus saligna*, Tallowwood *Eucalyptus microcorys*, Flooded Gum *Eucalyptus grandis*, Turpentine *Syncarpia glomulifera*
Small trees & shrubs	0.2 - 12	0.1 - 20	Soft Corkwood *Ackama paniculosa,* Lilly Pilly *Acmena smithii,* Rough Treefern *Cyathea australis,* Bolwarra *Eupomatia laurina,* Scentless Rosewood *Synoum glandulosum,* Rough Fruit Pittosporum *Pittosporum revolutum*
Ground covers	0.1 - 1	0.5 - 45	Gristle Fern *Blechnum cartilagineum*, Rainbow Fern *Calochlaena dubia*, Harsh Ground Fern *Hypolepis muelleri,* Spiny-headed Mat-rush *Lomandra longifolia*
Vines & climbers	N/A	0.1 – 2.5	Water Vine *Cissus Antarctica*, Giant Water Vine *Cissus hypoglauca*

Description: The canopy is mainly dominated by Brush Box *Lophostemon confertus* and Sydney Blue Gum *Eucalyptus saligna* with some occurrence of Tallowwood *Eucalyptus microcorys*, Flooded Gum *Eucalyptus grandis* and Turpentine *Syncarpia glomulifera*. The midstorey and shrub layerconsist of a well-developed layer dominated by rainforest species including Soft Corkwood *Ackama paniculosa,* Lilly Pilly *Acmena smithii,* Water Vine *Cissus antarctica,* Giant Water Vine *Cissus hypoglauca,* Rough Treefern *Cyathea australis,* Bolwarra *Eupomatia laurina,* Rough Fruit Pittosporum *Pittosporum revolutum* and Scentless Rosewood *Synoum glandulosum.* The ground cover is dominated by Gristle Fern *Blechnum cartilagineum*, Rainbow Fern *Calochlaena dubia*, Harsh Ground Fern *Hypolepis muelleri and* Spiny-headed Mat-rush *Lomandra longifolia*. Exotic species present include Camphor Laurel *Cinnamomum camphora*, Lantana *Lantana camara* and Small-leaved Privet *Ligustrum sinense*(Plate 4).



Plate 4 PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion

PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion

Vegetation formation: Forested Wetland

Vegetation class: Coastal Swamp Forest

PCT: 1064

BVT: NR217

Conservation status: Commonwealth EPBC Act: Not Listed. PCT not associated with any EPBC Act listed TECs. NSW BC Act: Endangered Ecological Community (refer Section 3.2).

Estimate of percent cleared: 75 %

Condition:

- VZ10: Moderate/good – Good: This vegetation zone maintains a complex vegetation structure with a high native species diversity and cover in all strata.
- VZ11: Moderate/good – Medium: This vegetation zone maintains a less complex vegetation structure with a moderate native species diversity and cover in all strata and low levels of modification, fragmentation and weed infestation (Camphor Laurel *Cinnamomum camphora*, Crofton Weed *Ageratina adenophora* and Small-leaved Privet *Ligustrum sinense*).
- VZ12: Moderate/good – Poor: This vegetation zone shows medium levels of modification and disturbance, with moderate levels of native canopy and shrub and ground cover with localised infestations of Lantana *Lantana camara*, Blue Billygoat Weed *Ageratum houstonianum* and Small-leaved Privet *Ligustrum sinense*.
- VZ16: Moderate/good – Other: This vegetation zone maintains a low complex vegetation structure with a low native species diversity in all strata, as well as low levels of modification, fragmentation and weed infestation (Camphor Laurel *Cinnamomum camphora* and Lantana *Lantana camara*).

Extent in the study area: 3.65 hectares of this PCT was recorded across numerous patches of varying size and condition restricted to Boambee and North Boambee Valley (Figure 4).

Plots completed in vegetation zone:

- VZ10: One plot/transect (PT_02).
- VZ11: One plot/transect (PT_01).
- VZ12: Two plot/transects (PT_03, PT_13).
- VZ16: One plot/transect (PT_12) (Figure 5).

Table 3.7 PCT 1064 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	2.5 - 30	2 - 45	Broad-leaved Paperbark *Melaleuca quinquenervia,* Willow Bottlebrush *Callistemon salignus*, Swamp Mahogany *Eucalyptus robusta,* Swamp Box *Lophostemon suaveolens,* Flax-leaved Paperbark *Melaleuca linariifolia*, *Melaleuca sieberi.*
Small trees & shrubs	1 - 12	3 - 5	Slender Tea-tree *Leptospermum trinervium,* Pink-flowered Doughwood *Melicope elleryana*
Ground covers	0 – 0.5	0.2 - 60	*Carex maculata,* Swamp Water Fern *Blechnum indicum,* Rainbow Fern*Calochlaena dubia,* Tall Saw-sedge *Gahnia clarkei,* Pouched Coral Fern *Gleichenia dicarpa*
Vines & climbers	N/A	0.2 - 20	Common Silkpod *Parsonsia straminea*

Description: The canopy is dominated by Broad-leaved Paperbark *Melaleuca quinquenervia*, Willow Bottlebrush *Callistemon salignus*, and Swamp Mahogany *Eucalyptus robusta* with occurrence of Swamp Box *Lophostemon suaveolens*, Flax-leaved Paperbark *Melaleuca linariifolia* and *Melaleuca sieberi*. The midstorey and shrub layer consists of Slender Tea-tree *Leptospermum trinervium*, Pink-flowered Doughwood *Melicope elleryana* and Common Silkpod *Parsonsia straminea*. Some infestations of Lantana *Lantana camara* and Easter Cassia *Senna pendula var. glabrata* were identified in poor condition areas. The groundcover consist of *Carex maculata*, Swamp Water Fern *Blechnum indicum*, Rainbow Fern *Calochlaena dubia*, Tall Saw-sedge *Gahnia clarkei* and Pouched Coral Fern *Gleichenia dicarpa*. Exotic species include *Ageratum houstonianum*, Trumpet Vine *Campsis radicans*, White Passionflower *Passiflora subpeltata*, Camphor Laurel *Cinnamomum camphora*, Crofton Weed *Ageratina adenophora* and Small-leaved Privet *Ligustrum sinense* (Plate 5).



Plate 5 PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion

PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast

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

Vegetation class: North Coast Wet Sclerophyll Forest

PCT: 1244

BVT: NR217

Conservation status: Commonwealth EPBC Act: Not Listed. PCT not associated with any EPBC Act listed TECs. NSW BC Act: Not Listed. PCT not associated with any BC Act listed TECs (refer Section 3.2).

Estimate of percent cleared: 60 %

Condition: This vegetation zone shows high levels of modification, fragmentation and disturbance in, with low to moderate levels of native shrub and ground cover mostly dominated by exotic species. Disturbance is primarily the result of surrounding agricultural activity, grazing and past clearing. Regeneration is inhibited by the weed infestation within the PCT.

Extent in the study area: 0.94 hectares of this PCT was recorded and mapped in two small patches located along a creek line on a coastal plain, south of North Boambee Road (Figure 4).These areas show high levels of exotic species and moderate species diversity.

Plots completed in vegetation zone:

- VZ8: One plot/transect (PT_09) (Figure 5)

Table 3.8 PCT 1244 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	5 - 20	2 - 10	Sydney Blue Gum *Eucalyptus saligna*, Brush Box *Lophostemon confertus,* Red Ash *Alphitonia excelsa*
Small trees & shrubs	3 - 12	5	Creek Sandpaper Fig *Ficus coronata*
Ground covers	0.1 - 1	1 - 2	Spiny-headed Mat-rush *Lomandra longifolia*, Gristle Fern *Blechnum cartilagineum*
Vines & climbers	N/A	5 - 20	Giant Water Vine *Cissus hypoglauca*, Sweet Morinda *Morinda jasminoides*

Description: The canopy is dominated by the exotic Camphor Laurel *Cinnamomum camphora* with remnant native canopy composed of Sydney Blue Gum *Eucalyptus saligna*, Brush Box *Lophostemon confertus* and Red Ash *Alphitonia excelsa*. The midstorey and shrub layer is dominated by Giant Water Vine *Cissus hypoglauca* and Creek Sandpaper Fig *Ficus coronata.* Exotic species include Lantana *Lantana camara* and Small-leaved Privet *Ligustrum sinense.* The groundcover layer is dominated by Sweet Morinda *Morinda jasminoides,* Spiny-headed Mat-rush *Lomandra longifolia* and Gristle Fern *Blechnum cartilagineum* (Plate 6).



Plate 6 PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast

PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast

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

Vegetation class: Northern Hinterland Wet Sclerophyll Forest

PCT: 1262

BVT: NR263

Conservation status: Commonwealth EPBC Act: Not Listed. PCT not associated with any EPBC Act listed TECs. NSW BC Act: Not Listed. PCT not associated with any BC Act listed TECs (refer Section 3.2).

Estimate of percent cleared: 30 %

Condition:

- VZ15: Moderate/good – Good: This vegetation zone maintains a moderately complex vegetation structure with a moderate native species diversity and cover in all strata and moderate levels of modification, fragmentation and a wide range of exotic species including Ginger Lily *Hedychium gardnerianum*, Lantana *Lantana camara*, White Passionflower *Passiflora subpeltata*, Elephant Grass *Pennisetum purpureum*, Easter Cassia *Senna pendula* var*. glabrata*, Umbrella Tree *Schefflera actinophylla*, Madeira Vine *Anredera cordifolia*, Moth Vine *Araujia sericifera* and Groundsel Bush *Baccharis halimifolia.*
- VZ100: Moderate/good – Other: This vegetation zone maintains a complex vegetation structure with a high native species diversity and cover in all strata and moderate levels of modification, fragmentation and a light to moderate weed infestation including Lantana *Lantana camara*, Small-leaved Privet *Ligustrum sinense* and Asparagus Fern *Asparagus scandens*.

Extent in the study area: 1.62 hectares of this PCT was recorded and mapped in four isolated patches of varying size and moderate condition. Two of the patches are located in the Korora along West Korora Road and the Pacific Highway and the other two at North Boambee Valley (Figure 4).

Plots completed in vegetation zone:

- VZ15: One plot/transect (PT_11).
- VZ100: One plot/transects (PT_25) (Figure 5).

Table 3.9 PCT 1262 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	5 - 40	1 - 20	Tallowwood *Eucalyptus microcorys*, Turpentine *Syncarpia glomulifera*, Blackbutt *Eucalyptus pilularis*, Small-fruited Grey Gum *Eucalyptus propinqua*, Grey ironbark *Eucalyptus paniculata*, Brush Box *Lophostemon confertus*
Small trees & shrubs	10 - 20	0.5 - 25	Bolwarra *Eupomatia laurina*, Maiden's Wattle *Acacia maidenii,* White Apple *Endiandra virens*
Ground covers	0 – 1.5	0.1 - 30	Gristle Fern *Blechnum cartilagineum*, Rainbow Fern *Calochlaena dubia*, Prickly Rasp Fern *Doodia aspera,* Blady Grass *Imperata cylindrical*, *Tripladenia cunninghamii.*
Vines & climbers	N/A	20	Small Supplejack *Ripogonum fawcettianum*

Description: The canopy is co-dominated by Tallowwood *Eucalyptus microcorys*, Turpentine *Syncarpia glomulifera*, Blackbutt *Eucalyptus pilularis*, Small-fruited Grey Gum *Eucalyptus propinqua*, Grey ironbark *Eucalyptus paniculata* and Brush Box *Lophostemon confertus*. The midstorey and shrub layer is dominated by Small Supplejack *Ripogonum fawcettianum*, Bolwarra *Eupomatia laurina*, Maiden's Wattle *Acacia maidenii* and White Apple *Endiandra virens*. Exotic species in this layer include Ginger Lily *Hedychium gardnerianum*, Lantana *Lantana camara*, White Passionflower *Passiflora subpeltata*, Elephant Grass *Pennisetum purpureum*, Easter cassia *Senna pendula* var. *glabrata*, Umbrella Tree *Schefflera actinophylla*, Madeira Vine *Anredera cordifolia*, Moth Vine *Araujia sericifera* and Groundsel Bush *Baccharis halimifolia.* The groundcover layer is dominated by Gristle Fern *Blechnum cartilagineum*, Rainbow Fern *Calochlaena dubia*, Prickly Rasp Fern *Doodia aspera,* Blady Grass *Imperata cylindrica,* and *Tripladenia cunninghamii* (Plate 7).



Plate 7 PCT 1262 Tallowwood – Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast

PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion

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

Vegetation class: North Coast Wet Sclerophyll Forest

PCT: 1285

BVT: NR274

Conservation status: Commonwealth EPBC Act: Not Listed. PCT not associated with any EPBC Act listed TECs. NSW BC Act: Not Listed. PCT not associated with any BC Act listed TECs (refer Section 3.2).

Estimate of percent cleared: 55 %

Condition:

- VZ101: Moderate/good – Poor: This vegetation zone maintains a low complex vegetation structure with a low native species diversity in all strata, as well as moderate levels of modification, fragmentation and weed infestation (Umbrella Tree *Schefflera actinophylla*, Camphor Laurel *Cinnamomum camphora*, Crofton Weed *Ageratina adenophora*, Mickey Mouse Plant *Ochna serrulata*, Broadleaf Paspalum *Paspalum mandiocanum* and Lantana *Lantana camara*).
- VZ103: Moderate/good: This vegetation zone maintains a complex vegetation structure with a high native species diversity and cover in all strata and low to moderate levels of modification, fragmentation and weed infestation (Camphor Laurel *Cinnamomum camphora*, Broadleaf Paspalum *Paspalum mandiocanum*, Mickey Mouse Plant *Ochna serrulata,* Crofton Weed *Ageratina adenophora* and Lantana *Lantana camara*).

Extent in the study area: 3.04 hectares of this PCT was recorded and mapped in a number of patches of varying size and condition located along the Pacific highway at Korora and within Kororo Nature Reserve (Figure 4).

Plots completed in vegetation zone:

- VZ101: Two plot/transects (PT_36, PT_37).
- VZ103: Three plot/transects (PT30, PT_31, PT_038) (Figure 5).

Table 3.10 PCT 1285 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	5 – 30	5 – 30	Tallowwood *Eucalyptus microcorys*, Small-fruited Grey Gum *Eucalyptus propinqua*, Pink Bloodwood *Corymbia intermedia,* Flooded Gum *Eucalyptus grandis*, Brush Box *Lophostemon confertus*
Small trees & shrubs	2 – 15	1 – 45	Jackwood *Cryptocarya glaucescens,* Hairy-leaved Bolly Gum *Neolitsea dealbata*, Scentless Rosewood *Synoum glandulosum*, Blue Lilly Pilly *Syzygium oleosum*
Ground covers	0.1 – 1	0.1 – 5	Gristle Fern *Blechnum cartilagineum*, Rainbow Fern *Calochlaena dubia*, Giant Maidenhair *Adiantum formosum*, Creeping Beard Grass *Oplismenus imbecillis*, Pastel Flower *Pseuderanthemum variabile*, *Tripladenia cunninghamii*
Vines & climbers	N/A	2 -5	Small Supplejack *Ripogonum fawcettianum*, Sweet Morinda *Morinda jasminoides*

Description: The canopy is co-dominated by Tallowwood *Eucalyptus microcorys*, Small-fruited Grey Gum *Eucalyptus propinqua*, Pink Bloodwood *Corymbia intermedia*, Flooded Gum *Eucalyptus grandis* and Brush Box *Lophostemon confertus*. The midstorey and shrub layer is dominated by Jackwood *Cryptocarya glaucescens*, Hairy-leaved Bolly Gum *Neolitsea dealbata*, Scentless Rosewood *Synoum glandulosum*, Blue Lilly Pilly *Syzygium oleosum*, Small Supplejack *Ripogonum fawcettianum* and Sweet Morinda *Morinda jasminoides*. Exotic species include Camphor Laurel *Cinnamomum camphora,* Umbrella Tree *Schefflera actinophylla*, Crofton Weed *Ageratina adenophora*, Mickey Mouse Plant *Ochna serrulata,* Broadleaf Paspalum *Paspalum mandiocanum* and Lantana *Lantana camara*. The groundcover layer is dominated by Gristle Fern *Blechnum cartilagineum*, Rainbow Fern *Calochlaena dubia*, Giant Maidenhair *Adiantum formosum*, Creeping Beard Grass *Oplismenus imbecillis*, Pastel Flower *Pseuderanthemum variabile,* Small Supplejack *Ripogonum fawcettianum* and *Tripladenia cunninghamii* (Plate 8).



Plate 8 PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion

PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion

Vegetation formation: Rainforest

Vegetation class: Subtropical Rainforest

PCT: 1302

BVT: NR280

Conservation status: Commonwealth EPBC Act: Not listed. This PCT can to conform to the EPBC Act listing for Lowland Rainforest of Subtropical Australia however the vegetation within the study area does not meet the listing requirements for Key Diagnostic Characteristics and Condition Class requirements (TSSC 2011a, b) as listed in Section 3.2. NSW BC Act: Endangered Ecological Community (refer Section 3.2).

Estimate of percent cleared: 75 %

Condition: This vegetation zone maintains a complex vegetation structure with a high native species diversity and cover in all strata and low to moderate levels of weed infestation (Camphor Laurel *Cinnamomum camphora*, Wandering Jew *Tradescantia fluminensis*, Crofton Weed *Ageratina adenophora*, Mickey Mouse Plant *Ochna serrulata,* Broadleaf Paspalum *Paspalum mandiocanum* and Lantana *Lantana camara*).

Extent in the study area: 1.91 hectares of this PCT was recorded and mapped in three isolated patches of varying size and in moderate condition. Two of these patches are located at Coffs Harbour along the North Coast Railway line and the other one along the Pacific Highway at Korora (Figure 4).

Plots completed in vegetation zone:

- VZ17: Three plot/transects (PT_10, PT_14, PT_15) (Figure 5).

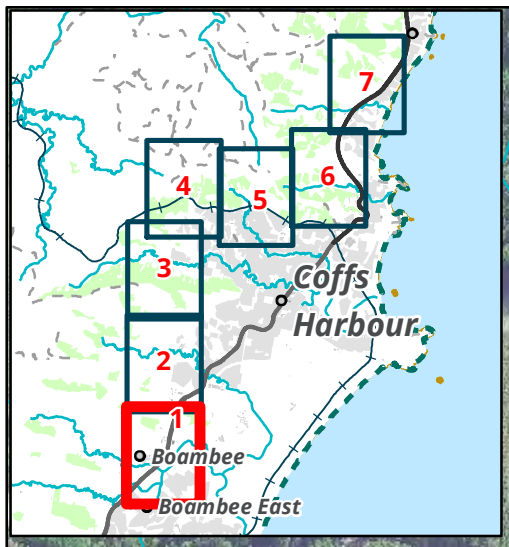
Table 3.11 PCT 1302 floristic summary from plot data

Structure (strata)	Average height and height range (m)	Average cover and cover range	Dominant species
Trees	5 - 25	1.5 - 45	Bangalow Palm *Archontophoenix cunninghamiana*, Hairy Rosewood *Dysoxylum rufum,* Strangling Fig *Ficus watkinsiana,* Native Tamarind *Diploglottis australis* Creek Sandpaper Fig *Ficus coronata,* Brush Box *Lophostemon confertus,* Maiden's Blush *Sloanea australis*
Small trees & shrubs	4 - 15	0.1 - 15	Lilly Pilly *Acmena smithii,* Cheese Tree *Glochidion ferdinandi,* , Murrogun *Cryptocarya microneura*, Guioa *Guioa semiglauca*
Ground covers	0.1 – 1.5	0.25 - 40	Creeping Beard Grass *Oplismenus imbecillis*, Rainbow Fern *Calochlaena dubia*, Austral Lady Fern *Diplazium australe,* Giant Maidenhair *Adiantum formosum*, Creeping Shield Fern *Lastreopsis microsora*
Vines & climbers	N/A	0.1 - 5	Water Vine *Cissus antarctica*, Common Silkpod *Parsonsia straminea*

Description: The canopy is dominated by Bangalow Palm *Archontophoenix cunninghamiana*, Hairy Rosewood *Dysoxylum rufum* and Strangling Fig *Ficus watkinsiana,* and includes Native Tamarind *Diploglottis australis,* Creek Sandpaper Fig *Ficus coronata*, Brush Box *Lophostemon confertus* and Maiden's Blush *Sloanea australis*. The midstorey and shrub layer is dominated by Lilly Pilly *Acmena smithii*, Cheese Tree *Glochidion ferdinandi*, Water Vine *Cissus antarctica*, Murrogun *Cryptocarya microneura*, Guioa *Guioa semiglauca* and Common Silkpod *Parsonsia straminea*. The dominant exotic species include Camphor Laurel *Cinnamomum camphora*, Wandering Jew *Tradescantia fluminensis*, Crofton Weed *Ageratina adenophora*, Mickey Mouse Plant *Ochna serrulata,* Broadleaf Paspalum *Paspalum mandiocanum* and Lantana *Lantana camara*. The groundcover is dominated by Creeping Beard Grass *Oplismenus imbecillis*, Rainbow Fern *Calochlaena dubia*, Austral Lady Fern *Diplazium australe,* Giant Maidenhair *Adiantum formosum* and Creeping Shield Fern *Lastreopsis microsora* (Plate 9).



Plate 9 PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion



BOAMBEE CREEK

Pacific Highway

Boambee Creek

CORDWELLS CREEK

Cordwells Creek Flood Channel

Cordwells Creek

Legend

- Study area
- Landscape assessment 550m buffer
- Construction footprint
- Native vegetation

Watercourses

- NonPerennial
- Perennial

Plant community type

- PCT 692, Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion

Figure 4.1: Native vegetation

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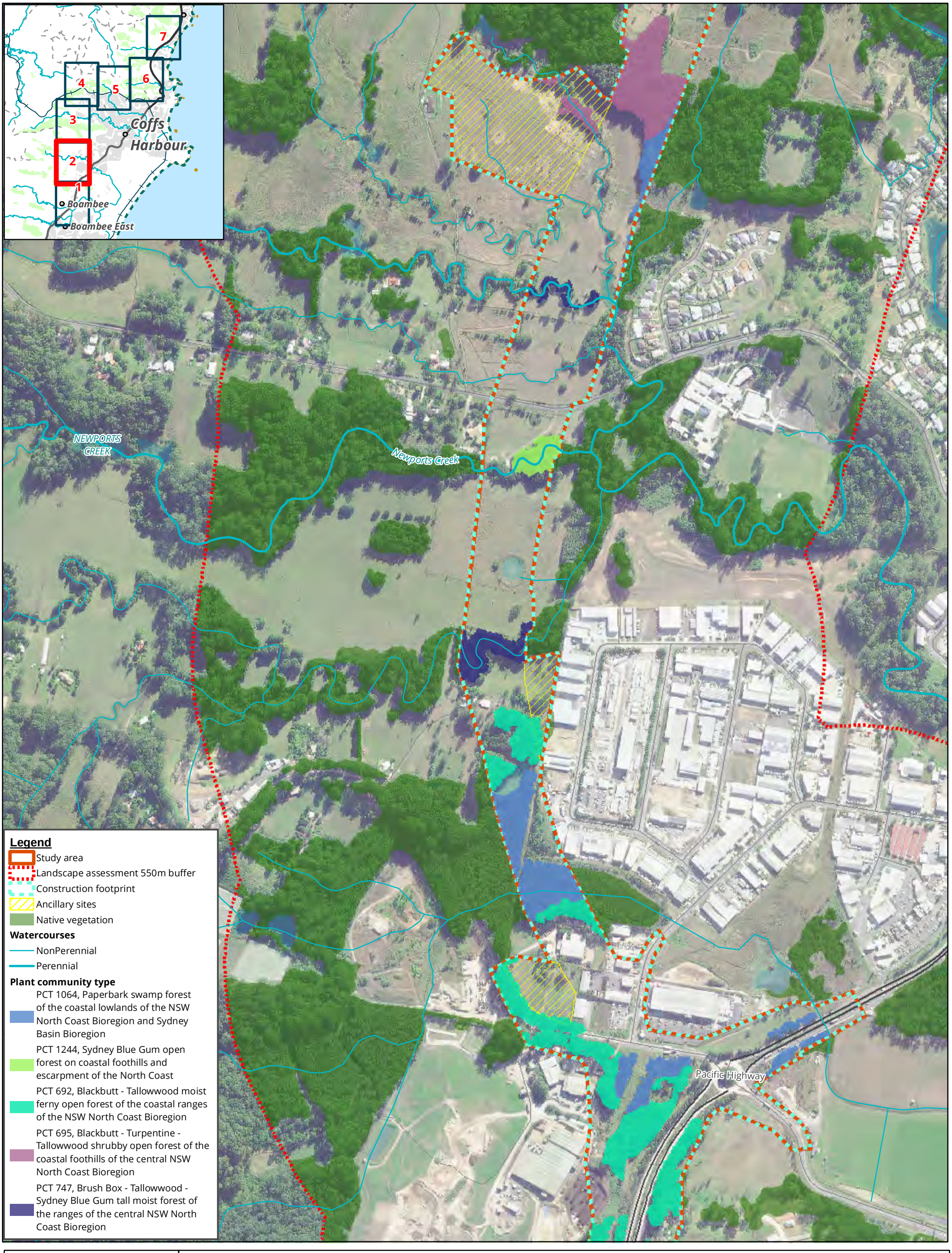
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Coordinate System: GDA 1994 MGA Zone 56

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Figure 4.2: Native vegetation

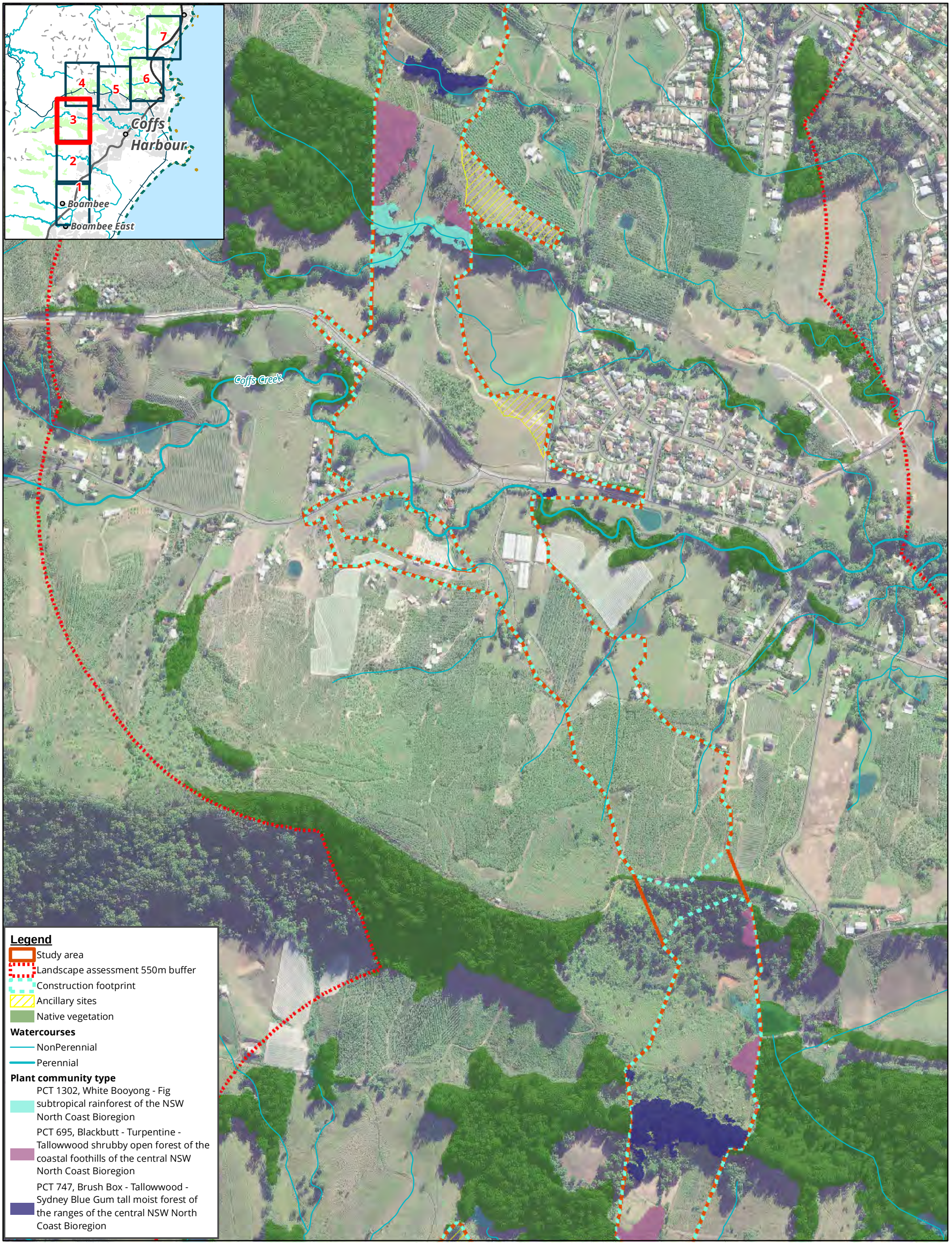
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Figure 4.3: Native vegetation

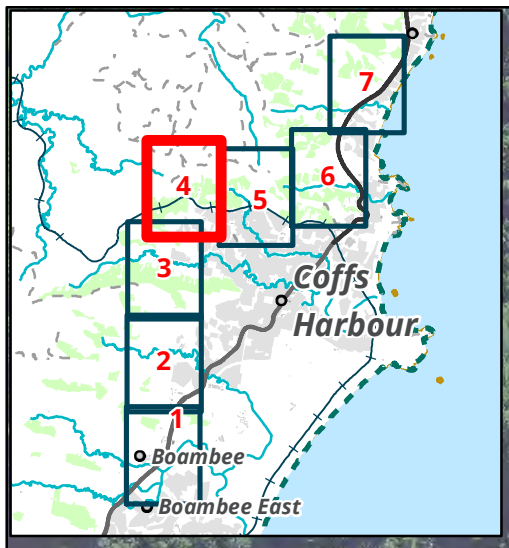
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Metres
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Coordinate System: GDA 1994 MGA Zone 56

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KARANGI CREEK

KARANGI CREEK

Karangi Creek

North Coast Railway

Legend

- Study area
- Landscape assessment 550m buffer
- Construction footprint
- Ancillary sites
- Native vegetation

Watercourses

- NonPerennial
- Perennial

Plant community type

- PCT 695, Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion
- PCT 747, Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion

Figure 4.4: Native vegetation

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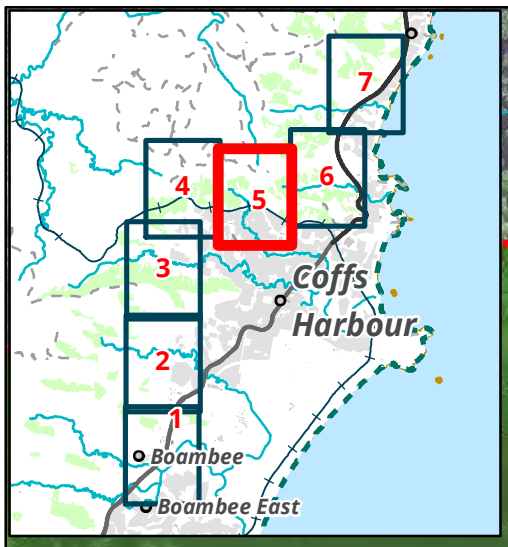
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Metres
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Bucca Bucca Creek

Jordans Creek

North Coast Railway

Treefern Creek

Legend

- Study area
- Landscape assessment 550m buffer
- Construction footprint
- Ancillary sites
- Native vegetation

Watercourses

- NonPerennial
- Perennial

Plant community type

- PCT 1302, White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion
- PCT 670, Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion
- PCT 692, Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion
- PCT 695, Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion
- PCT 747, Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion

Figure 4.5: Native vegetation

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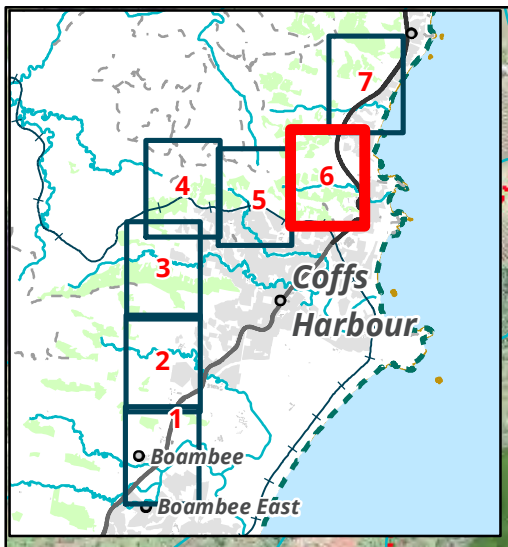


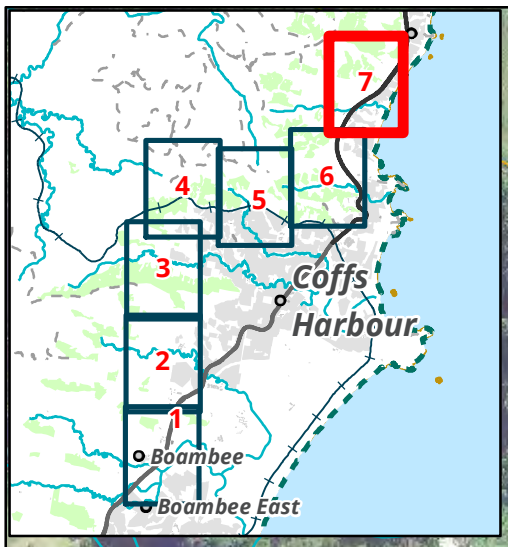
Figure 4.6: Native vegetation

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Metres
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Pacific Highway

Pine Brush Creek

PINE BRUSH CREEK

Gannet Place

Legend

- Study area
- Landscape assessment 550m buffer
- Construction footprint
- Ancillary sites
- Native vegetation

Watercourses

- NonPerennial
- Perennial

Plant community type

- PCT 1244, Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast
- PCT 1285, Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion
- PCT 692, Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion
- PCT 695, Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion

Figure 4.7: Native vegetation

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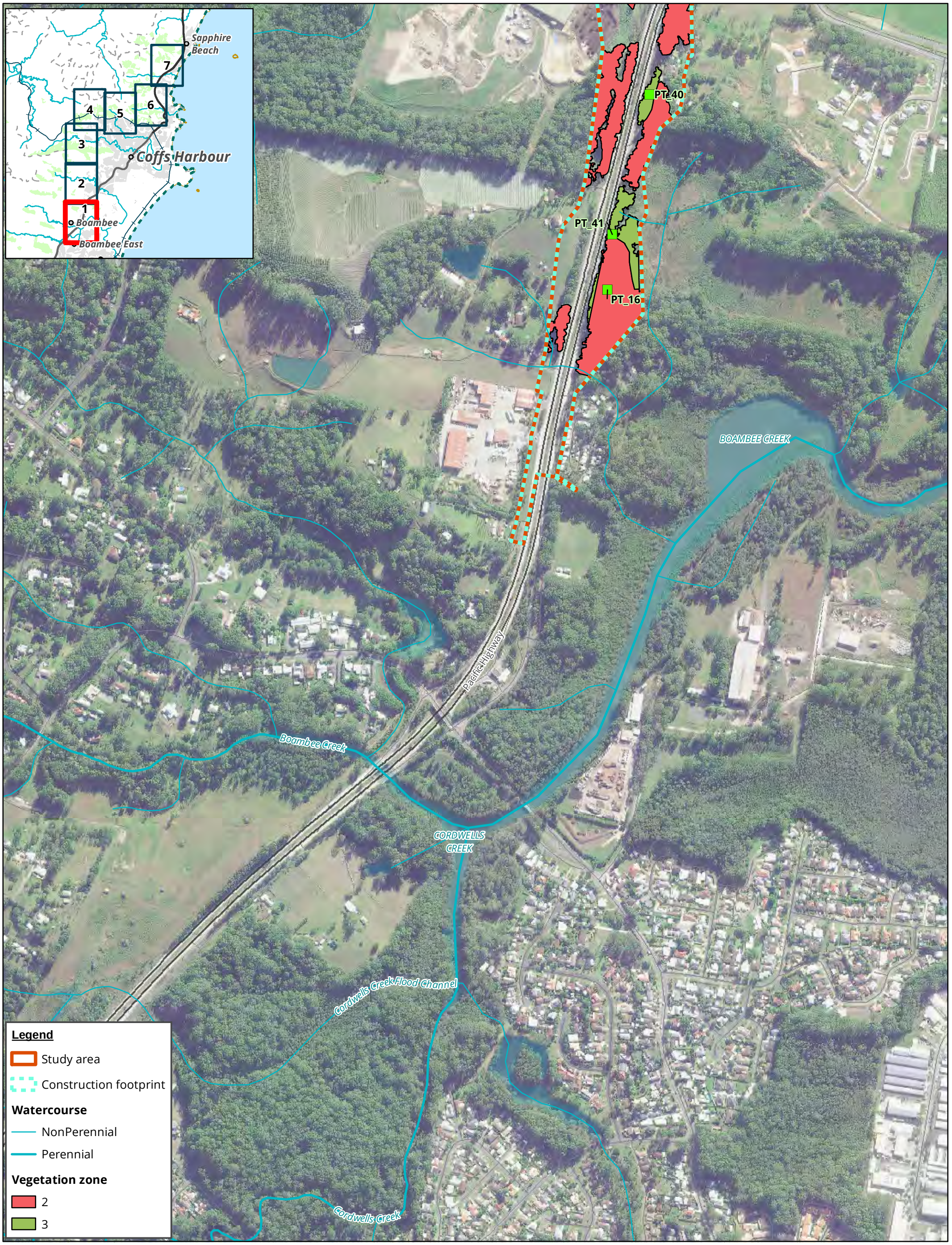


Figure 5.1: Vegetation zones

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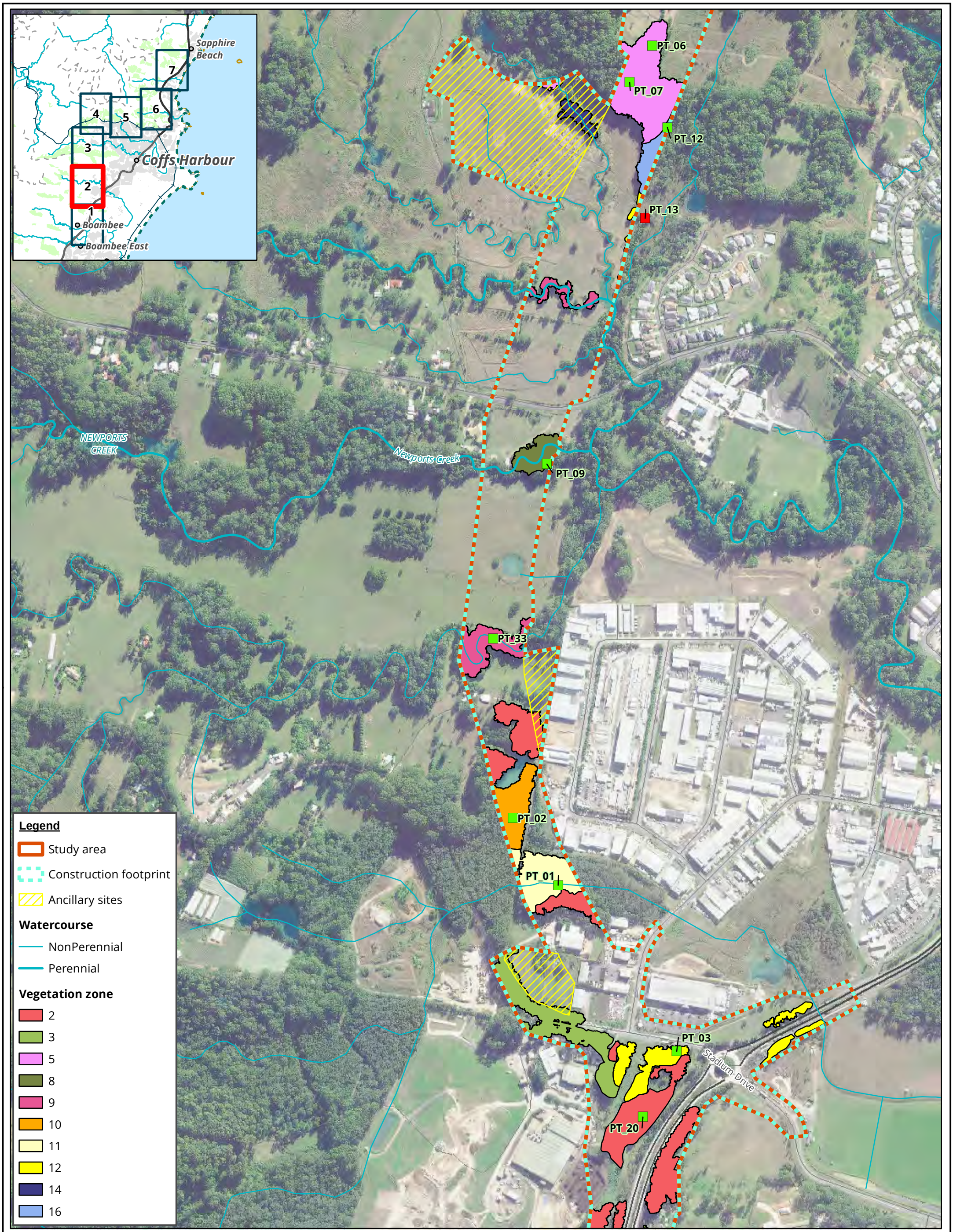


Figure 5.2: Vegetation zones

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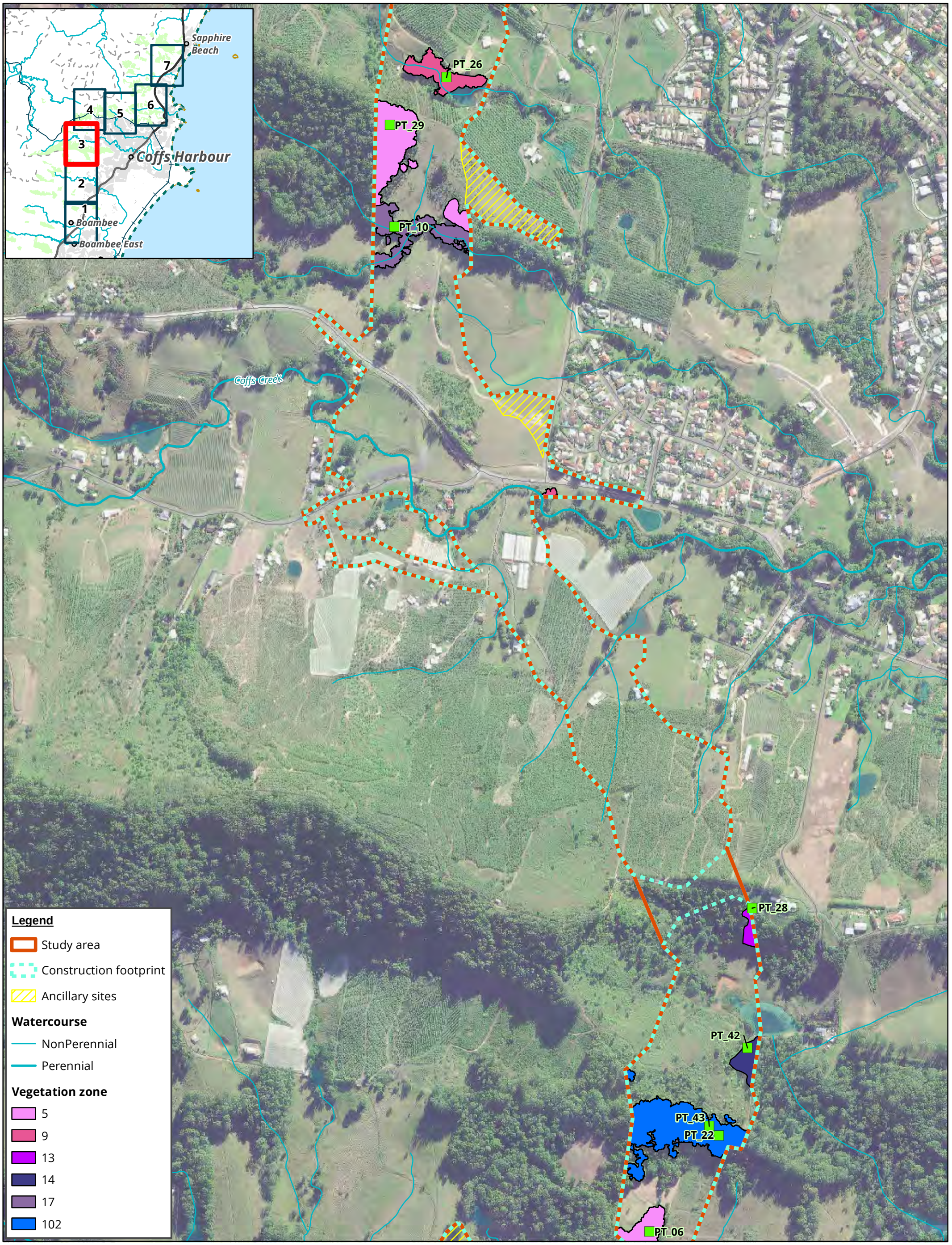


Figure 5.3: Vegetation zones

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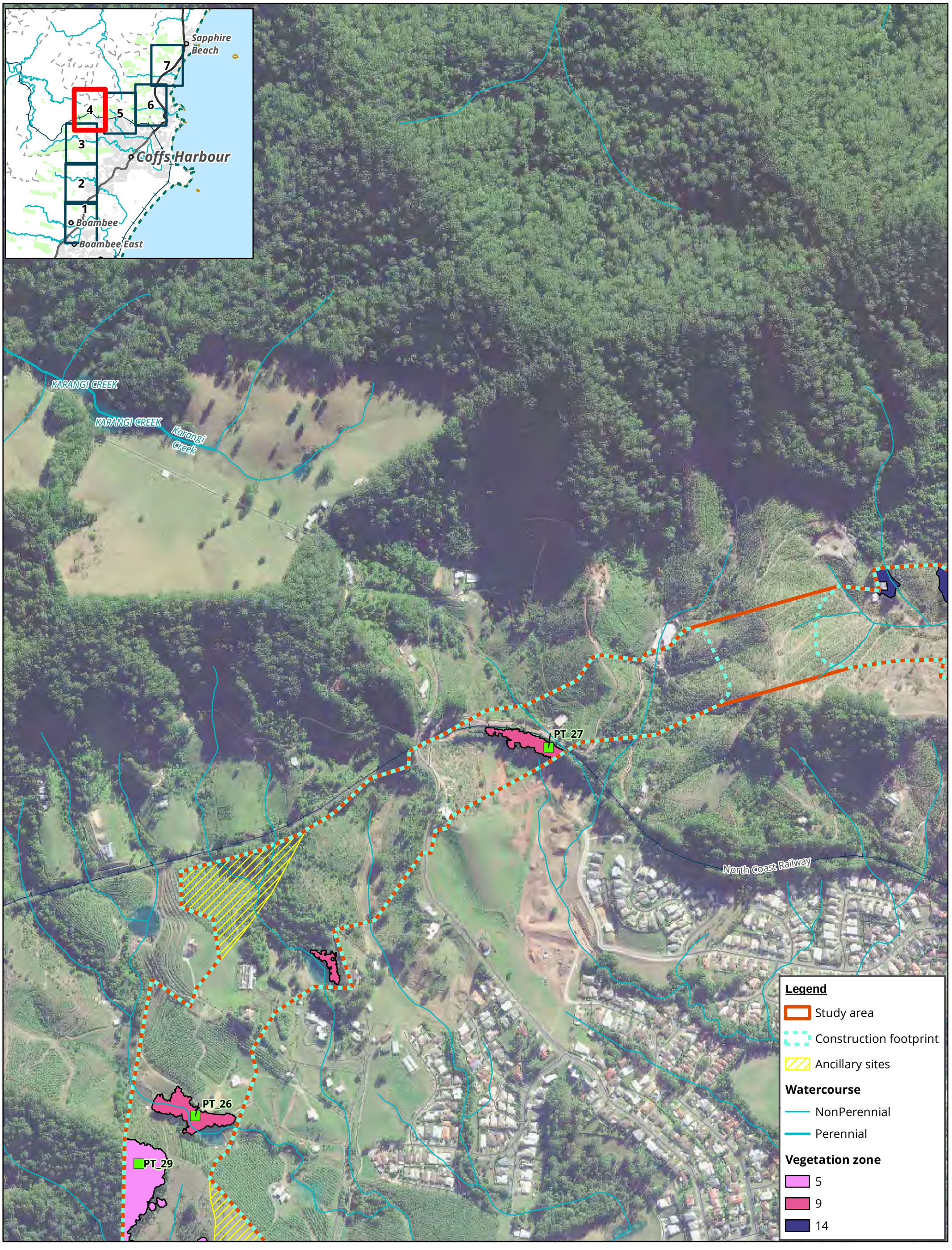


Figure 5.4: Vegetation zones

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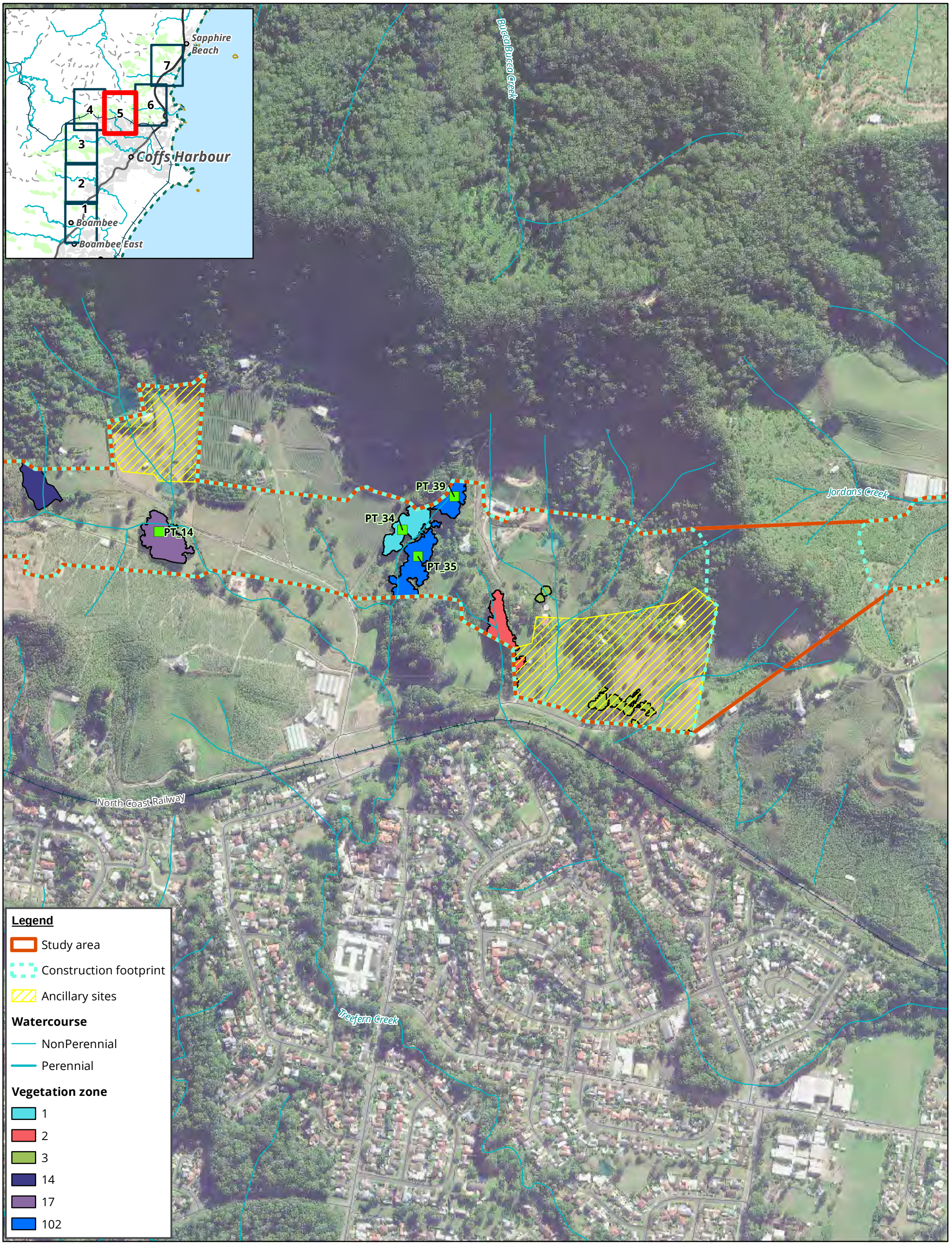


Figure 5.5: Vegetation zones

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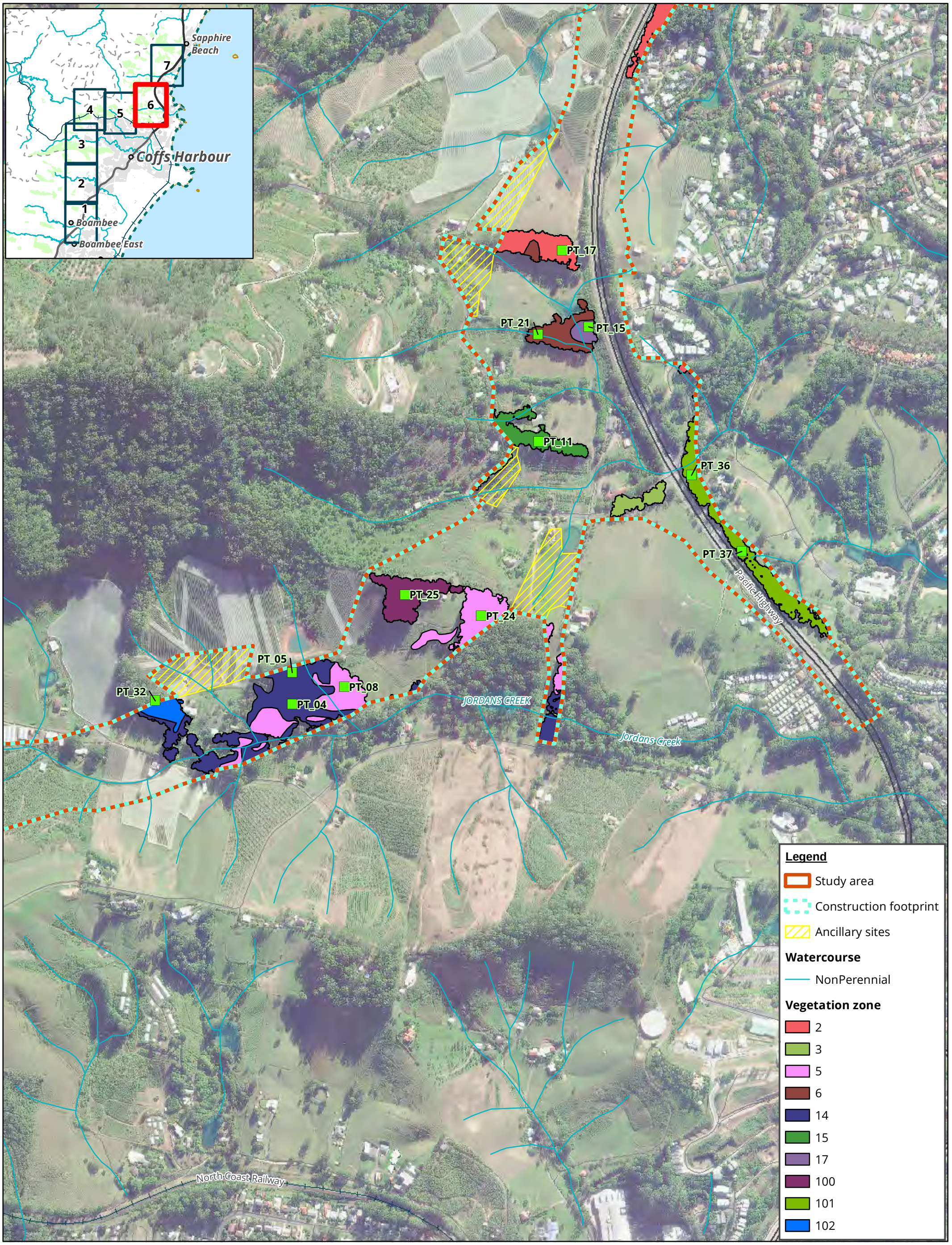


Figure 5.6: Vegetation zones

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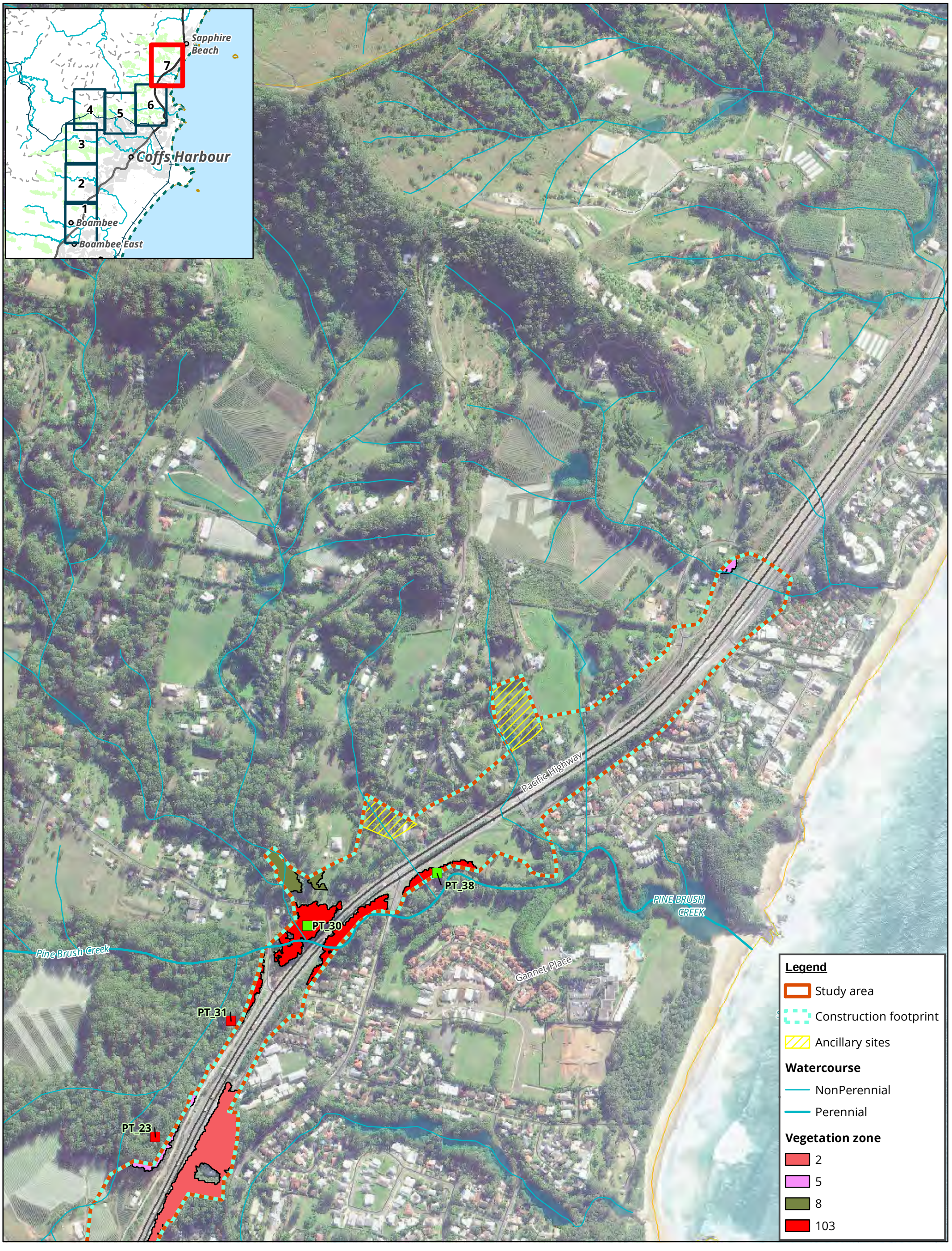


Figure 5.7: Vegetation zones

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3.2 Threatened ecological communities

Three PCTs recorded within the study area meet the description of TECs under the BC Act (see Table 3.12). Two of these PCTs (PCT1302 and PCT670) were also considered potential TECs under the EPBC Act. As the project has been deemed a controlled action under the EPBC Act, assessment of these communities has been undertaken to determine whether they satisfy listing criteria under the EPBC Act. In particular, *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions* has been identified as one of the controlling provisions for the project and PCTs 1302 and 670 can be listed as the TEC if they satisfy the key diagnostic characteristics (see section 8.3 for further details). However, neither community as it occurred within the study area met the condition class or key diagnostic species requirements of the listed community. Therefore, they were not considered to be the community as listed under the EPBC Act. TECs recorded within the study area are listed in Table 3.12 and discussed in greater detail in the following sections.

Table 3.12 TECs recorded in the study area

PCT	TEC Scientific name	Conservation status	
		EPBC	BC
PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (NR217)	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest EEC).	-	Endangered
PCT1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion (NR280)	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregion.	-	Endangered
PC 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion (NR111)		-	Endangered

3.2.1 PCT670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion (NR111)

BC Act

PCT 670 occurs within the study areas a single patch north of Treefern Creek. The PCT is known to conform to the BC Act listing for *Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion* (Lowland Rainforest). The Threatened Species Scientific Committee (TSSC) Final Determination for listing the community as endangered states that Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions is the name given to the ecological community of subtropical rainforest and some related, structurally complex forms of dry rainforest. Lowland Rainforest, in a relatively undisturbed state, has a closed canopy, characterised by a high diversity of trees. Typically, the trees form three major strata: emergents, canopy and sub-canopy. (Floyd 1990). In disturbed stands of this community the canopy continuity may be broken, or the canopy may be smothered by exotic vines. Although every stand of rainforest is unique in terms of its biota, Lowland Rainforest can be characterised by the list of species provided in the Final Determination.

The *NSW Scientific Committee Guidelines for interpreting listing criteria for species, populations and ecological communities under the NSW Threatened Species Conservation Act* (NSW Scientific Committee 2014) states a threatened ecological community is an *assemblage of species occupying a particular area*. In the case of Lowland Rainforest within the study area the 'particular area' is the NSW North Coast Bioregion, and the 'assemblage of species' is those listed in the Final Determination, 19 of which were recorded within the 20 x 10 metres floristic plot.

As such, PCT 670 within the study area is considered to conform to the BC Act listed community.

EPBC Act

This PCT has the potential to conform to the EPBC Act listing for Lowland Rainforest of Subtropical Australia however the vegetation within the study area does not meet the listing requirements for Key Diagnostic Characteristics and Condition Class requirements (TSSC 2011a, b).

Table 3.13 provides an assessment of PCT 670 against the Key Diagnostic Characteristics and Condition Thresholds for listing of a patch of vegetation as Lowland Rainforest of Subtropical Australia under the EPBC Act (TSSC 2011a, b). This assessment demonstrates that the examples of this PCT witin the study area would not be classified as a TEC under the EPBC Act.

Table 3.13 Lowland Rainforest of Subtropical Australia Key Diagnostic Characteristics and Condition Thresholds

EPBC Act key diagnostic characteristics	PCT 670
Description	Single isolated patch north of McKays Road
Area (Ha) of patch	0.51
Key diagnostic criteria	
Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland IBRA bioregions.	Yes
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments.	Yes
The ecological community generally occurs at an altitude less than 300 m above sea level.	Yes
The ecological community typically occurs in areas with high annual rainfall (>1300 mm).	Yes
The ecological community is typically more than 2 km inland from the coast.	Yes
The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.	Yes
Patches of the ecological community typically have high species richness.	Yes
Condition class requirements if patch is 0.1 ha - 1 ha (all conditions 1-4 must met)	
1. Trees listed in Appendix B of the Listing Advice (TSSC 2011b) must be present	Yes
2. The emergent/canopy/subcanopy cover must be ≥70%.	No. Canopy projective foliage cover is 30%
3. Species richness must be of ≥40 woody species listed in Appendix A of the Listing Advice (TSSC 2011b).	No. 14 woody species recorded (17 total species listed in Appendix A recorded)
4. Percent cover of native vegetation must be ≥70%.	Yes. 100% native species
Assessment against the EPBC Act key diagnostic characteristics	**No**

It should be noted that for patches under 2 hectares in area, canopy cover and species richness are to be evaluated over the entire patch, rather than within a 20 x 20 metres (species richness) and 50 metres transect (canopy cover) (BBAM plot/transect) as was the case during the current assessment. However, it is considered unlikely that the remainder of the patch (0.49 hectares) would support the significant increase in floristic diversity required for the vegetation to meet the listing threshold for species richness.

3.2.2 PCT1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion (NR280)

BC Act

PCT1302 occurs as three separate patches within the study area, one adjacent to Treefern Creek, one north of Bruxner Park Road, and one north of Coramba Road. The PCT is known to conform to the BC Act listing for *Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion* (Lowland Rainforest). The TSSC Final Determination for listing the community as endangered states that *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions* is the name given to the ecological community of subtropical rainforest and some related, structurally complex forms of dry rainforest. Lowland Rainforest, in a relatively undisturbed state, has a closed canopy, characterised by a high diversity of trees. Typically, the trees form three major strata: emergents, canopy and sub-canopy. (Floyd 1990). In disturbed stands of this community the canopy continuity may be broken, or the canopy may be smothered by exotic vines. Although every stand of rainforest is unique in terms of its biota, Lowland Rainforest can be characterised by the list of species provided in the Final Determination.

The *NSW Scientific Committee Guidelines for interpreting listing criteria for species, populations and ecological communities under the NSW Threatened Species Conservation Act* (NSW Scientific Committee 2014) states a threatened ecological community is an *assemblage of species occupying a particular area*. In the case of Lowland Rainforest within the study area the 'particular area' is the NSW North Coast Bioregion, and the 'assemblage of species' is those listed in the Final Determination, of which 33 species characteristic of Lowland Rainforest were recorded within the three 20 x 20 metres floristic plots.

As such, PCT 1302 within the study area is considered to conform to the BC Act listed community.

EPBC Act

This PCT is known to conform to the EPBC Act listing for Lowland Rainforest of Subtropical Australia however the vegetation within the study area does not meet the listing requirements for Key Diagnostic Characteristics and Condition Class requirements (TSSC 2011a, b).

Table 3.14 provides an assessment of PCT 1302 present within the study area against the Key Diagnostic Characteristics and Condition Thresholds for listing of a patch of vegetation as Lowland Rainforest of Subtropical Australia under the EPBC Act (TSSC 2011a, b).

Table 3.14 Lowland Rainforest of Subtropical Australia Key Diagnostic Characteristics and Condition Thresholds

EPBC Act key diagnostic characteristics	PCT 1302	PCT 1302	PCT 1302
Description	Isolated patch at Treefern Creek	Isolated patch at Bruxner Park Road	Riparian patch at Coramba Road
Area (ha) of patch	0.69	0.20	1.02
Key diagnostic criteria			
Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland IBRA bioregions.	Yes	Yes	Yes
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments.	Yes	Yes	Yes
The ecological community generally occurs at an altitude less than 300 m above sea level.	Yes	Yes	Yes
The ecological community typically occurs in areas with high annual rainfall (>1300 mm).	Yes	Yes	Yes
The ecological community is typically more than 2 km inland from the coast.	Yes	Yes	Yes

EPBC Act key diagnostic characteristics	PCT 1302	PCT 1302	PCT 1302
The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.	Yes	Yes	Yes
Patches of the ecological community typically have high species richness.	Yes	Yes	Yes
Condition class requirements if patch is 0.1 ha - 1 ha (all conditions 1-4 must met)			
1. Trees listed in Appendix B of the Listing Advice (TSSC 2011b) must be present	Yes	Yes	n/a (patch more than 1 ha)
2. The emergent/canopy/subcanopy cover must be ≥70%.	No. Canopy projective foliage cover is 54%	No. Canopy projective foliage cover is 44%	n/a (patch more than 1 ha)
3. Species richness must be of ≥40 woody species listed in Appendix A of the Listing Advice (TSSC 2011b).	No. 20 woody species recorded (24 total species listed in Appendix A recorded)	No. 21 woody species recorded (24 total species listed in Appendix A recorded)	n/a (patch more than 1 ha)
4. Percent cover of native vegetation must be ≥70%.	Yes. Native cover estimated at 88%	Yes. Native cover estimated at 80%	n/a (patch more than 1 ha)
Condition class requirements if patch is 1 ha - 2 ha (all conditions 1-4 must met)			
1. Trees listed in Appendix B of the Listing Advice (TSSC 2011b) must be present AND Natural regeneration present	n/a	n/a	Yes
2. The emergent/canopy/subcanopy cover must be ≥70%.	n/a	n/a	No. Canopy projective foliage cover is 23%
3. Species richness must be of ≥30 woody species listed in Appendix A of the Listing Advice (TSSC 2011b).	n/a	n/a	No. 11 woody species recorded (13 total species listed in Appendix A recorded)
4. Percent cover of native vegetation must be ≥50%.	n/a	n/a	Yes. Native cover estimated at 79%
Assessment against the EPBC Act key diagnostic characteristics	**No**	**No**	**No**

It should be noted that for patches under 2 hectares in area, canopy cover and species richness are to be evaluated over the entire patch, rather than within a 20 x 20 metres (species richness) and 50 metres transect (canopy cover) (BBAM plot/transect) as was the case during the current assessment. However it is considered unlikely that the remainder of any of the above patches would support the significant increase in floristic diversity required for the vegetation to meet the listing threshold for species richness.

3.2.3 PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (NR217)

BC Act

This PCT is known to conform to the BC Act listing for *Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (Swamp Sclerophyll Forest). The TSSC Final Determination for listing the community as endangered states that *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* is the name given to the ecological community associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Swamp Sclerophyll Forest on Coastal Floodplains generally occurs below 20 metres

(though sometimes up to 50 metres) elevation. The structure of the community is typically open forest, although partial clearing may have reduced the canopy to scattered trees. In some areas the tree stratum is low and dense, so that the community takes on the structure of scrub. The community also includes some areas of fernland and tall reedland or sedgeland, where trees are very sparse or absent. Typically these forests, scrubs, fernlands, reedlands and sedgelands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (Pressey 1989). The composition of Swamp Sclerophyll Forest on Coastal Floodplains is primarily determined by the frequency and duration of waterlogging and the texture, salinity nutrient and moisture content of the soil. Composition also varies with latitude (OEH 2018b).

The *NSW Scientific Committee Guidelines for interpreting listing criteria for species, populations and ecological communities under the NSW TSC Act* (NSW Scientific Committee 2014) states a threatened ecological community is an assemblage of species occupying a particular area. In the case of Swamp Sclerophyll Forest within the study area the 'particular area' is the NSW North Coast Bioregion, and the 'assemblage of species' is those listed in the Final Determination, 29 of which were recorded within the floristic plots undertaken with the PCT.

As such, PCT 1064 within the study area is considered to conform to the BC Act listed community.

EPBC Act

PCT1064 is not associated with any EPBC Act TECs.

3.3 Groundwater dependent ecosystems

Assessment of the potential for the study area to support groundwater dependent ecosystems (GDEs) was undertaken using the Australian Government's Bureau of Meteorology, Groundwater Dependent Ecosystems Atlas (GDE Atlas) (BOM 2018), the download of metadata from State of NSW (DPI Water 2016), and the NSW Office of Water *Risk Assessment guidelines for groundwater dependent ecosystems* (Serov et al 2012). No areas reliant on the surface expression of groundwater are mapped within the study area according to the GDE Atlas or metadata (DPI Water 2016). Nine PCTs, one a groundwater dependent wetland community and eight ground water dependent vegetation communities, all identified as 'High Probability GDEs' in the risk assessment guidelines, and reliant on subsurface expression of groundwater, are mapped within the study area (Table 3.15 and Figure 6).

Table 3.15 GDEs recorded in the study area

GDE Name	PCT Details	Landscape position
Groundwater Dependent Wetland Communities – High Probablity GDE		
Paperbark	PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (NR217)	PCT 1064 occurs in the southern and central parts of the study area east of Englands Road and west of Highlander Drive along and adjacent to tributaries of Newports Creek in the North Boambee Valley. PCT 1064 occurs on low lying, typically waterlogged ground within the study area and across the Coffs Harbour LGA this vegetation community is associated with low-lying inundated areas on alluvial floodplains and back-swamps. Areas of PCT 1064 present within the study area are considered to be ground water dependent vegetation, reliant on subsurface expression of groundwater.
Groundwater Dependent Vegetation Communities – High Probablity GDE		
Sub-Tropical Rainforest	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion (NR111)	PCT 670 occurs in well sheltered gullies and slopes at low altitudes, with only one occurrence of the PCT present within the study area north of Mackays Road.

GDE Name	PCT Details	Landscape position
Wet Sclerophyll Shrub Forests	PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (NR120)	PCT 692 is broadly located on foothills and ranges from the Manning Valley north to the Corindi River and within the study area commonly occurs towards the northern and southern end of the Project.
Wet Sclerophyll Shrub Forests	PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (NR122)	The PCT is known to occur on the ranges of the great escarpment from Dingo Tops north to Chandlers Creek. Within the study areas its occurrences include multiple locations throughout the centre and north of the alignment with the largest location adjacent to Jordans Creek.
Wet Sclerophyll Shrub Forests	PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion (NR138)	Distributed in near coastal valleys and foothills from the Nambucca Valley north to the Corindi River, the PCTs occurrence within the study area is generally associated with creeks and drainageline through the centre of the alignment.
Central Mid Elevation Sydney Blue Gum	PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast (NR258)	The PCT is generally known to exist as a tall wet forest with an over storey dominated by Sydney Blue Gum (*Eucalyptus saligna*). Two occurrences of the PCT occur within the study area to the north of the Kororo Nature Reserve and to the south of North Boambee Road.
Dry Grassy Tallowwood-Grey Gum	PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast (NR263)	Distributed throughout the coastal lowlands and foothills of the midnorth coast from the Manning Valley north to the Corindi River, this PCT exists as two patches in one location in Korara within the study area.
Open Coastal Brushbox	PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion (NR274)	Generally located on coastal lowlands and foothills from the Manning Valley north to the Corindi River, PCT 1285 occurs in two locations at the northern end of the study area adjacent to Kororo Nature Reserve, and adjacent to the existing Pacific Highway alignment near Charlesworth Bay.
Lowland Rainforest on Floodplain	PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion (NR280)	Located on the floodplains in the North Coast region, three occurrences of this PCT were recorded within the study area. these include adjacent to the Coffs Creek tributary north of Coramba Road, immediately west of Treefern Creek, and near an unnamed watercourse near Bruxner Park Road.

**Adapted from the NSW Office of Water (2012) Types of communities, including groundwater dependent vegetation, within the Northern Rivers Region (CMA)*

Further assessment of the potential for the vegetation within the study area to be a GDE reliant on the subsurface expression of groundwater was undertaken based on the information provided in the GDE Atlas and the rulesets detailed *Atlas of Groundwater Dependent Ecosystems (GDE Atlas), Phase 2 Task 5 Report: Identifying and mapping GDEs* (SKM 2012). The GDE Atlas illustrates vegetation present in the vicinity of the Newports Creek floodplain, south of Englands Road, to be the only area of High Potential GDE (from regional studies), with all other vegetation across the study area considered to be Low Potential GDE (from regional studies) (Figure 6). The landscape setting and flora species

composition of the vegetation within the study area supports the GDE Atlas as to the potential presence of GDEs within the study area.

Downstream impacts on hydrology and environmental flows on surface vegetation and groundwater dependent ecosystems are not assessed as part of the FBA. However, impacts to the surface expressions of GDEs have been assessed and further details are provided in Section 8.4 and relevant offsetting implications outlined in Section 10.

Potential indirect impacts to the SEPP (Coastal Management) 2018 mapped wetland that occurs within 100 metres to the east of the southern extent of the study area (Figure 3) are also addressed in Section 8.4.

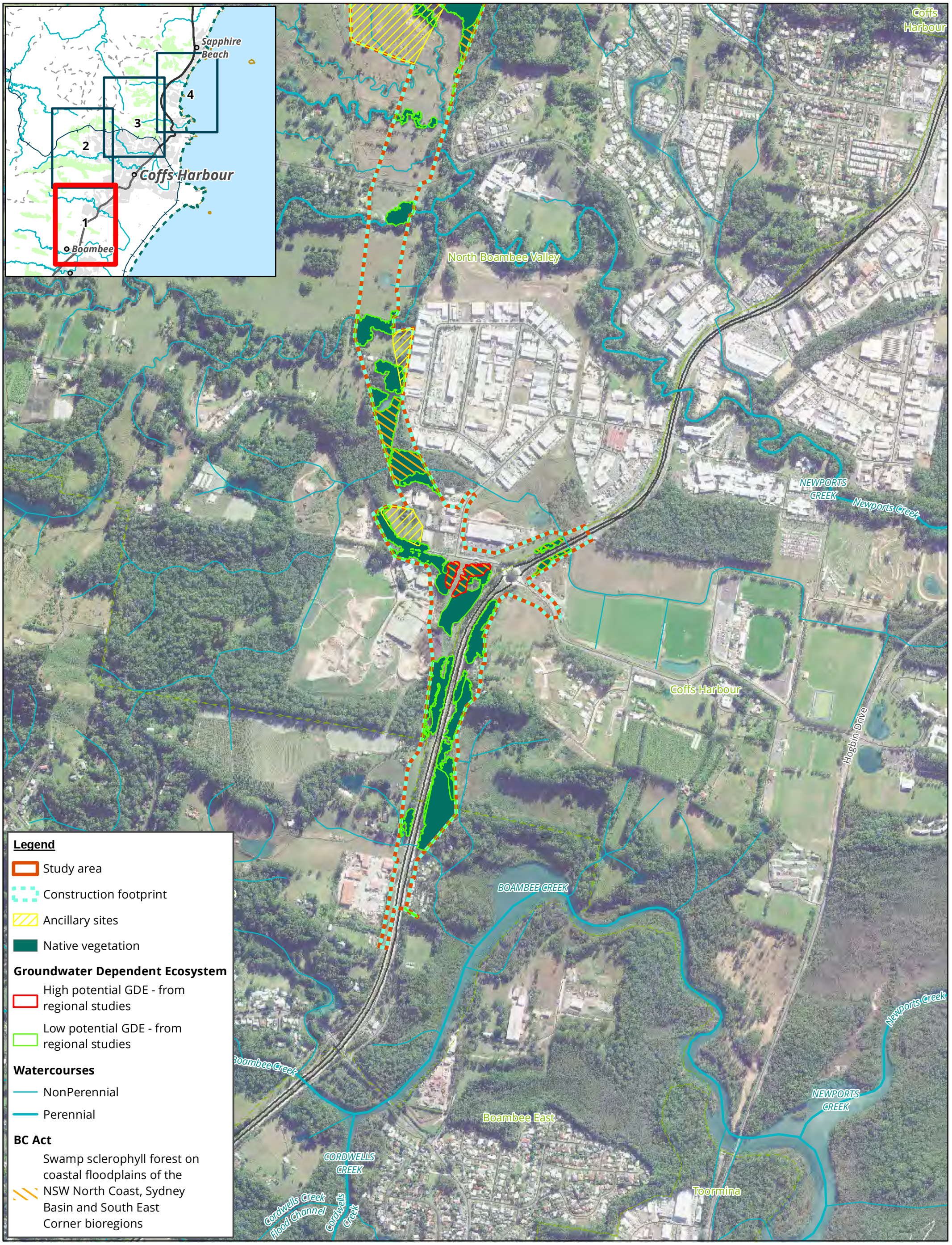


Figure 6.1: Threatened Ecological Communities and GDEs

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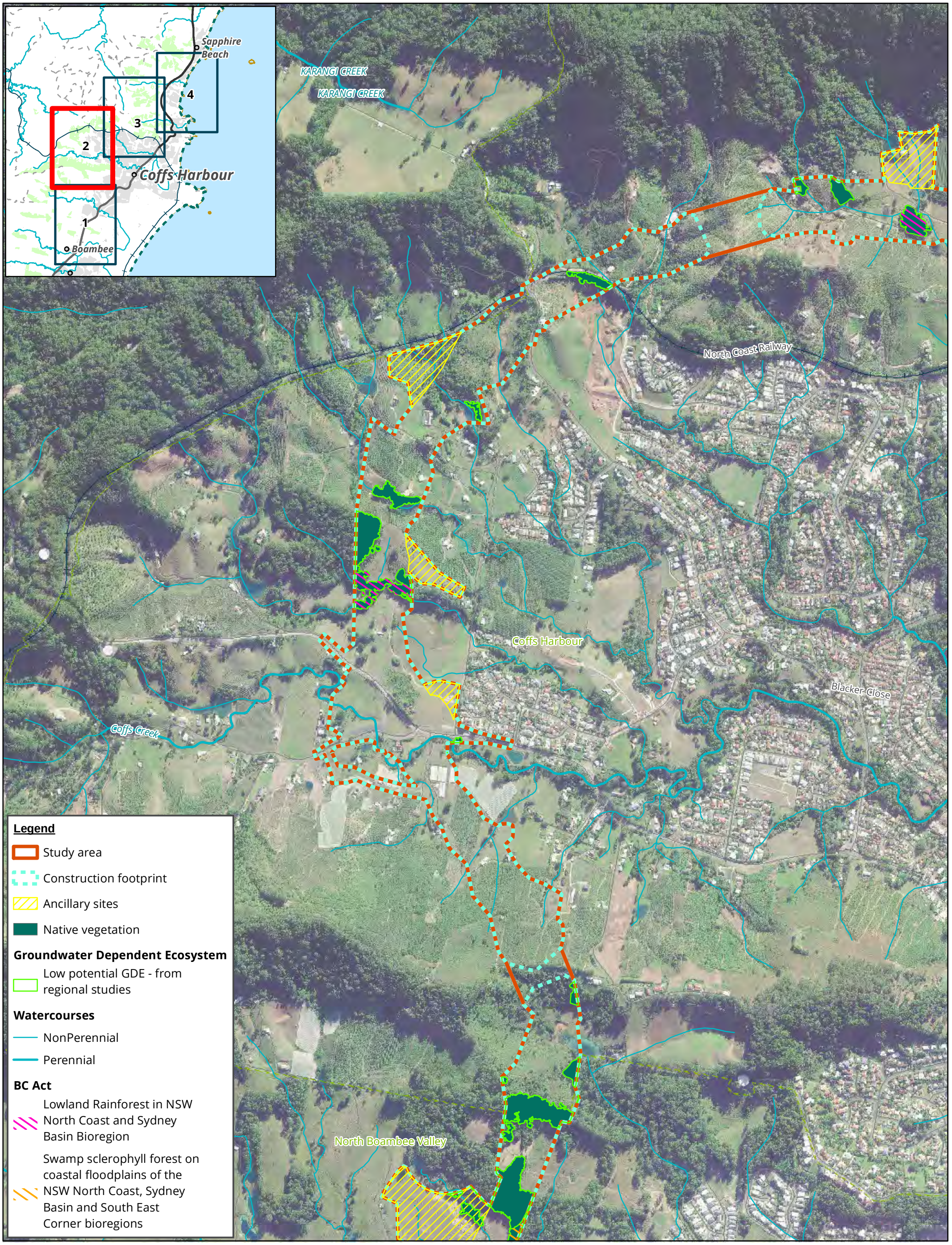


Figure 6.2: Threatened Ecological Communities and GDEs

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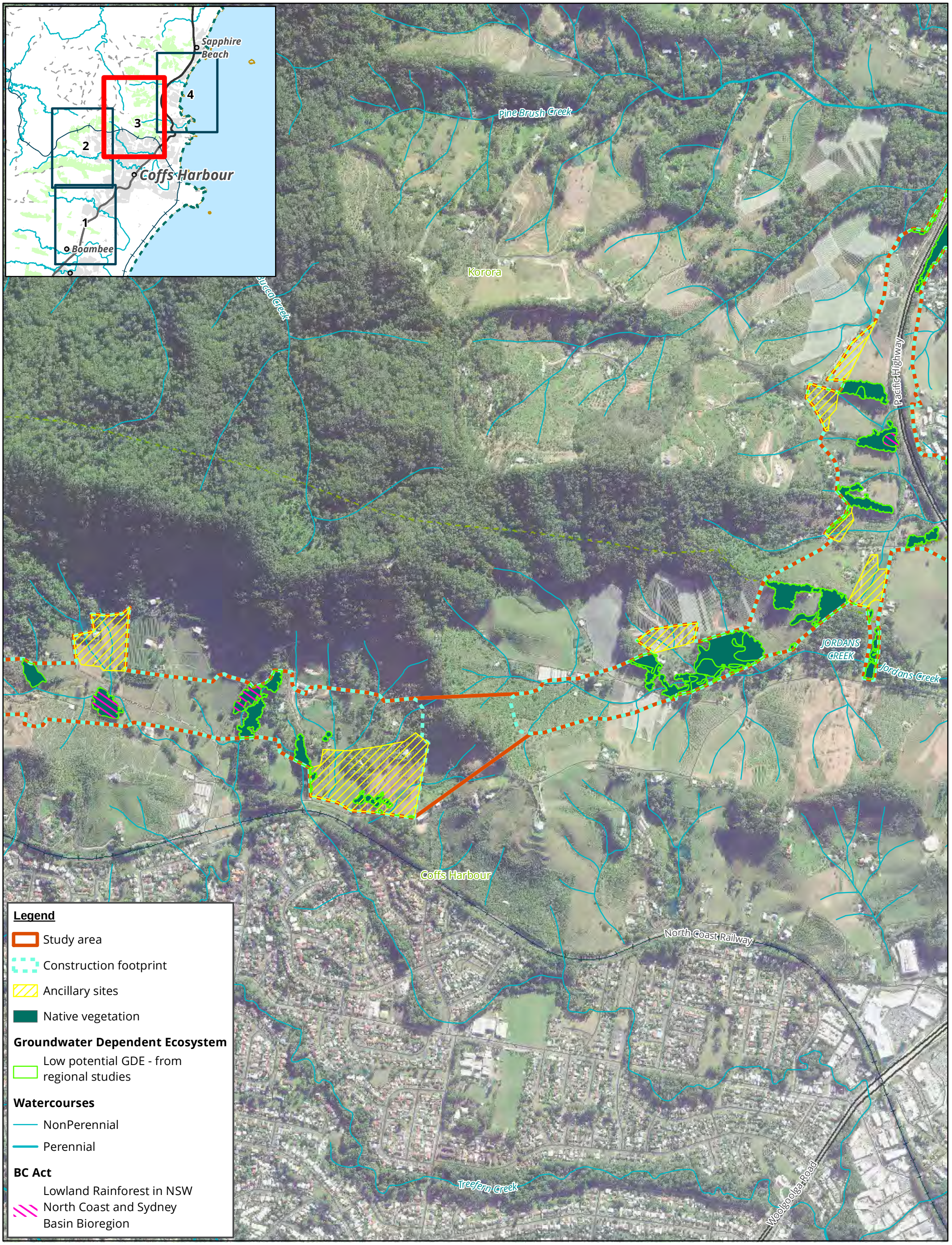


Figure 6.3: Threatened Ecological Communities and GDEs

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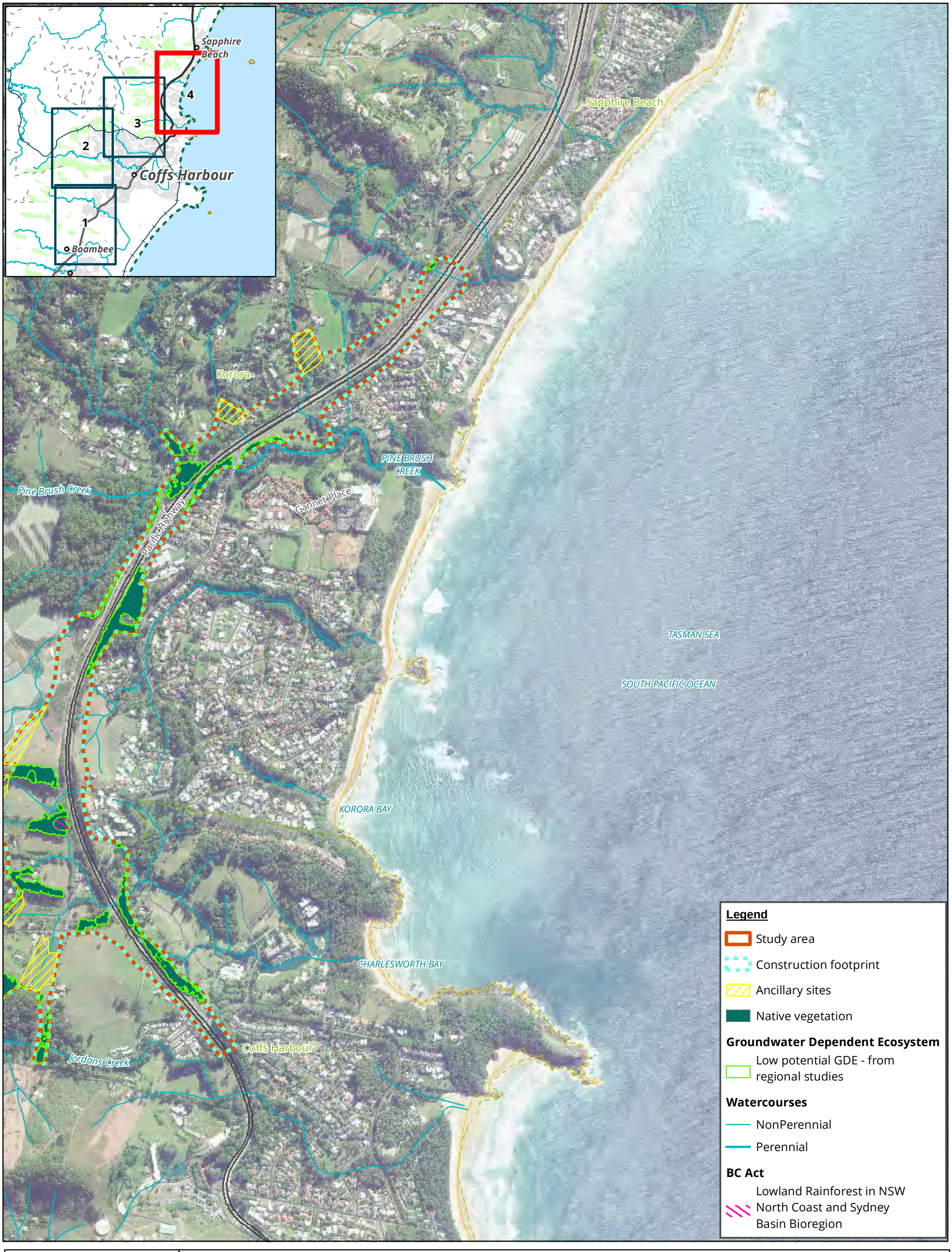


Figure 6.4: Threatened Ecological Communities and GDEs

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4 Threatened species

4.1 Candidate species

In order to provide a context for the study area, information about flora and fauna from within a 10 kilometre radius of the study area (the 'locality') was obtained from relevant public databases. Outlined in Section 3.1.1 above.

A preliminary assessment was undertaken using the OEH BioBanking Credit Calculator for Major Projects and BioBanking – Version 4.1 (BioBanking Calculator) to identify any additional threatened species not identified by database searches. PCTs that were ground-truthed and mapped during preliminary field investigations were entered into the BioBanking Calculator with maximum values included for landscape scores, patch sizes and vegetation condition to generate a complete list of candidate threatened species potentially present within the study area. Threatened species identified by the preliminary assessment were included in the list of candidate species for further consideration.

The full list of candidate species was further analysed and was used to develop a list of candidate threatened species requiring further assessment. Species habitat requirements, the presence of these habitats within the study area, the presence of existing records of threatened species in the locality, and an overall likelihood of occurrence within the study area was determined for each candidate species (refer Appendix B). This process identified the need for targeted survey of 24 threatened flora species and 33 threatened fauna species. Surveys for these species are detailed in the following sections.

4.2 Threatened species survey

4.2.1 Terrestrial flora surveys

The process outlined in Section 3.1.2 identified 24 candidate threatened flora species requiring further assessment in accordance with the FBA (OEH 2014b), these species are listed below in Table 4.1.

Table 4.1 Candidate threatened flora species

Scientific name	Common name	Conservation status	
		EPBC	BC
Alexfloydia repens	Floyd's Grass		E1
Arthraxon hispidus	Hairy Jointgrass	VU	V
Boronia umbellata	Orara Boronia	VU	V
Diospyros mabacea	Red-fruited Ebony	EN	E1
Diploglottis campbellii	Small-leaved Tamarind	EN	E1
Eidothea hardeniana	Nightcap Oak	CE	E1
Eleocharis tetraquetra	Square-stemmed Spike-rush		E1
Endiandra floydii	Crystal Creek Walnut	EN	E1
Endiandra hayesii	Rusty Rose Walnut	VU	V
Hakea archaeoides	Big Nellie Hakea	VU	V
Kennedia retrorsa		VU	V
Lindsaea incisa	Slender Screw Fern		E1
Marsdenia longiloba	Slender Marsdenia	VU	E1
Niemeyera whitei	Rusty Plum, Plum Boxwood		V

Scientific name	Common name	Conservation status	
		EPBC	BC
Parsonsia dorrigoensis	Milky Silkpod	EN	V
Peristeranthus hillii	Brown Fairy-chain Orchid		V
Phaius australis	Southern Swamp Orchid	EN	E1
Pomaderris queenslandica	Scant Pomaderris		E1
Quassia sp. Moonee Creek (BC Act listing) *Samadera* sp. Moonee Creek (EPBC Act listing)	Moonee Quassia	EN	E1
Senna acclinis	Rainforest Cassia		E1
Thesium australe	Austral Toadflax	VU	V
Tylophora woollsii	Cryptic Forest Twiner	EN	E1
T*yphonium* sp. aff. *brownii*	Stinky Lily		E1
Uromyrtus australis	Peach Myrtle	EN	E1

EPBC Act: VU – Vulnerable; EN – Endangered; CE – Critically Endangered. TSC Act: V – Vulnerable; E1 – Endangered; CE – Critically Endangered

Targeted surveys were undertaken over two survey phases; Spring (October and November) 2016 and late summer (February) 2017 to meet the seasonal survey requirements of cryptic taxa in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016). Targeted flora survey was intensive and, in accordance with OEH (2016) involved traversing parallel transects 5 to 10 metres apart through native vegetation considered potential habitat for the target species within the construction footprint (Figure 7). Transect lines were preloaded onto handheld Differential GPS units to provide up to 1 metre accuracy for locations. All threatened flora records were captured using these highly accurate GPS units to ensure the accuracy of impacts from the project were maintained.

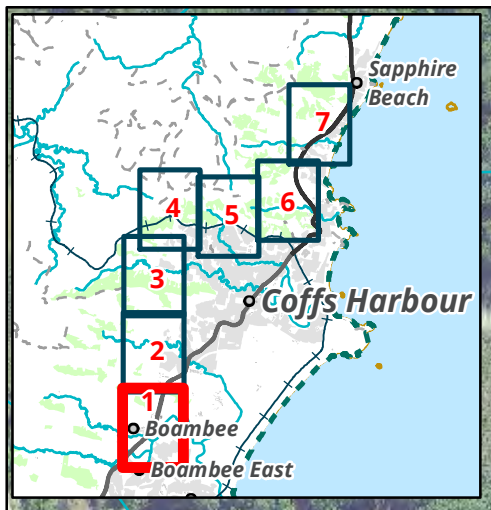
Targeted flora surveys consisted of 259 person hours over the three field survey periods.

Weather observations for each survey date are shown in Table 4.2.

Table 4.2 Weather observations (Coffs Harbour Airport Weather Station – BoM)

Survey date	Temperature (°C)		Rainfall to 0900 hrs (mm)
	Minimum (recorded at 0900 hrs)	Maximum (recorded at 1500 hrs)	
24 October2016	8.2	21.4	0
25 October 2016	8.3	23.7	0
26 October 2016	9.6	27.2	0
27 October 2016	13.8	29.3	0
28 October 2016	18.5	25.0	0
29 October 2016	14.9	25.1	0.5
30 October 2016	18.9	27.6	0
31 October 2016	9.4	29.4	0.6
01 November 2016	5.7	24.7	28.0
02 November 2016	15.8	23.9	38.8

Survey date	Temperature (°C)		Rainfall to 0900 hrs
19 February 2017	22.9	26.8	0.1
20 February 2017	19.6	27.1	16.2
21 February 2017	15.6	26.1	0
22 February 2017	20.2	27.2	1.0
23 February 2017	17.0	27.8	0
24 February 2017	16.6	27.2	0
25 February 2017	19.9	27.8	0
26 February 2017	20.3	27.1	8.0
27 February 2017	19.0	23.1	6.8
28 February 2017	18.9	23.2	37.6



BOAMBEE CREEK

Pacific Highway

Boambee Creek

CORDWELLS CREEK

Cordwells Creek Flood Channel

Cordwells Creek

Legend

- Study area
- Construction footprint
- Targeted Flora Survey – February 2017
- Targeted Flora Survey – October 2016

Perenniality

- NonPerennial
- Perennial
- Native vegetation

Figure 7.1: Threatened flora survey effort

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Matter: 22156
Date: 24 May 2019,
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Location:P:\22100s\22156\Mapping\
22156_F7.1-3,5_ThrFloraSurveyEffort

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Metres
Scale 1:7,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

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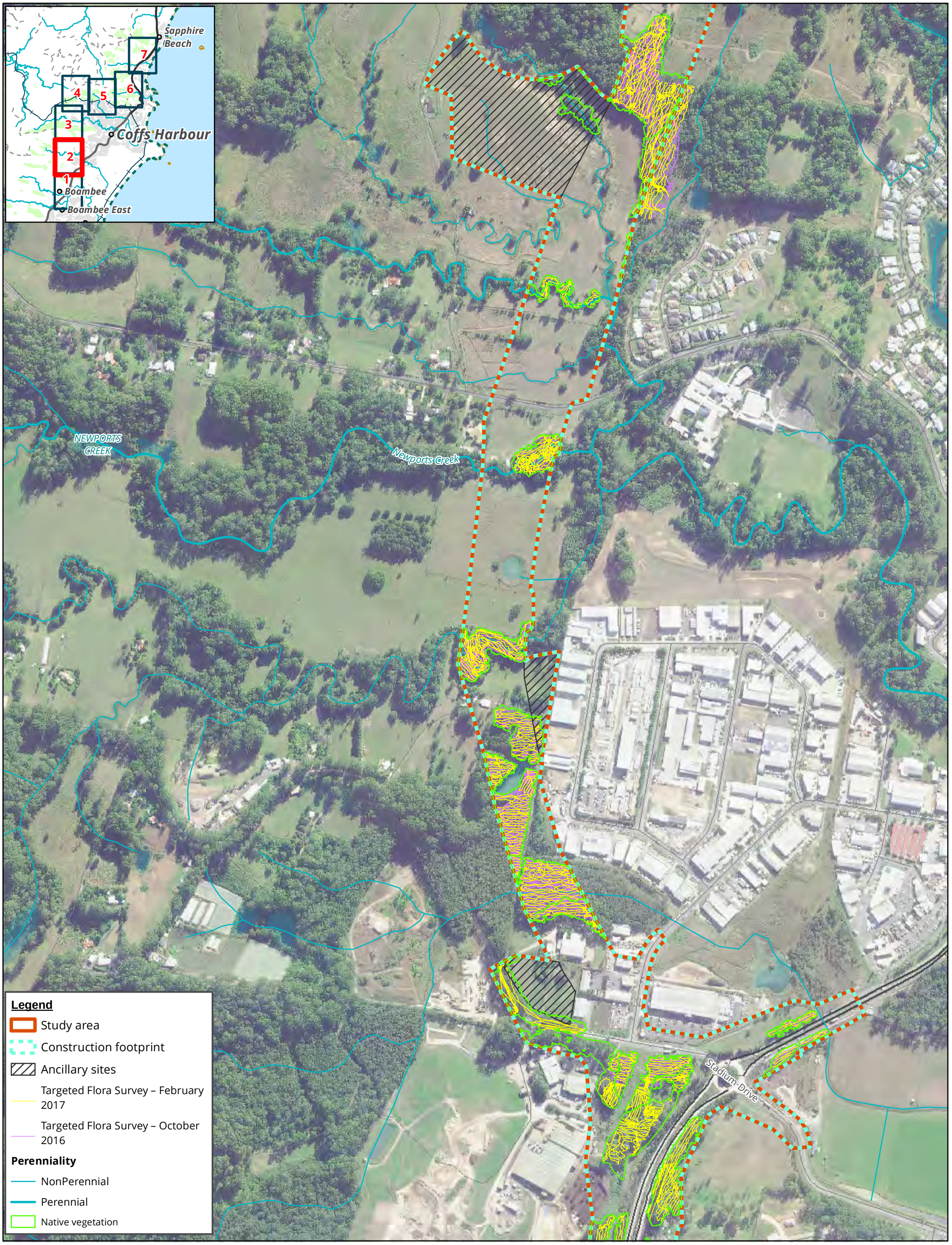


Figure 7.2: Threatened flora survey effort

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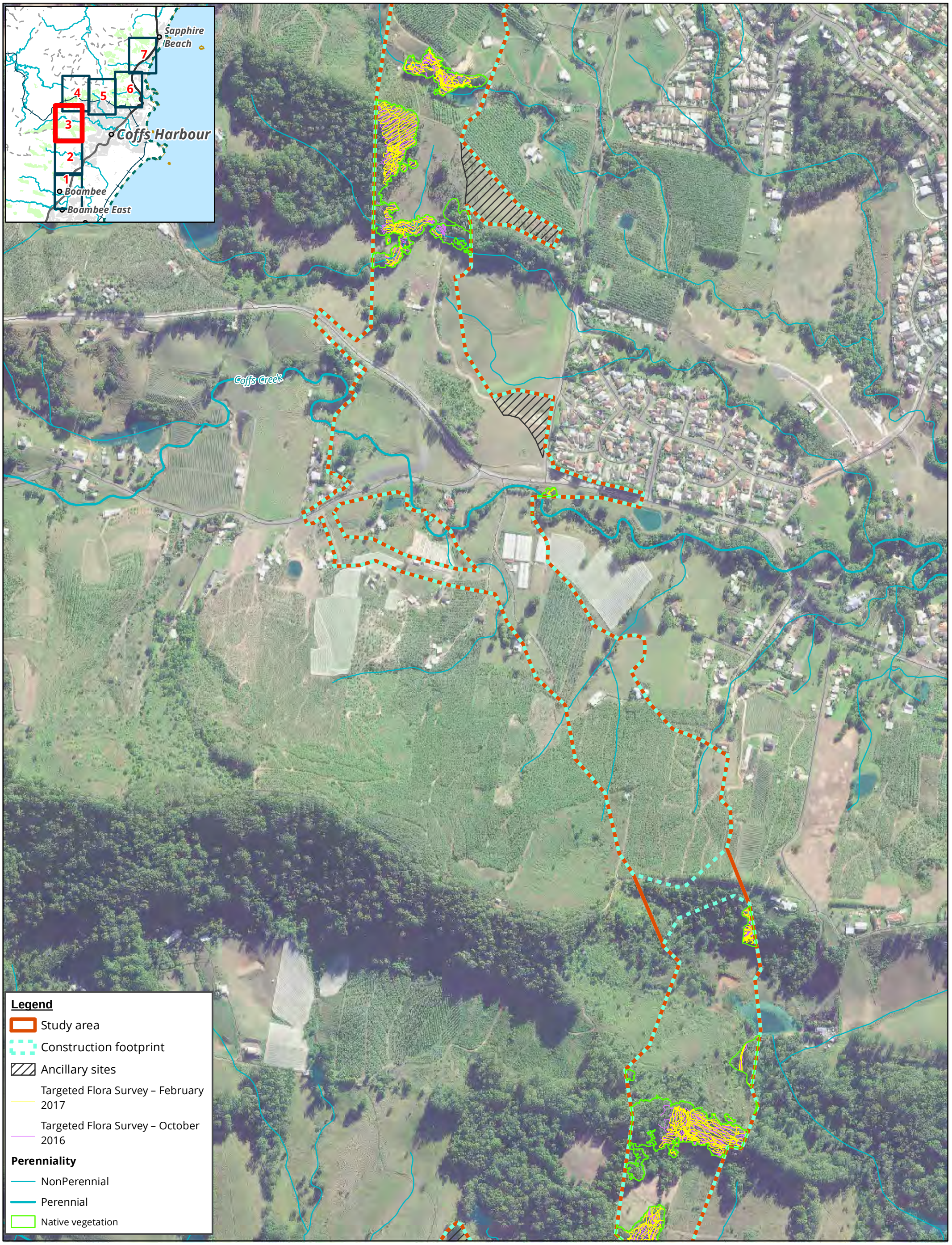


Figure 7.3: Threatened flora survey effort

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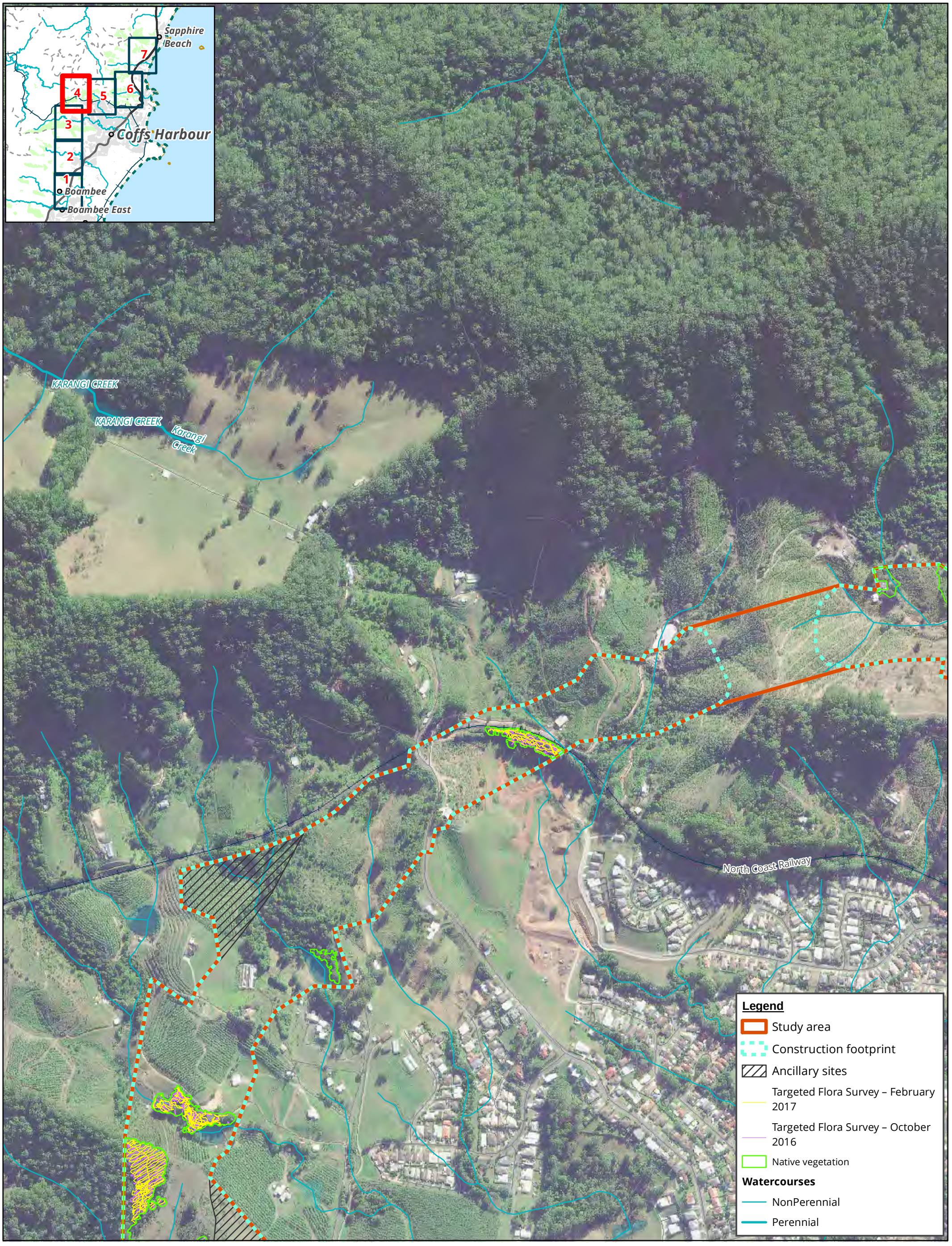


Figure 7.4: Threatened flora survey effort

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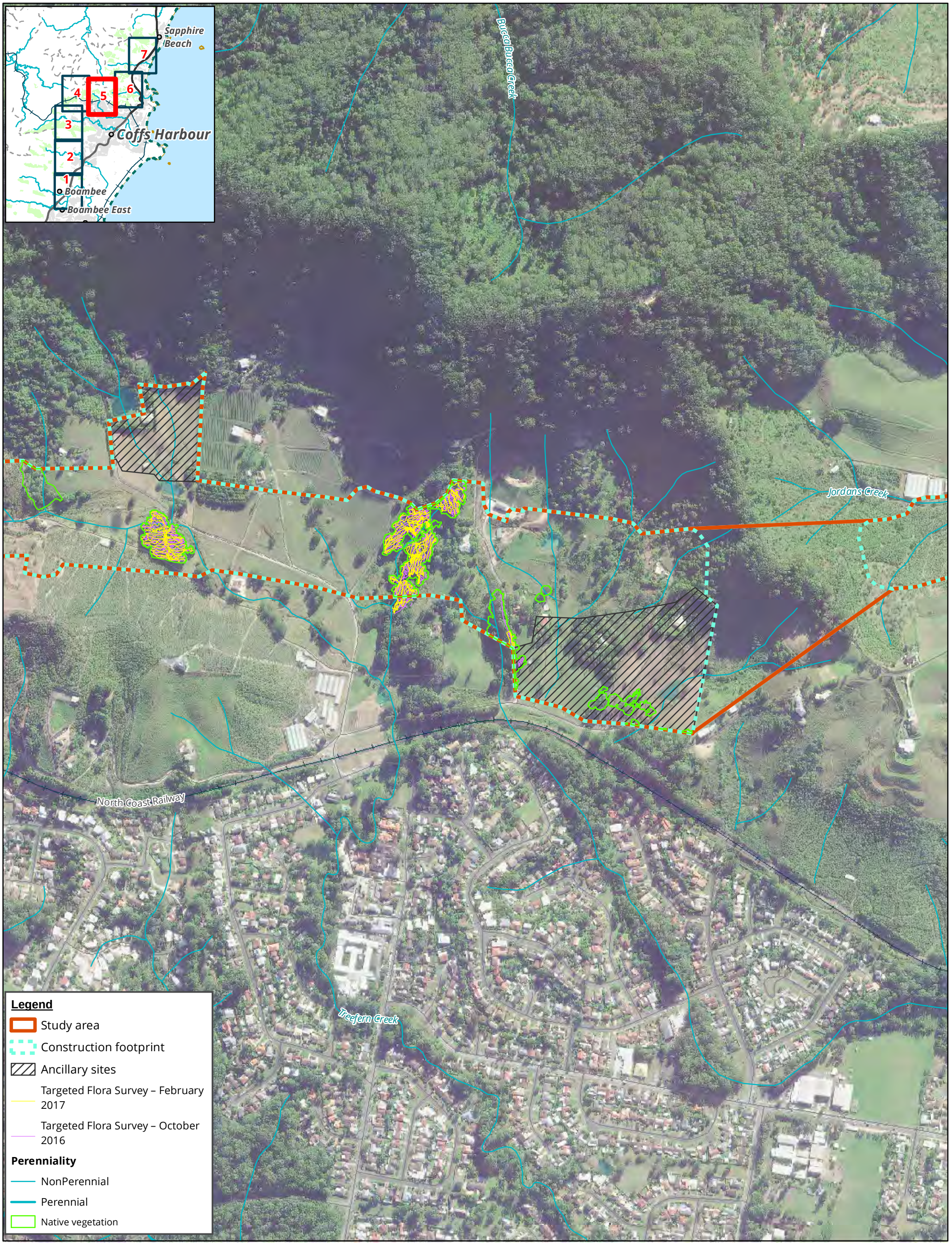


Figure 7.5: Threatened flora survey effort

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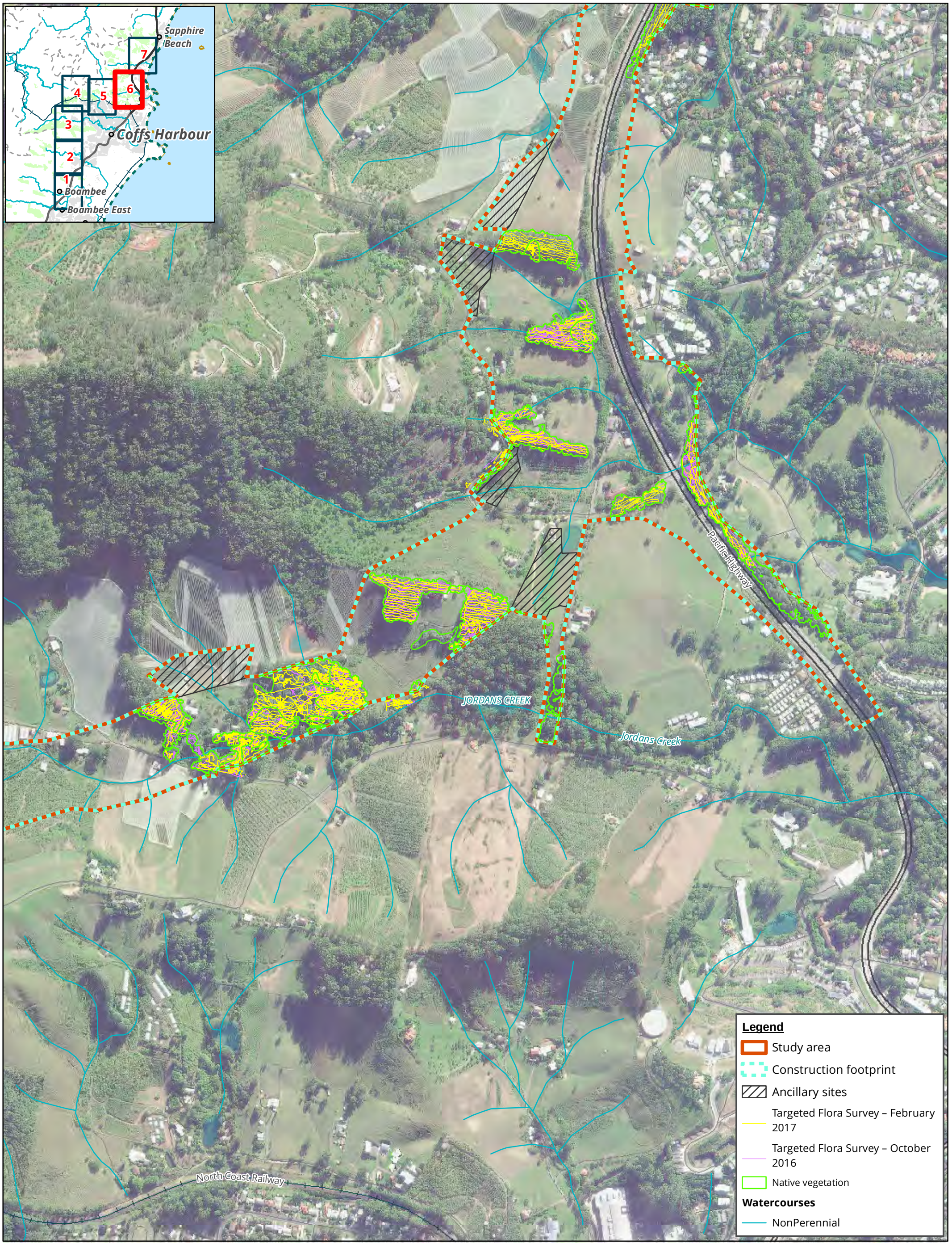


Figure 7.6: Threatened flora survey effort

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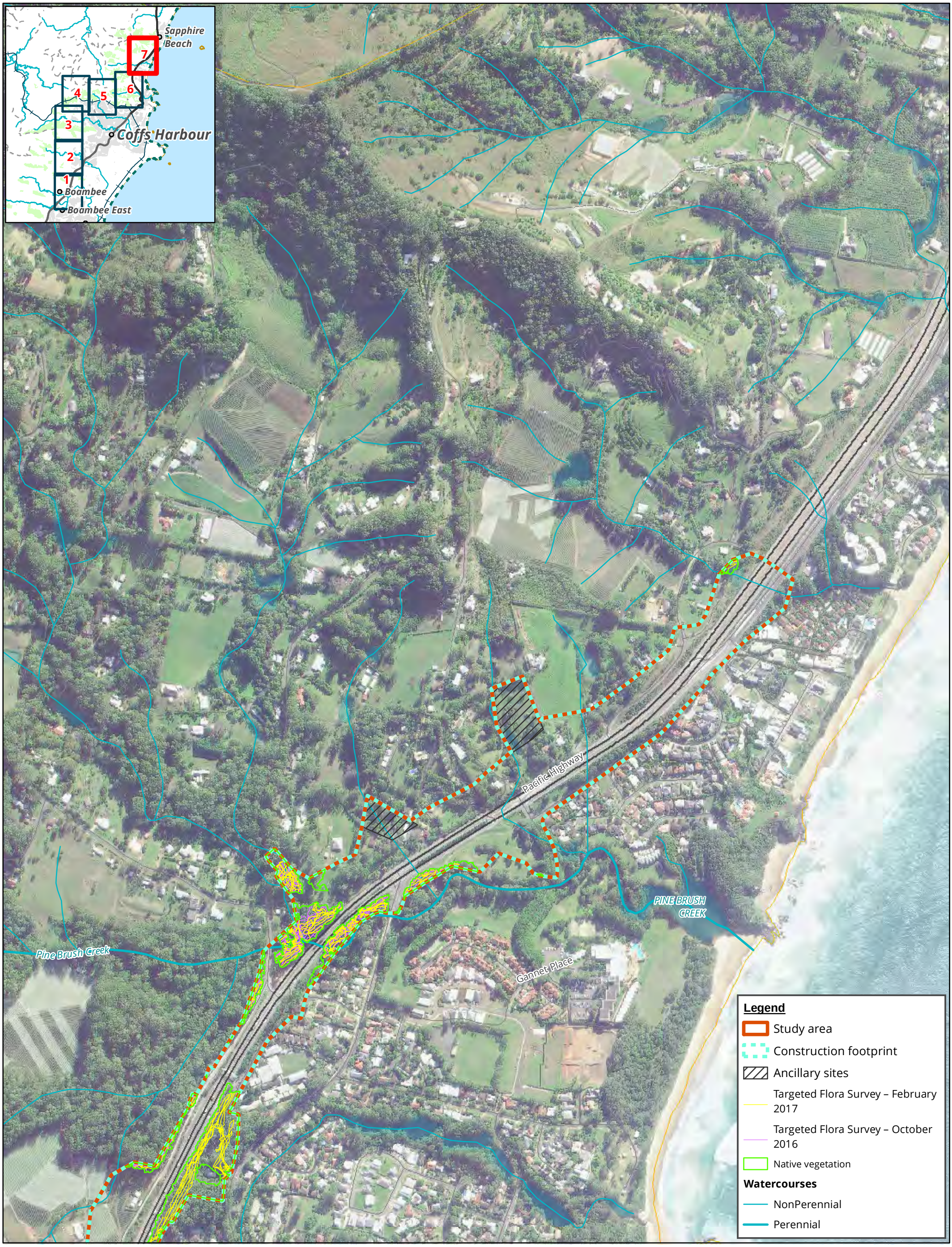


Figure 7.7: Threatened flora survey effort

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4.2.2 Terrestrial fauna surveys

Twenty-eight threatened fauna, listed as species credit species under the FBA and/or listed as threatened under the EPBC Act were identified as candidate threatened fauna requiring targeted surveys in accordance with the Section 6.5 of the FBA (OEH 2014a) and provisions of the EPBC Act (Table 4.3). Candidate species credit species were identified in accordance with Section 6.5 of the FBA and are based on existing records from database searches and habitat suitability assessments as those that had a moderate to high likelihood of occurrence within the study area (refer Appendix B).

In accordance with Section 6.3 of the FBA (OEH 2014a), ecosystem credit species are predicted to occur within relevant vegetation zones and targeted survey is not required. However, where ecosystem credit species have a high threatened species offset multiplier and can therefore influence ecosystem credit requirements, detailed habitat assessment and / or targeted surveys is warranted.

Five ecosystem credit species with an offset multiplier of greater than 2.2 were therefore included in the list of candidate threatened fauna requiring targeted surveys. These species include:

- Yellow-bellied Glider *Petaurus australis*
- Barking Owl *Ninox connivens*
- Powerful Owl *Ninox strenua*
- Masked Owl *Tyto novaehollandiae*
- Sooty Owl *Tyto tenebricosa.*

Table 4.3 Candidate threatened fauna species requiring targeted surveys

Scientific name	Common name	Conservation status	
		EPBC	BC / FM
Mammals			
Cercartetus nanus	Eastern Pygmy-possum	-	V
Dasyurus maculatus maculatus	Spotted-tail Quoll	EN	V
Miniopterus australis	Little Bentwing-bat	-	V
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	-	V
Myotis macropus	Southern Myotis	-	V
Petaurus norfolcensis	Squirrel Glider	-	V
Petaurus australis	Yellow-bellied Glider	-	V
Phascogale tapoatafa	Brush-tailed Phascogale	-	V
Phascolarctos cinereus	Koala	VU	V
Planigale maculata	Common Planigale	-	V
Potorous tridactylus tridactylus	Long-nosed Potoroo	VU	V
Pteropus poliocephalus	Grey-headed Flying-fox	VU	V
Birds			
Anthochaera phrygia	Regent Honeyeater	CE	E4A

Scientific name	Common name	Conservation status	
		EPBC	BC / FM
Dromaius novaehollandiae	Emu	-	E2
Ephippiorhynchus asiaticus	Black-necked Stork	-	E1
Irediparra gallinacea	Comb-crested Jacana	-	V
Ixobrychus flavicollis	Black Bittern	-	V
Lathamus discolor	Swift Parrot	CE	E
Ninox connivens	Barking Owl	-	V
Ninox strenua	Powerful Owl	-	V
Tyto novaehollandiae	Masked Owl	-	V
Tyto tenebricosa	Sooty Owl	-	V
Pandion cristatus	Osprey	-	V
Reptiles			
Hoplocephalus stephensii	Stephens' Banded Snake	-	V
Fish			
Nannoperca oxleyana	Oxleyan Pygmy Perch	EN	E1
Frogs			
Crinia tinnula	Wallum Froglet	-	V
Litoria aurea	Green and Golden Bell Frog	VU	E1
Litoria brevipalmata	Green-thighed Frog	-	V
Mixophyes balbus	Stuttering Frog	VU	E1
Mixophyes iteratus	Giant Barred Frog	EN	E1
Invertebrates			
Argyreus hyperbius	Australian Fritillary	CE	E1
Ocybadistes knightorum	Black Grass-dart Butterfly	-	E1
Petalura litorea	Coastal Petaltail	-	E1

EPBC Act: VU – Vulnerable; EN – Endangered; CE – Critically Endangered. TSC Act: V – Vulnerable; E1 – Endangered; E2 – Endangered Population; CE – Critically Endangered

Threatened fauna surveys were conducted for the above species across nine separate field campaigns during spring 2016, March 2017, winter 2017, spring / summer 2017-2018 and autumn 2018. Fauna surveys were undertaken in accordance with relevant State and Commonwealth guidelines including:

- Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities (OEH 2004).
- Threatened species survey and assessment guidelines: field survey methods for fauna – Amphibians (OEH 2009).
- Survey Guidelines for Australia's Threatened Bats (Commonwealth of Australia 2010).
- Survey guidelines for Australia's Threatened Frogs, Commonwealth of Australia (Department of the Environment, Water, Heritage and the Arts 2010).
- Survey Guidelines for Australia's threatened Mammals (Commonwealth of Australia 2011).
- EPBC Act referral guidelines for the vulnerable Koala (Commonwealth of Australia 2014).
- Survey Guidelines for Australia's threatened Birds (Commonwealth of Australia 2010).

Fauna survey methods included;

- Koala Spot Assessment Technique (SAT) survey (Phillips and Callaghan 2011)
- Terrestrial Elliot A Trapping, Arboreal Elliot B Trapping, Harp trapping.
- Ultrasonic bat call recording, culvert/bridge/tunnel inspections.
- Spotlighting.
- Nocturnal and diurnal waterbody searches.
- Diurnal area searches (threatened birds).
- Nocturnal and diurnal call playback.
- Camera trapping surveys.
- Winter frog survey.
- Invertebrate area search and transect searches.
- Habitat tree assessment.

Targeted survey details and survey effort undertaken for each species are provided in Table 4.4. Weather conditions encountered during each survey period are summarised in Table 4.5. The spatial distribution of all fauna survey locations relative to the project is shown in Figure 8.

Table 4.4 Summary of targeted fauna survey effort

Survey method	Method details	Threatened species targeted	Survey effort
Koala SAT	Each Koala SAT survey included a Koala scat search within 1 metre around the base of thirty trees greater than 10 cm DBH (Phillips and Callaghan 2011)	Koala	38 SAT surveys
Terrestrial Elliot A trapping	Twenty A Elliott traps (9 x 10 x 33 cm) were placed along a line transect approximately 10 m apart at seven sites. Each trap contained dry bedding and was baited with a standard peanut butter and oat mix bait.	Common Planigale, Brush-tailed Phascogale	546 trap nights
Arboreal Elliot B trapping	Ten B Elliott traps (15 x 15.5 x 46 cm) placed in trees along a line transect approximately 10-20 m apart. Each trap contained dry bedding and was baited with a standard peanut butter and oat mix bait. The area surrounding the trap was sprayed with a sugar spray as an additional attractant.	Squirrel Glider, Eastern Pygmy-possum, Brush-tailed Phascogale, Yellow-bellied Glider	240 trap nights
Diurnal bird surveys	20 minute surveys over a 200 m transect or a 20 minute survey point in Rainforest, Wet Sclerophyll Forest and Swamp Forest.	Regent Honeyeater, Swift Parrot	8 person hours
Harp trap	Harp traps erected at six sites	Southern Myotis, Little Bent-wing Bat, Eastern Bent-wing Bat	18 trap nights
Culvert / bridge and tunnel Inspection	Inspection of bridges, culverts and tunnels within the alignment	Southern Myotis, Little Bent-wing Bat, Eastern Bent-wing Bat	All possible habitat within the alignment
Nocturnal spotlight survey	Spotlighting was carried out by two observers using 50-100 Watt head or hand-held torches.	Squirrel Glider, Koala, Yellow-bellied Glider, Eastern Pygmy-possum, Brush-tailed Phascogale, Spotted-tailed Quoll, Common Planigale, Grey-headed Flying Fox, Stephens Banded Snake, Giant Barred Frog, Stuttering Frog, Green-thighed Frog, Green and Golden Bell Frog, Wallum Froglet, Barking Owl, Powerful Owl, Masked Owl, Sooty Owl	140 person hours
Nocturnal Waterbody search	Sites with suitable creek line or ephemeral water habitat as well as dams were inspected on two occasions. Spotlighting transects including call playback was undertaken.	Giant Barred Frog, Stuttering Frog, Green-thighed Frog, Wallum Froglet, Green and Golden Bell Frog, Black Bittern, Australasian Bittern, Australian painted Snipe	39 person hours

Survey method	Method details	Threatened species targeted	Survey effort
Nocturnal call playback	Calls of gliders, Koala and owls were played during standard call playback sessions including an initial 10 minute listening, 5 minutes of playing a species call followed by 5 minute listening period. The other species calls were played opportunistically in suitable habitat under suitable conditions.	Squirrel Glider, Koala, Yellow-bellied Glider, Giant Barred Frog, Stuttering Frog, Green-thighed Frog, Green and Golden Bell Frog, Wallum Froglet, Barking Owl, Powerful Owl, Masked Owl, Sooty Owl	21 hours
Diurnal waterbody searches	Dams and creeklines with suitable fringing vegetation were inspected during the day on two occasions.	Black-necked Stork, Comb-crested Jacana, Black Bittern, Australian Fritillary, Australasian Bittern, Australian painted Snipe	22 person hours
Diurnal call playback	Species calls were played opportunistically in suitable habitat under suitable conditions.	Pale-vented Bush-hen, Lewins Rail, Black bittern	3.5 hours
Camera trap – spring / summer	Reconyx Hyperfire cameras were set at 36 locations throughout the alignment. Cameras were baited with bread mixed with peanut butter and fish based cat food and set with the following parameters: Medium sensitivity, three photos per trigger with no delay, quiet period of three seconds between triggers.	Common Planigale, Spotted-tailed Quoll, Eastern Pygmy-possum, Koala, Brush-tailed Phascogale	1332 nights
Camera trap – winter	Reconyx Hyperfire cameras were set at 30 locations throughout the alignment. 24 cameras were baited with raw chicken necks to target Spotted-tailed Quoll. Six cameras were baited with peanut butter and oat bait with pistachio oil to target Long-nosed Potoroo. All cameras were set with the following parameters: Medium sensitivity, three photos per trigger with no delay, quiet period of three seconds between triggers.	Common Planigale, Spotted-tailed Quoll, Eastern Pygmy-possum, Koala, Brush-tailed Phascogale, Long-nosed Potoroo.	756 nights
Winter Frog Survey	Swamp forest habitat was inspected on two evenings during suitable conditions.	Wallum Froglet	8 person hours
Invertebrate area search	Diurnal transects through suitable habitat.	Australian Fritillary, Black Grass-dart Butterfly, Coastal Petaltail	2.5 person hours
Invertebrate transect search	5 m transects across suitable habitat within the alignment.	Coastal Petaltail	90 person hours
Pink Underwing Moth Survey	10 m transects across suitable habitat for larval food vine *Carronia multisepalea.*	Southern Pink Underwing Moth	18 person hours

Survey method	Method details	Threatened species targeted	Survey effort
Ultrasonic bat call recording	Anabat Express ultrasonic bat recorders were set to record entire nights at 12 sites.	Southern Myotis, Little Bent-wing Bat, Eastern Bent-wing Bat	396 hours
Hollow-bearing tree assessment	Hollow-bearing trees within the study area were recorded in accordance with the BBAM (OEH 2014). The following attributes were recorded for all hollo-bearing trees where access was available. • GPS location • Scientific name • Common name • Condition (dead or alive) • Tree height • Diameter at breast height (DBH) • Hollow count (approximate number of hollows) • Position of hollows (trunk / limb) • Size class (small =<50 mm; medium = 50-150 mm; large = >150 mm)	Squirrel Glider, Yellow-bellied Glider, Sooty Owl, Masked Owl, Barking Owl, Powerful Owl, Southern Myotis, Eastern Pygmy-possum, Brush-tailed Phascogale	Ongoing during all fauna survey efforts
Grey-headed Flying-fox camp assessment	During fauna surveys undertaken evidence of potential Grey-headed Flying-fox camps was noted to assess potential “species credit” impacts to the dual credit species.	Grey-headed Fying-fox	Ongoing during all fauna survey efforts

Table 4.5 Weather observations during survey periods

Survey undertaken	Survey date	Temperature (°C)		Relative Humidity %		Rain (mm) in the 24 hours to 9am.	Rain (mm) previous 7 days
		Min.	Max.	9am	3pm		
Wallum Froglet Survey	22/08/2016	6.6	22.1	--	--	0	4
	23/08/2016	14.7	22.8	--	--	9.8	
	24/08/2016	12.6	16.6	--	--	19.8	
Arboreal and Terrestrial trapping, spotlight, call playback, diurnal waterbody searches, nocturnal waterbody searches, SAT survey, HBT survey	31/10/16	18	25	78	78	104.8	0.5
	1/11/2016	15.7	24.7	62	62	28	
	2/11/2016	15.8	23.9	49	49	38.8	
	3/11/2016	12.8	25.7	58	58	0	
	4/11/2016	12.8	27	70	70	0	
	5/11/2016	15.6	35	31	31	0	
	20/11/2016	17.8	26.2	75	68	0	11.8
	21/11/2016	14.7	26.3	65	66	0	
	22/11/2016	16.6	25.9	60	65	0	
	23/11/2016	16.9		56	69	0	
	24/11/2016	17.8	24.1	57	52	0	
	25/11/2016	13.5	25.6	53	67	0	
Spotlight, call playback, diurnal waterbody searches, nocturnal waterbody searches, SAT survey , HBT survey	13/03/2017	21	24	86	67	0	45.7
	14/03/2017	20	23	90	85	6.8	
	15/03/2017	19	22	95	94	50.6	
	16/03/2017	19	26	95	79	142.8	
	17/03/2017	20	28	82	69	0.2	
Coastal Petaltail survey, Koala SAT, Culvert inspections	26/11/2017	16	25.9	72	71	0	23.4
	27/11/2017	16.8	26.7	68	68	0	
	28/11/2017	17	27.2	68	70	0	
Coastal Petaltail survey	10/01/2018	20.5	26.3	85	77	8	31.4
	11/01/2018	21.4	26.6	83	79	0.2	
	12/01/2018	21.3	31.3	79	69	1.2	
	30/01/2018	20	28	72	72	0	4.2
	31/01/2018	18.5	28.8	77	73	0	
	01/02/2018	19.5	26	61	53	0	

Survey undertaken	Survey date	Temperature (°C)		Relative Humidity %		Rain (mm) in the 24 hours to 9am.	Rain (mm) previous 7 days
		Min.	Max.	9am	3pm		
Koala SAT, Spotlighting, culvert inspection	7/05/2018	11.3	23.4	82	64	0.2	1.2
	8/05/2018	12.9	23.4	78	76	0.2	1.4
	9/05/2018	16	23.4	85	68	4	0.4
	10/05/2018	12.3	26.9	52	40	0	4.4
	11/05/2018	8.6	20.3	36	33	0	
	12/05/2018	8.2	22.3	47	41	0	

4.2.3 Limitations

Surveys were conducted in accordance with relevant guidelines outlined in Section 4.2.2. Survey was limited to areas where access could be achieved, this included the majority of the alignment and allowed survey across all vegetation types. All surveys were conducted at the appropriate time of year as listed in the Threatened Species Profile Database and were generally undertaken in appropriate weather conditions.

Vegetation and flora survey provide a sampling of plant taxa at a given time and season. Surveys undertaken for the current study were undertaken over multiple seasons at various times of the year and therefore are expected to provide a good representation of floristic structure and composition of vegetation within the study area. Nevertheless, not all taxa will have been detected at each site during survey due to a range of factors including species dormancy, seasonal conditions, time since fire and the highly cryptic native of some taxa. Moreover, resource and access constraints inevitably mean it is impossible to achieve complete survey coverage of the study area across all seasons.

Limited access in some areas may have prevented mapping of some hollow-bearing trees. Vegetation in these sections is likely to contain similar habitat value as the equivalent vegetation type and age classes elsewhere in the alignment and surrounding areas. Although every effort was made to effectively survey for hollows, hollow-bearing tree surveys are limited by the ability to see through dense understorey, or lack of vantage points in some areas. As such the hollow-bearing tree survey is considered to be representative of the relative abundance of hollows within vegetation of the alignment.

Spotlighting surveys are limited in places with dense understorey or canopy where animals may be harder to detect. Repetition of survey sites and appropriately powered torches reduce issues associated with detection and provide effective survey effort within these habitats. Weather conditions during spotlight surveys were considered ideal across the survey sessions. A significant amount of rain occurred during spotlighting on the 16 March 2016, this prevented effective spotlight for mammals and reptiles. This rainfall event significantly increased the number and diversity of common frog species detected, however, heavy rain may have hindered threatened frog detection due to both the noise of the rain, the conditions being generally unsuitable for threatened frogs calling and through the noise created by common species.

Terrestrial and arboreal fauna trapping is limited by a number of factors including the willingness of fauna to enter traps (trap shyness), abundance of food within the area, mechanical trap failure, and weather conditions. Trapping was undertaken in ideal survey conditions, Coffs Harbour has a high rainfall which can create sub-optimal conditions for detection of terrestrial and arboreal mammals. Although rain was experienced during the first trapping session it is not considered to have limited the results of the survey as rainfall was not experienced for the entire night and common species were trapped. Although non-target species were captured trap saturation within each site was considered adequate, trapping of non-target species is not likely to have impacted on detection of target species.

Harp traps are an effective method in detecting and identifying threatened microbats. Efficacy of harp traps is highest in dense vegetation such as Wet Sclerophyll Forest where bats cannot easily avoid being trapped. Studies on the efficacy of trapping methods have shown that less than 4% of encounters result in capture of microbats in harp traps (Berry et al. 2004). Repetition of survey within sites over multiple nights assists with detection rate. Moving the traps within each site after two nights of survey also assists in preventing trapping the same individuals and in preventing microbats from avoiding the trap. Harp traps were placed in suitable positions within flyways, over streams and adjacent to suitable habitat to maximise capture rate.

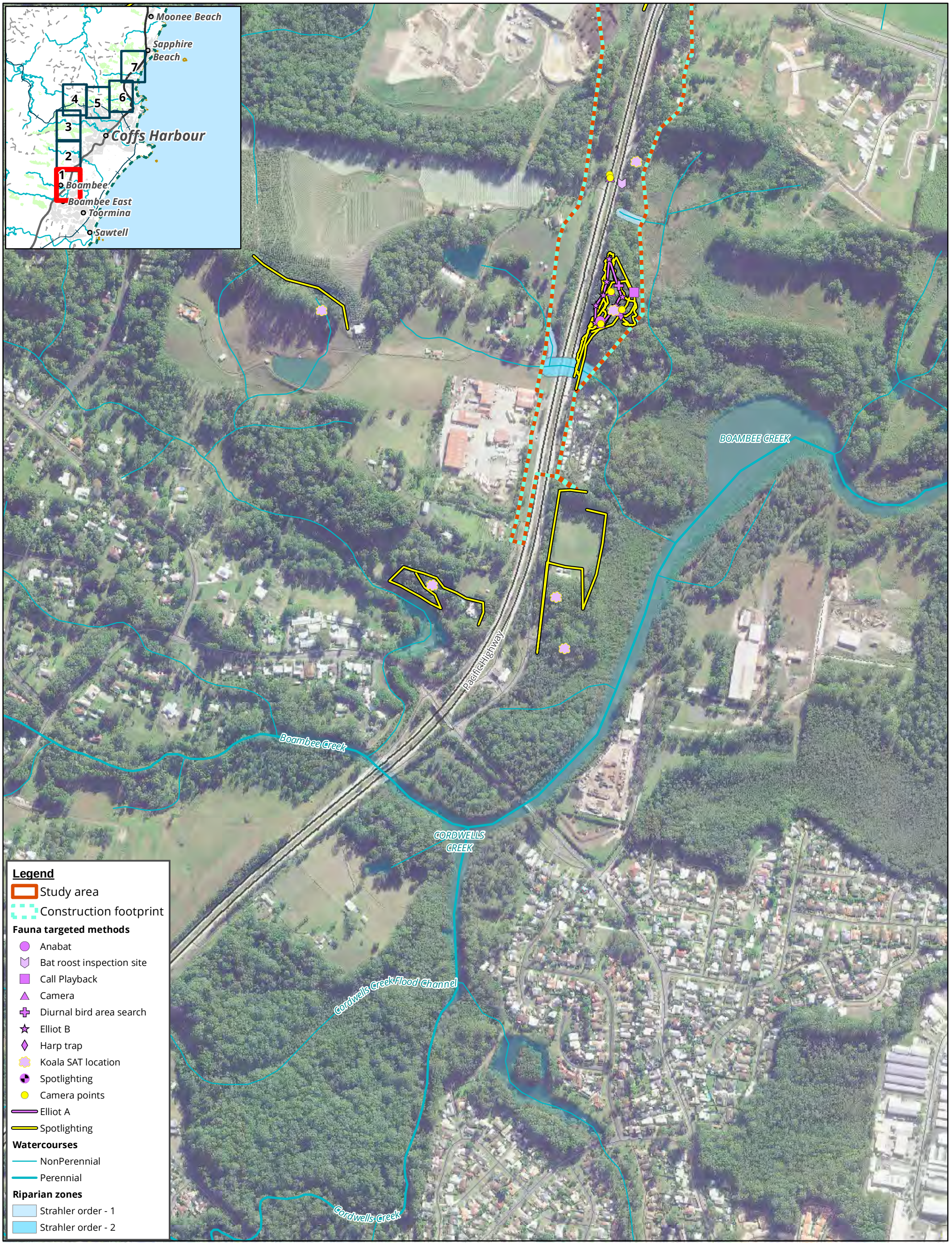


Figure 8.1: Fauna survey effort

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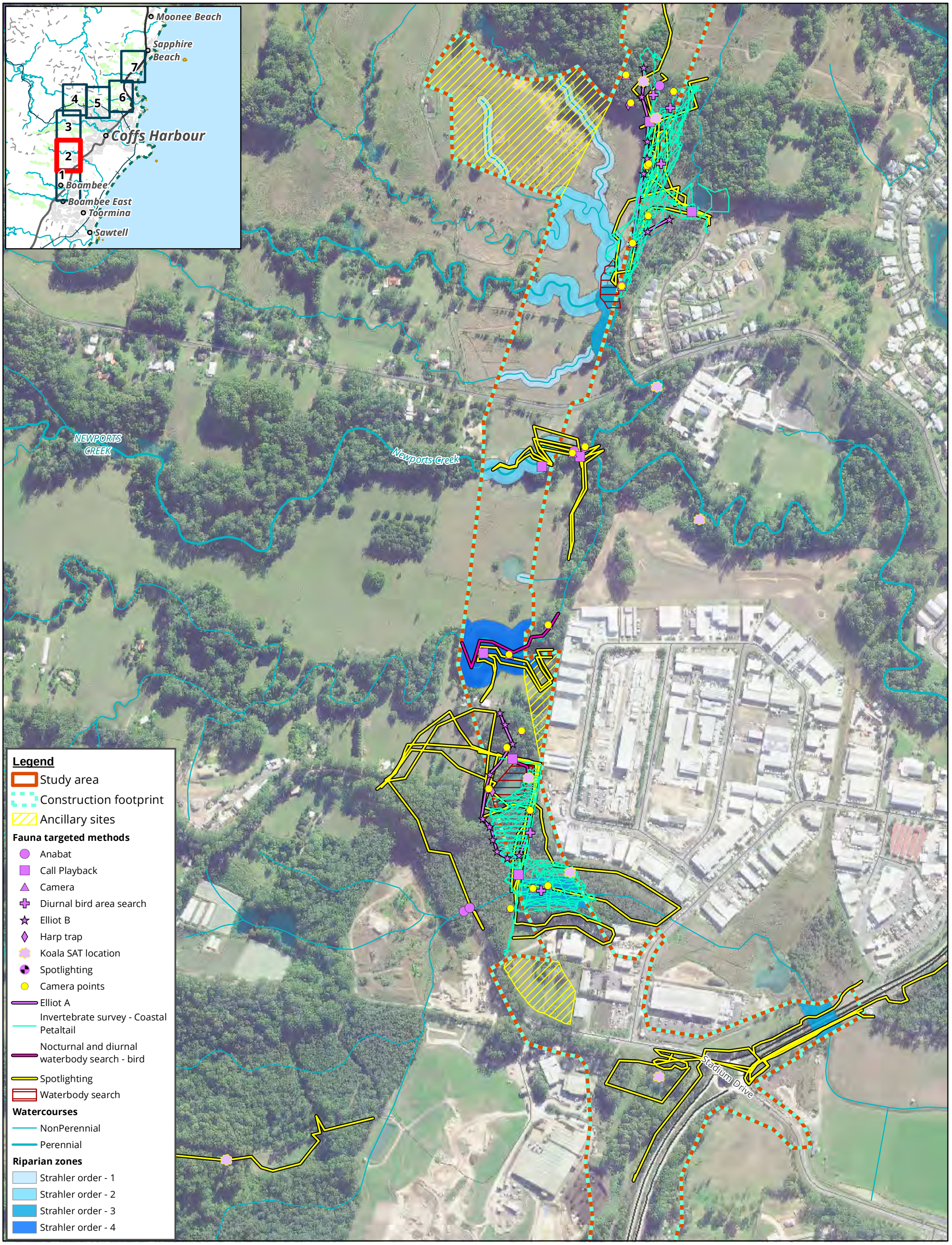


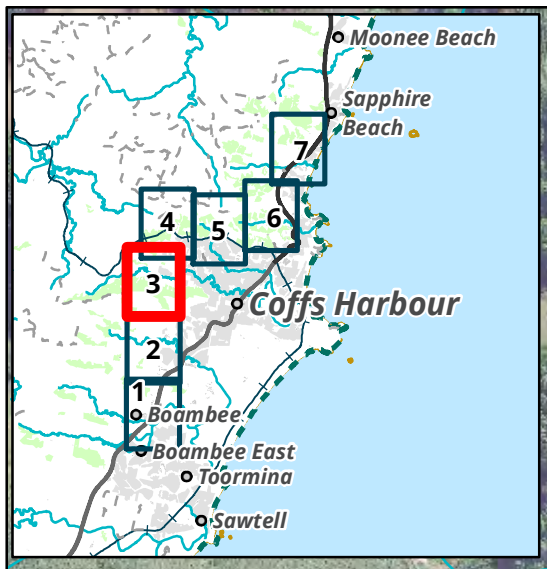
Figure 8.2: Fauna survey effort

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Coffs Creek

Legend

- Study area
- Construction footprint
- Ancillary sites

Fauna targeted methods

- Anabat
- Bat roost inspection site
- Call Playback
- Camera
- Diurnal bird area search
- Elliot B
- Koala SAT location
- Spotlighting
- Camera points
- Elliot A
- Invertebrate survey - Coastal Petaltail
- Invertebrate survey - Pink Underwing Moth
- Spotlighting
- Moth Survey
- Waterbody search

Watercourses

- NonPerennial
- Perennial

Riparian zones

- Strahler order - 1
- Strahler order - 2
- Strahler order - 3

Figure 8.3: Fauna survey effort

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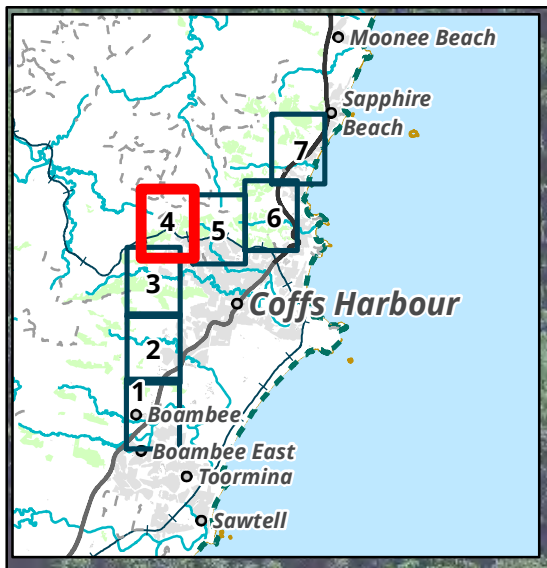
Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

Matter: 22156
Date: 24 May 2019,
Checked by: CW, Drawn by: SSK, Last edited by: lharley
Location:P:\22100s\22156\Mapping\
22156_F8.1-3,5_FaunaSurveyEffort

0 60 120 180 240 300

Metres
Scale 1:7,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N



KARANGI CREEK

KARANGI CREEK

Karangi Creek

North Coast

Legend

- Study area
- Construction footprint
- Ancillary sites

Fauna targeted methods

- Anabat
- Call Playback
- Camera
- Diurnal bird area search
- Elliot B
- Koala SAT location
- Spotlighting
- Camera points
- Elliot A
- Spotlighting
- Moth Survey

Watercourses

- NonPerennial
- Perennial

Riparian zones

- Strahler order - 1
- Strahler order - 2
- Strahler order - 3

Figure 8.4: Fauna survey effort

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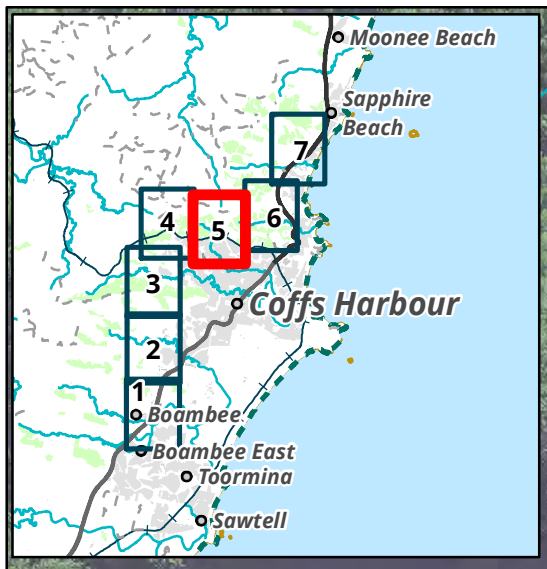
Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

Matter: 22156
Date: 24 May 2019,
Checked by: CW, Drawn by: SSK, Last edited by: lharley
Location:P:\22100s\22156\Mapping\
22156_F8.4,6-7_FaunaSurveyEffort

0 60 120 180 240 300

Metres
Scale 1:7,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N



Bucca Bucca Creek

Jordans Creek

Treefern Creek

Legend

- Study area
- Construction footprint
- Ancillary sites

Fauna targeted methods

- Anabat
- Call Playback
- Camera
- Diurnal bird area search
- Koala SAT location
- Camera points
- Elliot A
- Invertebrate survey - Pink Underwing Moth
- Nocturnal and diurnal waterbody search - bird
- Nocturnal and diurnal waterbody search - bird/frog
- Spotlighting
- Moth Survey
- Waterbody search

Watercourses

- NonPerennial
- Perennial

Riparian zones

- Strahler order - 1
- Strahler order - 2
- Strahler order - 3

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Figure 8.5: Fauna survey effort

Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
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Date: 24 May 2019,
Checked by: CW, Drawn by: SSK, Last edited by: lharley
Location:P:\22100s\22156\Mapping\
22156_F8.1-3,5_FaunaSurveyEffort

0 60 120 180 240 300

Metres
Scale 1:7,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

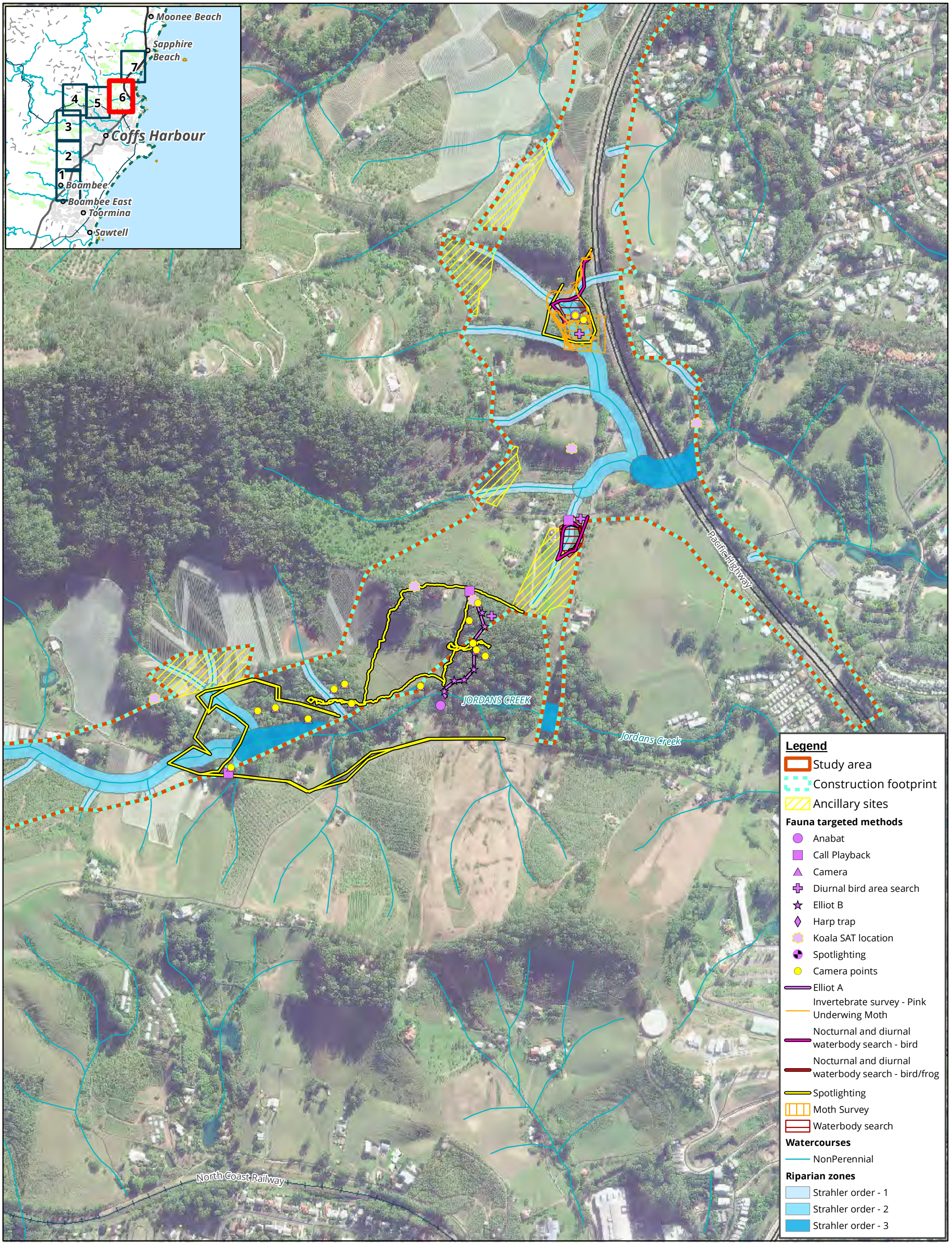


Figure 8.6: Fauna survey effort

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Matter: 22156
Date: 24 May 2019,
Checked by: CW, Drawn by: SSK, Last edited by: lharley
Location:P:\22100s\22156\Mapping\
22156_F8.4,6-7_FaunaSurveyEffort

0 60 120 180 240 300

Metres
Scale 1:7,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

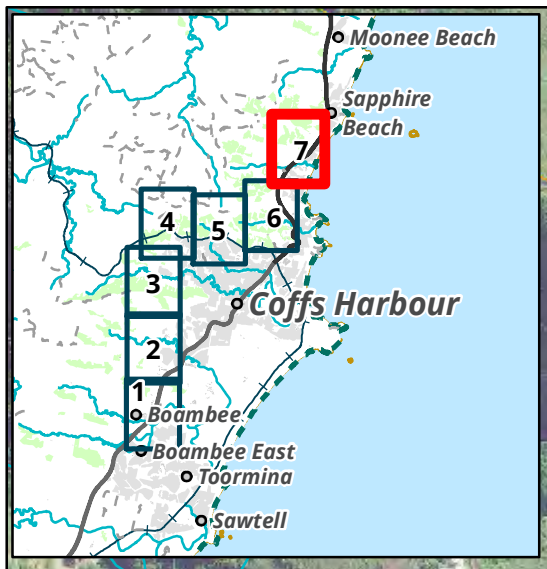


Figure 8.7: Fauna survey effort

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Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
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Matter: 22156
Date: 24 May 2019,
Checked by: CW, Drawn by: SSK, Last edited by: lharley
Location:P:\22100s\22156\Mapping\
22156_F8.4,6-7_FaunaSurveyEffort

0 60 120 180 240 300
Metres
Scale 1:7,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

4.2.4 Threatened species results

Threatened flora

Two threatened flora species; Southern Swamp Orchid *Phaius australis* (Endangered EPBC Act and BC Act) and Rusty Plum *Niemeyera whitei* (Vulnerable BC Act) were recorded within the study area (Figure 9).

Southern Swamp Orchid occurs in swampy grassland or swampy forest in coastal areas. In NSW, most of the populations occur between Coffs Harbour and Ballina. It has a flowering stem of up to 2 metres tall, one of the largest species of ground orchids in Australia (TSSC 1998). One individual Southern Swamp Orchid was recorded in the study area within a small patch of remnant vegetation consistent with PCT 695 Blackbutt – Turpentine shrubby open forest of the coastal foothills of the central North Coast. This individual was located approximately 700 metres north of North Boambee Road (Figure 9).

Rusty Plum is a small to medium-sized tree with a fluted trunk. It typically occurs in gullies of warm temperate or littoral rainforests on poor soils below an altitude of 600 metres above sea level (OEH 2002). In total, 57 individuals were counted and recorded as likely to be impacted by the Project during the field investigations, predominantly in the northern extent of the study area in gullies and depressions associated with the riparian corridors of Pine Brush Creek and Jordans Creek. This species occurred across seven PCTs with most records recorded within PCT 695 Blackbutt – Turpentine shrubby open forest of the coastal foothills of the central North Coast (Figure 9 and Table 4.6).

Table 4.6 Summary of Rusty Plum records and associated PCTs

Plant community type	Number of records
PCT 670 Black Booyong – Rosewood – Yellow Carabeen subtropical rainforest of the North Coast	2
PCT 692 Blackbutt – Tallowwood moist ferny open forest of the coastal ranges of the North Coast	7
PCT 695 Blackbutt – Turpentine – Tallowwood shrubby open forest of the coastal foothills of the central North Coast	23
PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	9
PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	3
PCT 1302 White Booyong – Fig subtropical rainforest of the NSW North Coast	13

Threatened fauna

The study area contains a broad suite of fauna habitats, with the 14 kilometre alignment crossing expanses of agricultural land interspersed with patches of native vegetation and riparian systems. The study area is bordered by Ulidarra National Park and large expanses of remnant vegetation within the reserve system. Connectivity between patches, in regards to wildlife movement, is limited within the region however, corridors for fauna exist within the study area. Fauna habitat within the study area is supported within low-lying wetlands inclusive of riparian corridors, and mixed forested slopes/hills.

Fauna habitat for threatened fauna is primarily limited to areas where remnant vegetation persists. Remnant vegetation within the study area ranges from tall open wet sclerophyll forest to dense coastal rainforest type habitats. Fauna species recorded and predicted to occur within the study area are typically capable of tolerating some degree of anthropogenic activity. Structural habitat components identified during fauna surveys included hollow-bearing trees, coarse woody debris, dense mats of fine litter and rock outcrops.

A full list of fauna recorded during field surveys is provided in Appendix B. Unless of particular relevance to this assessment (ie. listed threatened species), the majority of these species are not discussed further.

Twelve threatened fauna species were recorded within the study area and include:

- Species credit species
    - Coastal Petaltail (burrows), Endangered BC Act.
    - Giant Barred Frog, Endangered BC Act, Endangered EPBC Act.
    - Green-thighed Frog, Vulnerable BC Act.
    - Koala, Vulnerable BC Act, Vulnerable EPBC Act.
    - Pale-vented Bush-hen, Vulnerable BC Act.
    - Southern Myotis (breeding culverts), Vulnerable BC Act.
- Ecosystem credit species
    - Eastern False Pipistrelle, Vulnerable BC Act.
    - Eastern Freetail-bat, Vulnerable BC Act.
    - Greater Broad-nosed Bat, Vulnerable BC Act.
    - Grey-headed Flying-fox, Vulnerable BC Act, Vulnerable EPBC Act.
    - Little Bentwing-bat (foraging), Vulnerable BC Act.
    - Olive Whistler, Vulnerable BC Act
    - Square-tailed Kite, Vulnerable BC Act.
    - White-bellied Sea-eagle, Vulnerable BC Act.

A total of four migratory species listed under the EPBC Act were recorded during field survey and include:

- Black-faced Monarch, Migratory, EPBC Act.
- Rufous Fantail, Migratory, EPBC Act.
- Spectacled Monarch, Migratory, EPBC Act.
- Wanderer Butterfly, Migratory, EPBC Act.

Migratory species recorded or predicted to occur within the study area by background database review are located in Appendix B. These species may occur within the study area on occasion, whilst moving through their large home ranges, but are not expected to rely on the study area for important life cycle stages.

Terrestrial, arboreal and harp trapping

No threatened species were detected during terrestrial and arboreal fauna trapping. One introduced species the Black Rat *Rattus rattus* was captured. Three native species Bush Rat *Rattus fuscipes,* Brown Antechinus *Antechinus stuartii,* and Fawn-footed Melomys *Melomys cervinipes* were recorded during field surveys.

Two threatened microbat species were captured during harp-trapping; Little Bentwing-bat and Southern Myotis.

Spotlight, call playback, remote cameras and waterbody searches, anabat recordings

Four threatened species, Koala, Green-thighed Frog, Giant Barred Frog (species credit species) and Grey-headed Flying-fox (ecosystem credit species) were recorded during spotlight surveys. Locations of these records are provided in (Figure 10).

Call playback is utilised to elicit a response from Koalas, this is generally a vocalisation from a male Koala as a territorial display, with the likelihood of a response increased during breeding season (September to March). Koala recorded during call playback were within vegetation supporting primary Koala feed trees to the north of Highlander Drive (Swamp Mahogany *Eucalyptus robusta*) and at the southern end of the alignment, east of the Pacific Highway and south of Stadium Drive (Tallowwood *Eucalyptus microcorys*).

Remote cameras detected one threatened bird species, Pale-vented Bush Hen. The species was recorded at two sites (Figure 10) in proximity to vegetated creek lines. No Bionet records of Pale-vented Bush Hen occur in the vicinity of Coffs Harbour, with the majority of the species' records in NSW centred around the Byron Bay area. However, the species is predicted to occur in the Coffs Coast and

Escarpments and Macleay Hastings (north of South West Rocks) IBRA subregions (OEH 2018b) with OEH noting the species appears to be expanding its range southwards, with recent records as far south as the Nambucca River (OEH 2018b). It is considered likely that the species occurs more commonly in the broader Project locality than predicted from records based on the cryptic nature of the species and the probable lack of community records captured outside more targeted bird surveys for the species, such as those undertaken for the current assessment. Further discussion of the species occurrence and potential impacts is provided in Section 8.2.3.

Remote cameras also captured one instance of a female Koala with a joey moving across the ground within vegetation to the east of the Pacific Highway at the southern end of the alignment.

Nocturnal and diurnal waterbody searches did not detect any threatened species.

Anabat recordings identified five threatened species with a high level of confidence and a further three with a moderate to low level of confidence based on the quality of calls recorded (Table 4.7).

Table 4.7 Threatened microbat species recorded using ultrasonic detectors

Scientific Name	Common Name	Confidence level	EPBC Act status	BC Act status
Falsistrellus tasmaniensis	Eastern False Pipistrelle	High	-	V
Miniopterus australis	Little Bentwing-bat	High	-	V
Mormopterus norfolkensis	Eastern Freetail-bat	High	-	V
Myotis Macropus	Southern Myotis	High	-	V
Scoteanax reuppellii	Greater Broad-nosed Bat	High	-	V
Miniopterus oceanensis schreibersii	Eastern Bentwing-bat	Moderate	-	V
Chalinolobus dwyeri	Large-eared Pied Bat	Low	V	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Low	-	V

EPBC Act: VU – Vulnerable; EN – Endangered; CE – Critically Endangered. TSC Act: V – Vulnerable; E1 – Endangered; E2 – Endangered Population; CE – Critically Endangered

Large-eared Pied Bat *Chalinolobus dwyeri* was recorded with a low confidence level by anabat detectors during field surveys, and has conservatively been included in the table above. However the calls were considered low quality due to the short duration and very small number of pulses. The characteristic frequency of each call was just above 25 kHz and the distinct pattern of alternation in the calls was less obvious, with calls being more horizontally elongated, which could represent the non-threatened Gould's Wattle Bat *Chalinolobus gouldii* in search and attack phase. Gould's Wattle Bat was also recorded by anabat, and trapped, during the survey work within the study area.

No BioNet records exist for Large-eared Pied Bat within 20 kilometres of the study area, with the most recent record of the species over that distance being from 2004. The species is not an ecosystem credit, or species credit species, associated with any of the PCTs impacted by the project, as provided in the BioBanking calculator, and was not listed by DoEE as an MNES likely to be impacted by the Project. As such, the likelihood of occurrence of the species within the study has been assessed as low (Appendix B), therefore impacts are not considered likely, and the species is not discussed further.

Koala SAT surveys

Koala Spot Assessment Technique (SAT) surveys were conducted in 38 locations throughout areas determined as potential Koala habitat within the study area. Potential habitat was based on the presence of movement corridors, generally running east-west across the study area and the presence of PCTs known to support Koala feed tree species.

Koala activity level is expressed as a percentage of the 30 surveyed trees within the site that recorded a Koala faecal pellet within the search area (1 metre radius surrounding the tree). There are three population density categories defined by the SAT, activity is classified as low, medium or high based on the area/ population density categories (Phillips and Callaghan 2011). Coffs Harbour is an area of medium to high Koala density on the east coast, therefore Koala activity is categorized by the values outlined in Table 4.8.

Table 4.8 Mean Activity levels Extract (Phillips and Callaghan 2011)

Activity Level	Percentage
Low	≤22.52
Medium	≥22.5, ≤32.84
High	>32.84

SAT surveys were undertaken in November 2017 and May 2018, the results of which are detailed in

Table **4.9** below, with survey locations and corridors detailed on Figure 8 and Figure 10 respectively. Generally, Koala activity was found to be low based on the results of the SAT surveys, with only two of the 38 surveys recording a medium or high level of activity.

Table 4.9 Koala SAT survey results

SAT number	Activity %	Activity level	SAT number	Activity %	Activity level
1	0	Low	20	0	Low
2	46	High	21	0	Low
3	0	Low	22	0	Low
4	26	Medium	23	0	Low
5	0	Low	24	3	Low
6	10	Low	25	0	Low
7	0	Low	26	0	Low
8	3	Low	27	0	Low
9	0	Low	28	3	Low
10	0	Low	29	3	Low
11	0	Low	30	0	Low
12	0	Low	31	0	Low
13	0	Low	32	3	Low
14	0	Low	33	0	Low
15	0	Low	34	0	Low
16	0	Low	35	0	Low
17	0	Low	36	13.3	Low
18	0	Low	37	0	Low
19	0	Low	38	0	Low

Low activity recorded across the study area within habitat that might otherwise be of medium to high carrying capacity habitat may be a result of historical disturbance, population dynamics and landscape configuration (DECC 2008b). Koala habitat within remnant vegetation surrounding Coffs Harbour may provide important connective corridors, particularly within gullies containing feed tree species which provide preferred habitat within the Coffs Harbour region (DECC).

In spite of these results the study area is known to support larges areas of potential Koala habitat and suitability for the species was confirmed through the project alignment.

Tunnel, bridge and culvert inspections

Bridges and culverts within the alignment were inspected for microbat roosting habitat, with culverts ranked based on their potential for supporting roosting microbats. Culverts were ranked based on the following parameters:

- High - known roosts, ideal roosting requirements or culverts which had roosting bats during inspection.
- Medium - culverts which contained features suitable for roosting and were considered potential roosting habitat, or those that could not be accessed due to the size and are assumed to contain some habitat.
- Low - culverts which did not have clear access for microbats at the time of inspection or those which lacked typical features for roosting and were unlikely to be used as roosts.
- None - culverts with no microbat access or no suitable roosting habitat.

Two threatened microbat species were recorded within Culverts 8 and 10 during inspections, with another microbat detected in a third culvert (Culvert 28) that was unable to be identified to species level. These culverts are outlined in further detail below. Culvert locations are provided in Figure 9 and results for all culverts inspected to date are provided in Table 4.10.

Culvert 8 is located on Englands Road in the south of the alignment (Figure 10). During inspection of this culvert approximately 20 individuals of both adult and juvenile Southern Myotis were observed. This culvert is a maternity roost and is highly sensitive to disturbance during the breeding season for the species.

Culvert 10 is located along Coramba Road beneath an un-named road providing access to 353 Coramba Road (Figure 10). This culvert consists of three concrete culverts forming a bridge over Coffs Creek. The culvert contains one square section two and a half metres wide, by two metres high, and is three metres in length. There are two round sections approximately two metres diameter and include habitat features such as several small holes in the roof and a number of expansion joints. Two species were recorded within this culvert, Little Bentwing-bat and Southern Myotis, in separate holes within the roof of the square section during field survey, totalling approximately 10 to 15 individuals. A large number of Eastern Water Dragons *Intellagama lesueurii* were present within the expansion joints.

Culvert 28 is located at the northern end of the pipeline under the Pacific Highway. This culvert contained one roosting microbat. The individual bat was identified as a Bentwing-bat *Miniopterus sp*. but was not identified to species level due to inaccessibility.

Two timber bridges were located on Old Coast Road near Kororo Nature Reserve. The southernmost bridge was inspected for roosting microbats. No bats were observed roosting in this bridge and the bridge underwent upgrade maintenance works during the course of the field investigations for the project, further decreasing the likelihood of the structure supporting roosting bats. The second bridge, located further north along Old Coast Road was not inspected during the field investigation for roosting microbats. However, a Koala SAT survey was undertaken adjacent to the bridge which provided some detail of the habitat in that location, and following an additional desktop inspection was concluded that the bridge supports features that make it suitable for potential roosting including; suitable height for a flyway, well vegetated surrounding and access to the creekline below.

Table 4.10 Culvert Inspection results

Culvert number	Potential microbat roost	Species recorded	Culvert number	Potential microbat roost	Species recorded
1	Low	-	15	Medium	-
2	None	-	16	unknown	-
3	None	-	17	High	-
4	Medium	-	18	Low	-
5	Low	-	19	None	-
6	None	-	20	Medium	-
7	High	-	21	Low	-
8	High	Southern Myotis	22	High	-
9	None	-	23	Medium	-
10	High	Southern Myotis,	24	Low	-

Culvert number	Potential microbat roost	Species recorded	Culvert number	Potential microbat roost	Species recorded
		Little Bentwing-bat			
11	Medium	-	25	Low	-
12	None	-	26	Medium	-
13	None	-	27	Low	-
14	High	-	28	High	Bentwing-bat (species)

Hollow-bearing tree survey

A total of 121 hollow-bearing trees were recorded during the fauna survey. These hollows provide a variety of fauna with habitat and included hollows of multiple size categories including: small (<50 millimetres), medium (50-149 millimetres), large (150-400 millimetres) and extra-large (>400 millimetres) hollows. Hollow-bearing tree locations are displayed on Figure 10. Large and extra-large hollows within wet forest gullies may provide threatened owls with nesting or roosting habitat. Smaller hollows may provide threatened gliders with roosting habitat, hollows of multiple sizes may provide threatened microbats with roosting habitat. No large forest owls or gliders were recorded during field survey. No evidnce of native bees was recorded.

Petalura surveys

Transect surveys for Coastal Petaltail, a native species of dragonfly listed as Endangered under the BC Act, recorded approximately 50 burrows characteristic of the species' larval burrows over an approximate 0.5 hectare area. Burrows were located within and adjacent to PCT 1064 Paperbark swamp forest of the coastal lowlands of the North Coast adjacent to Highlander Drive off North Baombee Road. Burrows found within swamp vegetation known to be associated with the species (OEH BioNet) (Figure 10) are considered highly likely to indicate the presence of the Coastal Petaltail.

No adults specimens or exuviae were detected during targeted survey, however the species is known to exists in its larval form for an extended period of time (at least 10 years) and the recording of characteristic burrows, within suitable habitats, is considered evidence of the species presence within the study area. Potential habitat has been assessed as including all occurrences of PCT 1064 that maintain low levels of hydrological modification have been included within the threatened species polygon. PCT 1064 is the only PCT present within the study area that the species is associated with, based on information contained in the Threatened Species Profile Database (Table 4.12).

Table 4.11 provides additional detail on the threatened species recorded within the study area.

Table 4.11 Threatened species survey results

Species	Ecosystem or species credit species	Identification method (assumed, recorded, expert report)	Can the species withstand further loss?	Habitat feature/ component	Known/ potential habitat (ha/ individuals)*
Southern Swamp Orchid	Species	Recorded	No	PCT695 PCT1064	Known: 1 indv. Potential: 5.77 ha
Rusty Plum	Species	Recorded	Yes	PCT670. PCT692, PCT695, PCT747, PCT1302	Known: 57 indv. Potential: 24.57 ha
Coastal Petaltail	Species	Recorded	No	PCT1064	Known: 2.50 ha Potential: 3.65 ha
Giant Barred Frog	Species	Recorded	No	PCT695	Known: 3.28 ha Potential: 4.79 ha
Green-thighed Frog	Species	Recorded	Yes	PCT695	Known: 1.79 ha Potential: 4.79 ha

Species	Ecosystem or species credit species	Identification method (assumed, recorded, expert report)	Can the species withstand further loss?	Habitat feature/ component	Known/ potential habitat (ha/ individuals)*
Koala	Species	Recorded	Yes	All PCTs	Known: 36.70 ha Potential: 43.37 ha
Pale-vented Bush-hen	Species	Recorded	Yes	PCT695 and Non-native vegetation (farm dam)	Known: 4.95 ha Potential: Up to 50 ha
Southern Myotis	Species (Breeding)	Recorded	Yes	Culverts 8 and 10 and foraging over riparian areas	Known: 15.10 ha Potential: Up to 50 ha
Grey-headed Flying-fox	Ecosystem	Recorded	Yes (foraging)	Foraging over site	Known: 43.37 ha Potential: Up to 307 ha
Little Bentwing-bat (foraging)	Ecosystem	Recorded	Yes (foraging)	Roosting culvert 10, foraging over site	Known: 1 culvert Potential: Up to 307 ha
Eastern False Pipistrelle	Ecosystem	Recorded	Yes	Foraging over site	Known: n/a Potential: Up to 307 ha
Eastern Freetail-bat	Ecosystem	Recorded	Yes	Foraging over site	Known: n/a Potential: Up to 307 ha
Greater Broad-nosed Bat	Ecosystem	Recorded	Yes	Foraging over site	Known: n/a Potential: Up to 307 ha
White-bellied Sea-eagle	Ecosystem	Recorded	Yes	Foraging over site	Known: n/a Potential: Up to 307 ha
Olive Whistler	Ecosystem	Recorded	Yes	PCT695	Known: 10.48 ha Potential: 10.48 ha
Square-tailed Kite	Ecosystem	Recorded	Yes	Foraging over site	Known: n/a Potential: Up to 307 ha

*Hectares of impact refers to total suitable habitat for each species recorded wtin the study area

4.2.5 Threatened species habitat polygons

Threatened species polygons have been prepared for the eight species credit species recorded within the study area in accordance with Section 6.5.1.18 of the FBA. Table 4.12 provide the details of these threated species polygons, with locations provided in Figure 11.

Table 4.12 Threatened species habitat polygons

Threatened species	Polygon area (ha)	PCT	Justification

Threatened species	Polygon area (ha)	PCT	Justification
Rusty Plum	7.55	PCT670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion. PCT692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion. PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. PCT747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion. PCT1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion.	The area of species occurrence within the PCTs where the species was recorded.
Southern Swamp Orchid	2.12	PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (TSPD associated PCT). PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (recorded location in the study area).	The extent of the contiguous patch of vegetation within which the species was recorded.
Coastal Petaltail	2.50	1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.	Coastal Petaltails burrows were recorded over a 0.5ha area forming part of a contiguous patch of habitat comprising approximately 1.16ha. Species polygons and hence potential impacts to the species have been determined to include all occurrences of PCT 1064 that maintain low levels of hydrological modification within the study area. These additional areas have been included to account for the potential for burrows to occur in higher quality habitats in and around dense sedge-dominated swamp vegetation that were not recorded during targeted survey due to the cryptic nature of the microhabitats (burrows). PCT 1064 is the only PCT present within the study area that the species is associated with, based on information contained in the Threatened Species Profile Database.
Giant Barred Frog	3.28	695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion. 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast. Modified riparian vegetation.	Threatened species polygon incudes riparian vegetation within 500 m of the species' records within the study area, centred around the Kororo Nature Reserve at the northern end of the study area. Riparian habitats along Newports Creek, south of North Boambee Road have also been included due to the high likelihood of the species' occurrence in the area based on the proximity of the habitat to the known population present in that waterway to the east of the study area.

Threatened species	Polygon area (ha)	PCT	Justification
Green-thighed Frog	1.79	695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.	Threatened species polygon incudes riparian vegetation within 500 m of the species' records within the study area. Habitat is centred around the Kororo Nature Reserve at the northern end of the study area.
Koala	36.70	692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion. 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion. 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion. 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast. 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast. 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion. 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion. Modified riparian vegetation.	Threatened species polygon includes vegetation present within the study area where it occurs in association with connecting links considered likely to be used by Koala, and in the proximity of records of the species.
Pale-vented Bush-hen	4.95	695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. Modified riparian vegetation.	Threatened species polygon includes native and non-native riparian vegetation, and a large intact connecting patch of PCT 695 within 400 m of the species' records centred around Jordans Creek north of West Korora Road. A second patch of mixed native and non-native vegetation fringing a farm dam is included due to the recording of the species in that location.

Threatened species	Polygon area (ha)	PCT	Justification
Southern Myotis	15.10	692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion. 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion. 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion. 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast. 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion. Modified riparian vegetation.	Threatened species polygon includes areas of native vegetation (and a small patch on non-native vegetation) supporting hollow-bearing trees along riparian zones within 200 – 600 m of culverts supporting roosts for the species. Habitat is centred around the riparian zones of Pine Bruch Creek, Jordans Creek, Coffs Creek, and an unnamed tributary of Newports Creek adjacent to Englands Road.

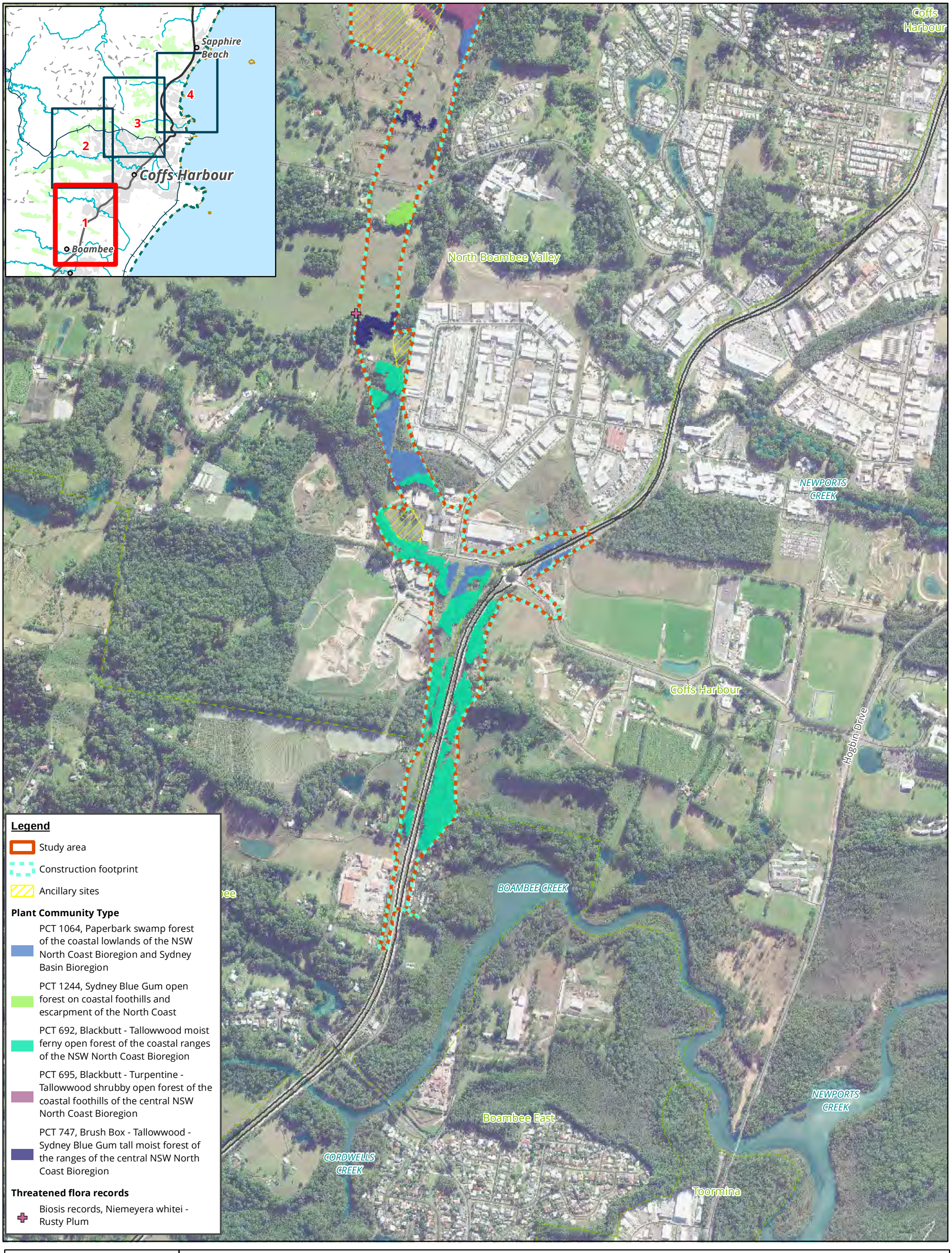


Figure 9.1: Threatened flora records

Biosis Pty Ltd
Albury, Ballarat, Melbourne, Newcastle, Sydney, Wangaratta & Wollongong

Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

Matter: 22156
Date: 24 May 2019,
Checked by: CW, Drawn by: SSK, Last edited by: lharley
Location:P:\22100s\22156\Mapping\
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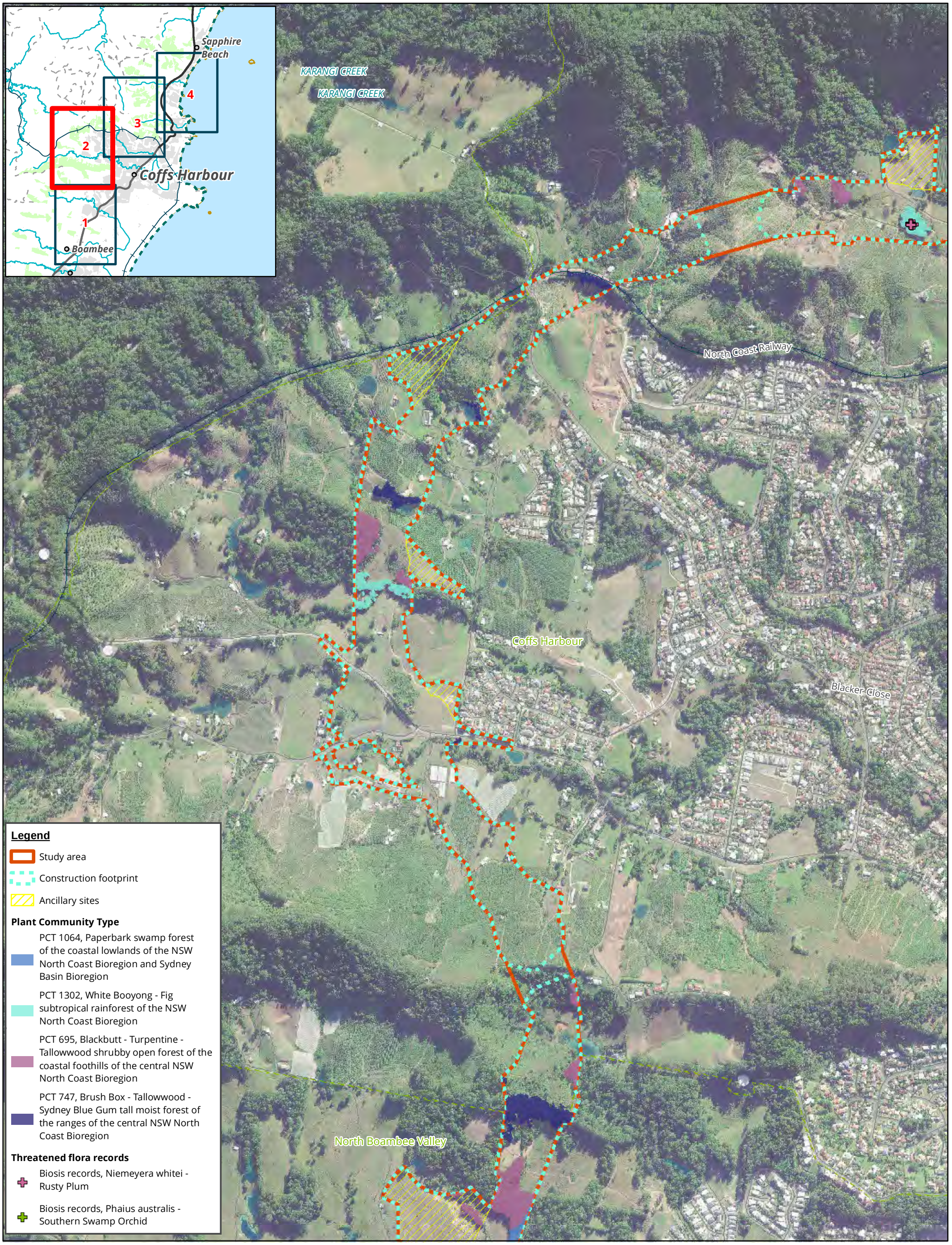


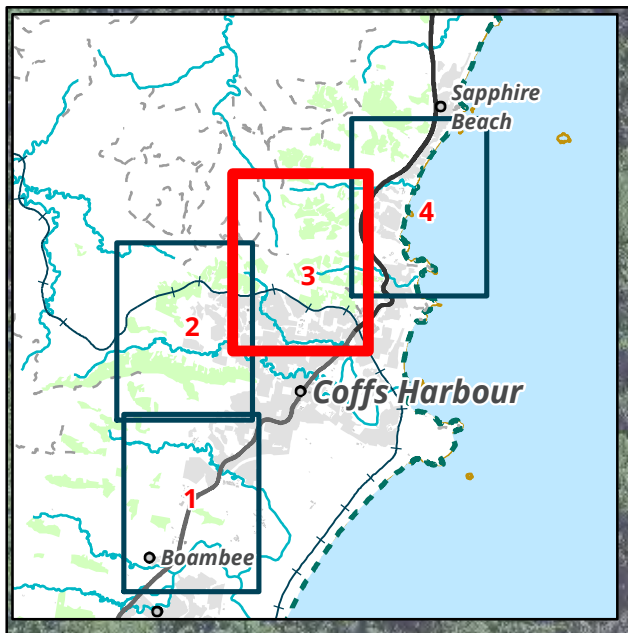
Figure 9.2: Threatened flora records

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Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
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Matter: 22156
Date: 24 May 2019,
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22156_F9.1-2_ThreatenedFlora

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Metres
Scale 1:12,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56
N



Korora

Pacific Highway

JORDANS GREEK

Coffs Harbour

North Coast

Blacker Close

Legend

- Study area
- Construction footprint
- Ancillary sites

Plant Community Type

- PCT 1262, Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast
- PCT 1285, Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion
- PCT 1302, White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion
- PCT 670, Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion
- PCT 692, Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion
- PCT 695, Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion
- PCT 747, Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion

Threatened flora records

- Biosis records, Niemeyera whitei

Figure 9.3: Threatened flora records

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Date: 24 May 2019,
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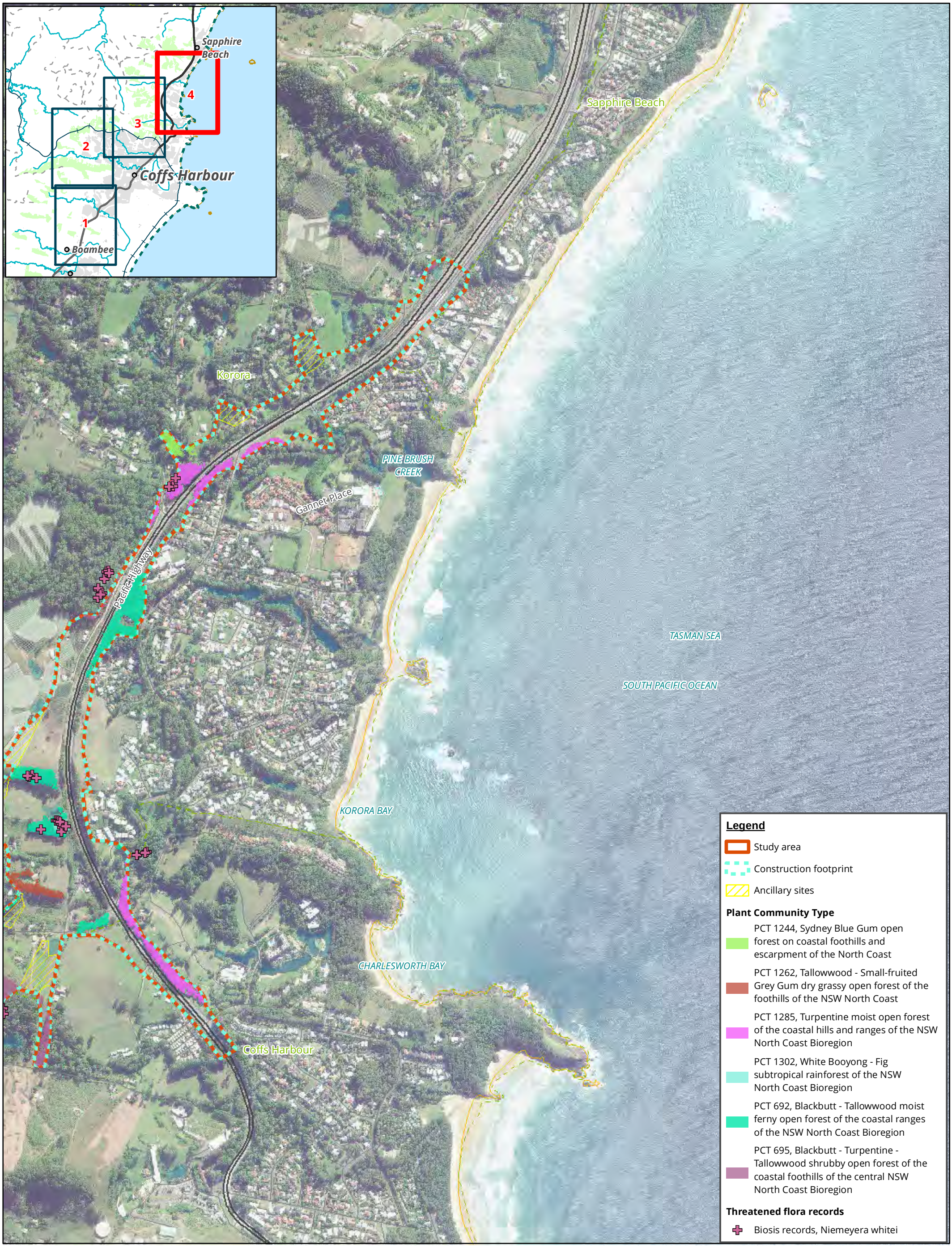


Figure 9.4: Threatened flora records

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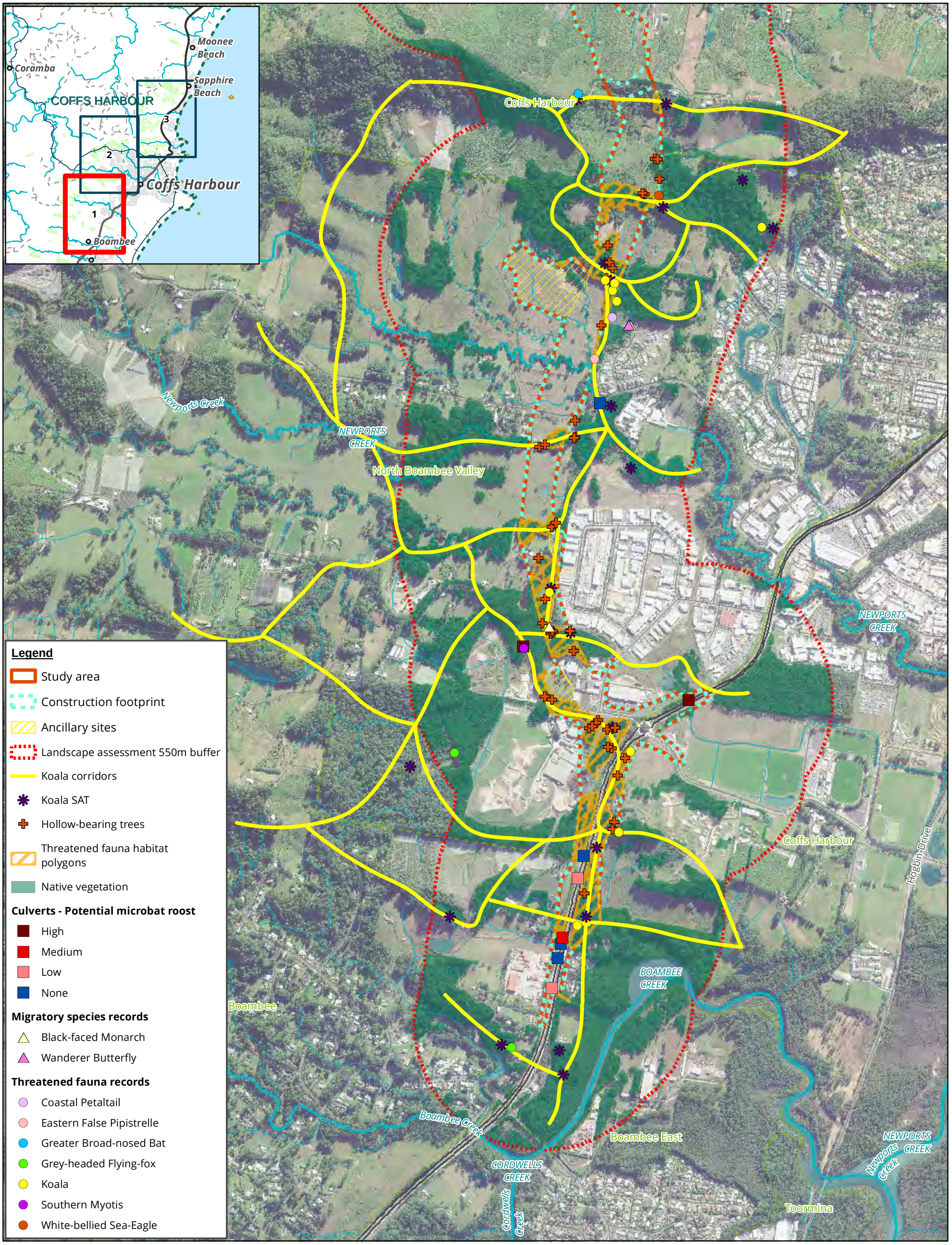


Figure 10.1: Threatened fauna records

Biosis Pty Ltd
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Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

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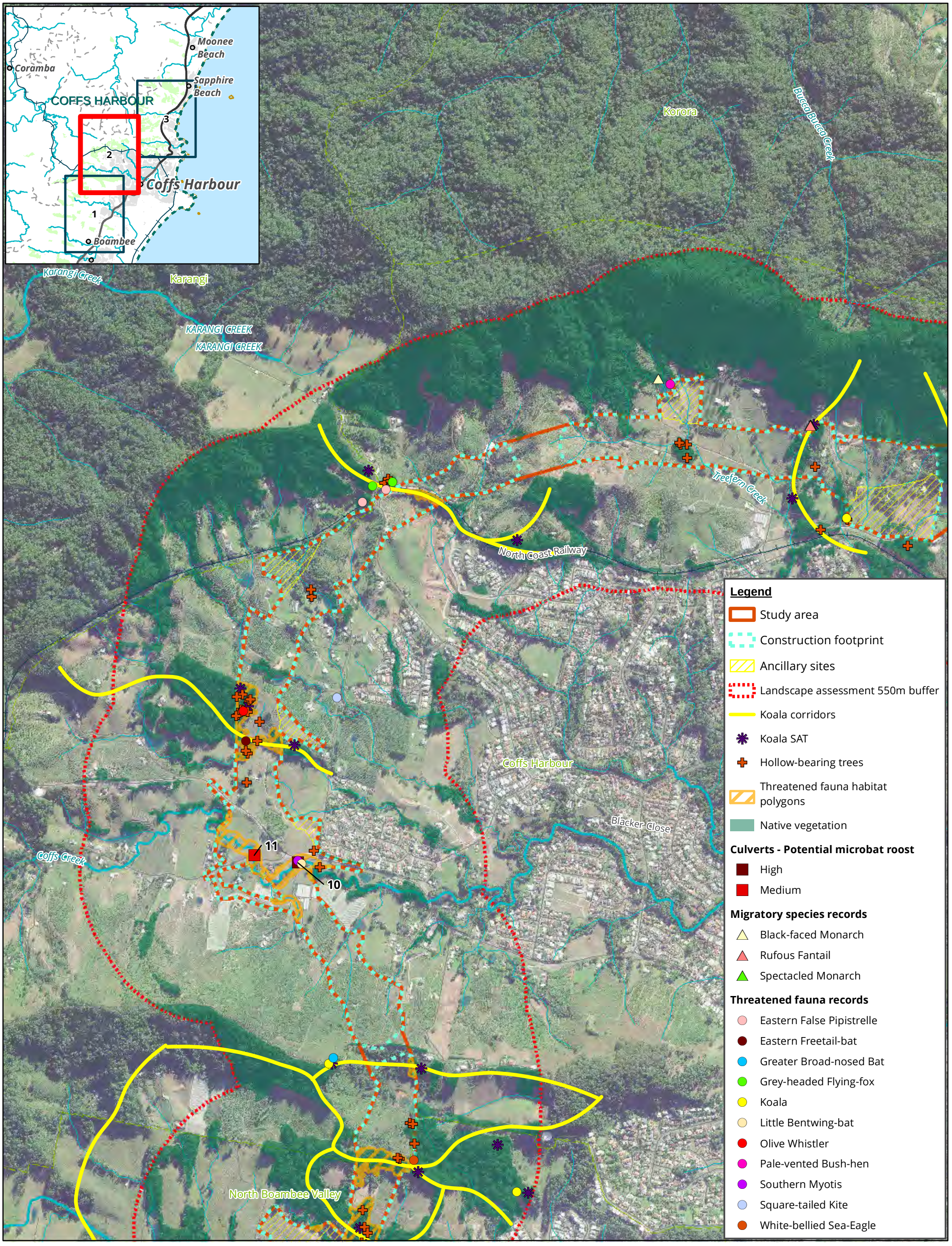


Figure 10.2: Threatened fauna records

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Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
Imagery (c) Arup 2018

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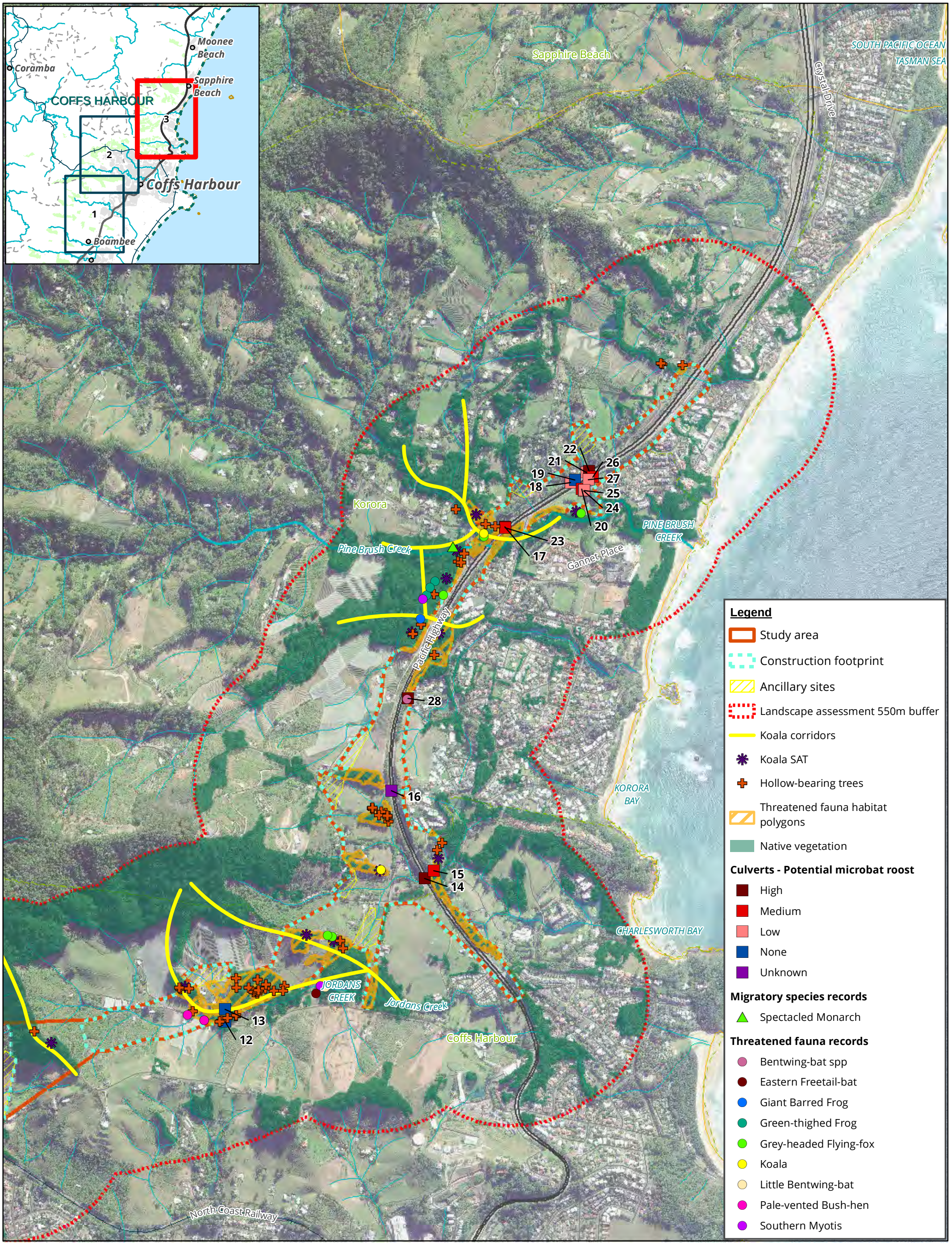


Figure 10.3: Threatened fauna records

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
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Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
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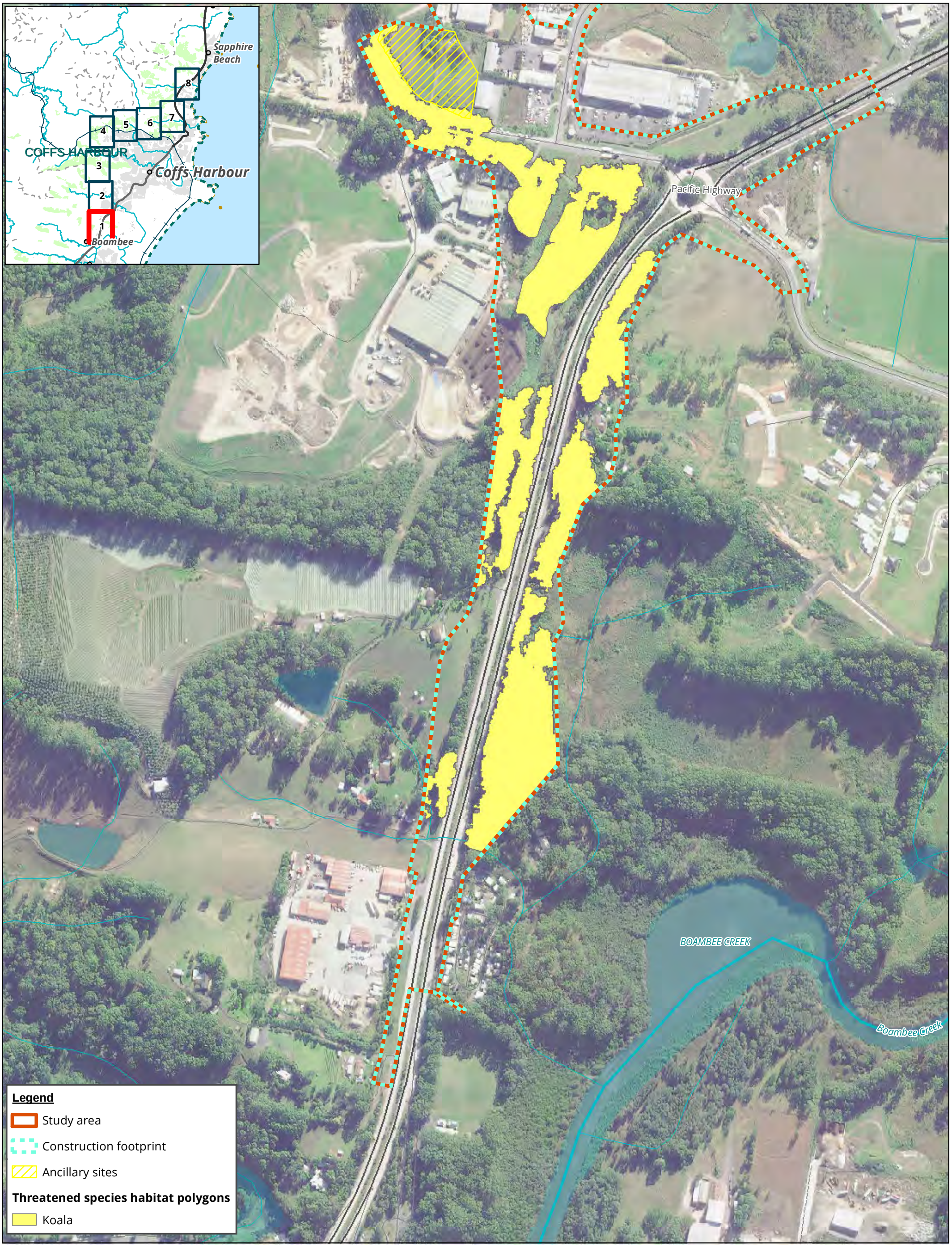


Figure 11.1: Threatened species habitat polygons

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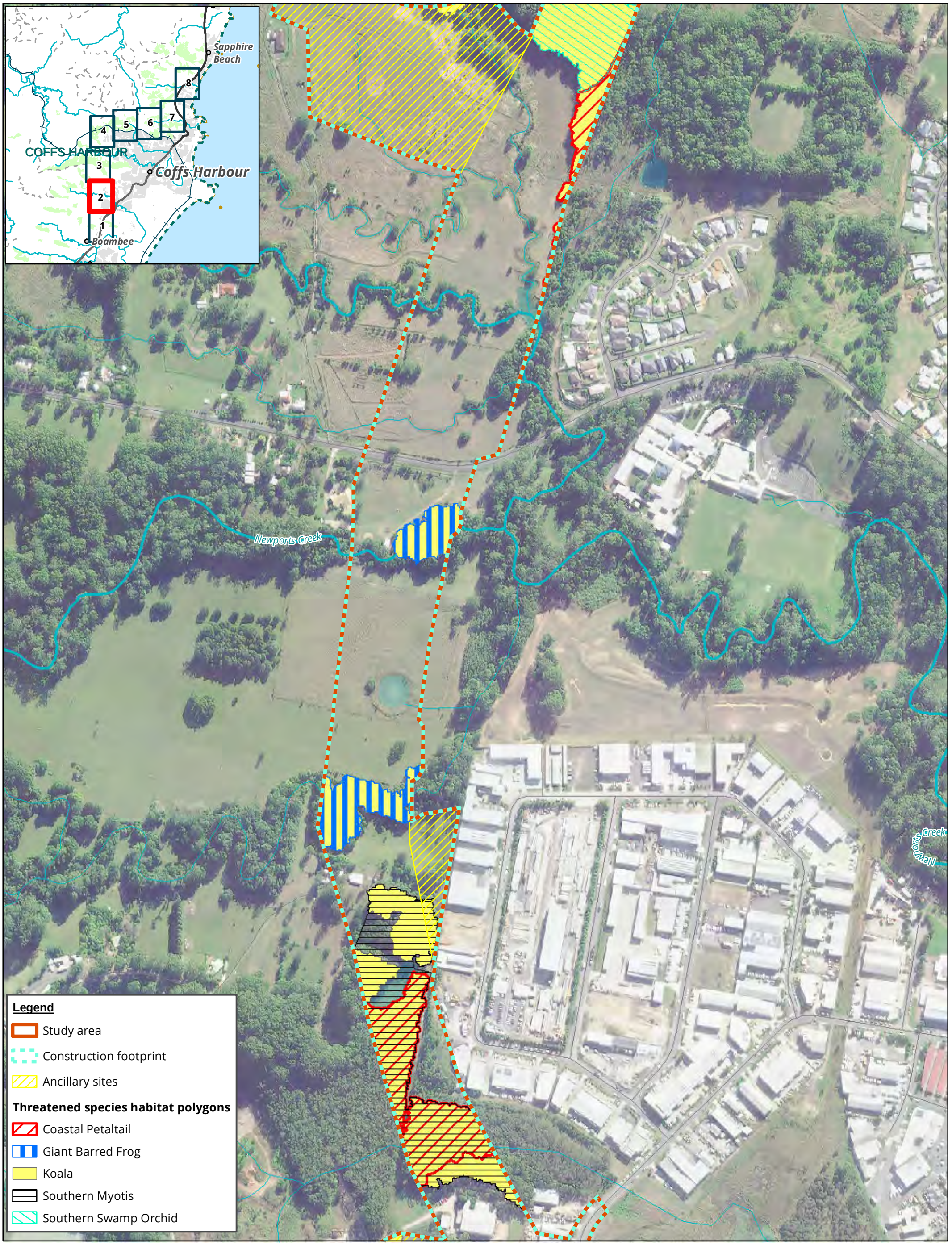


Figure 11.2: Threatened species habitat polygons

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Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
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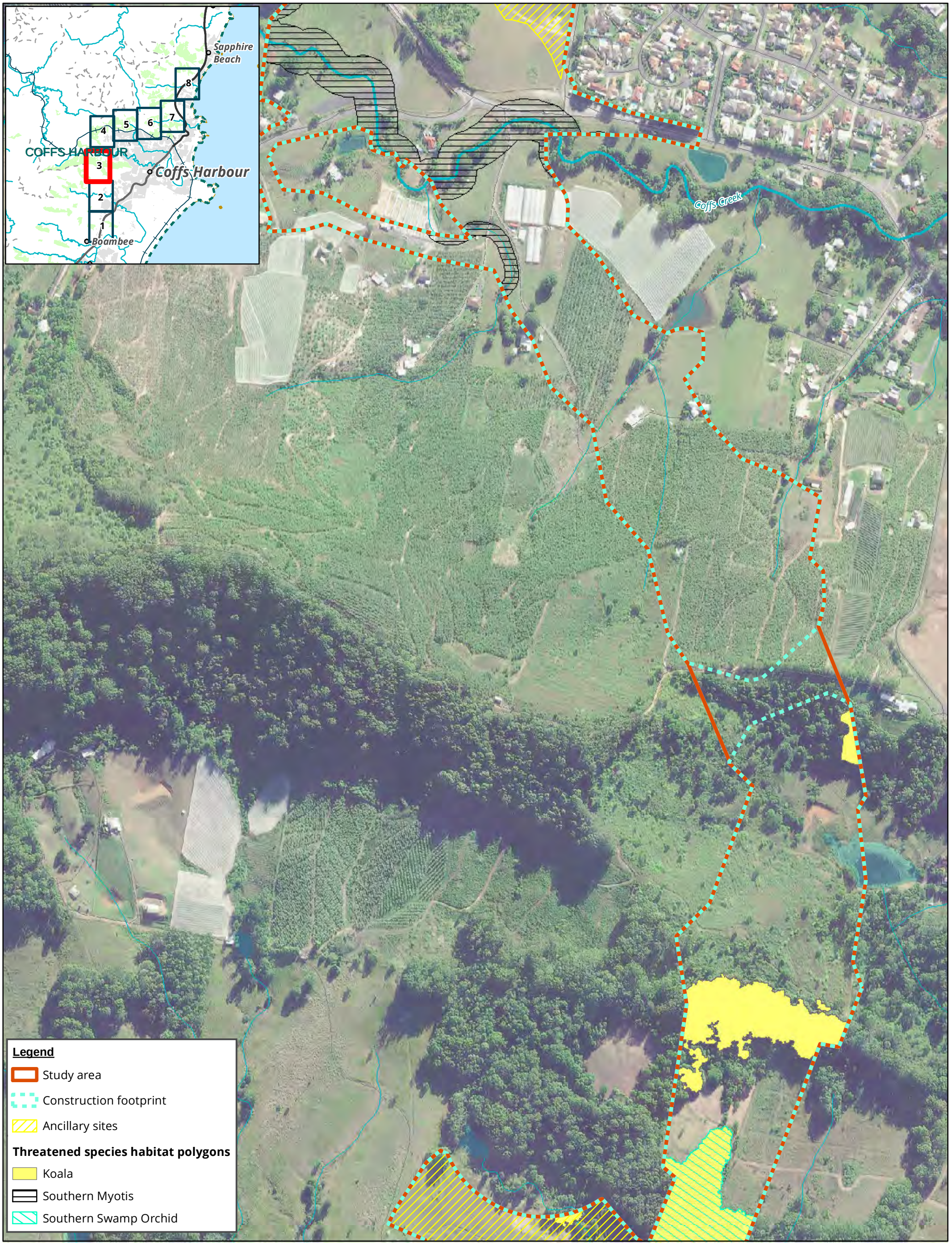


Figure 11.3: Threatened species habitat polygons

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Acknowledgements: Topo (c) NSW Land and Planning Information (2012)
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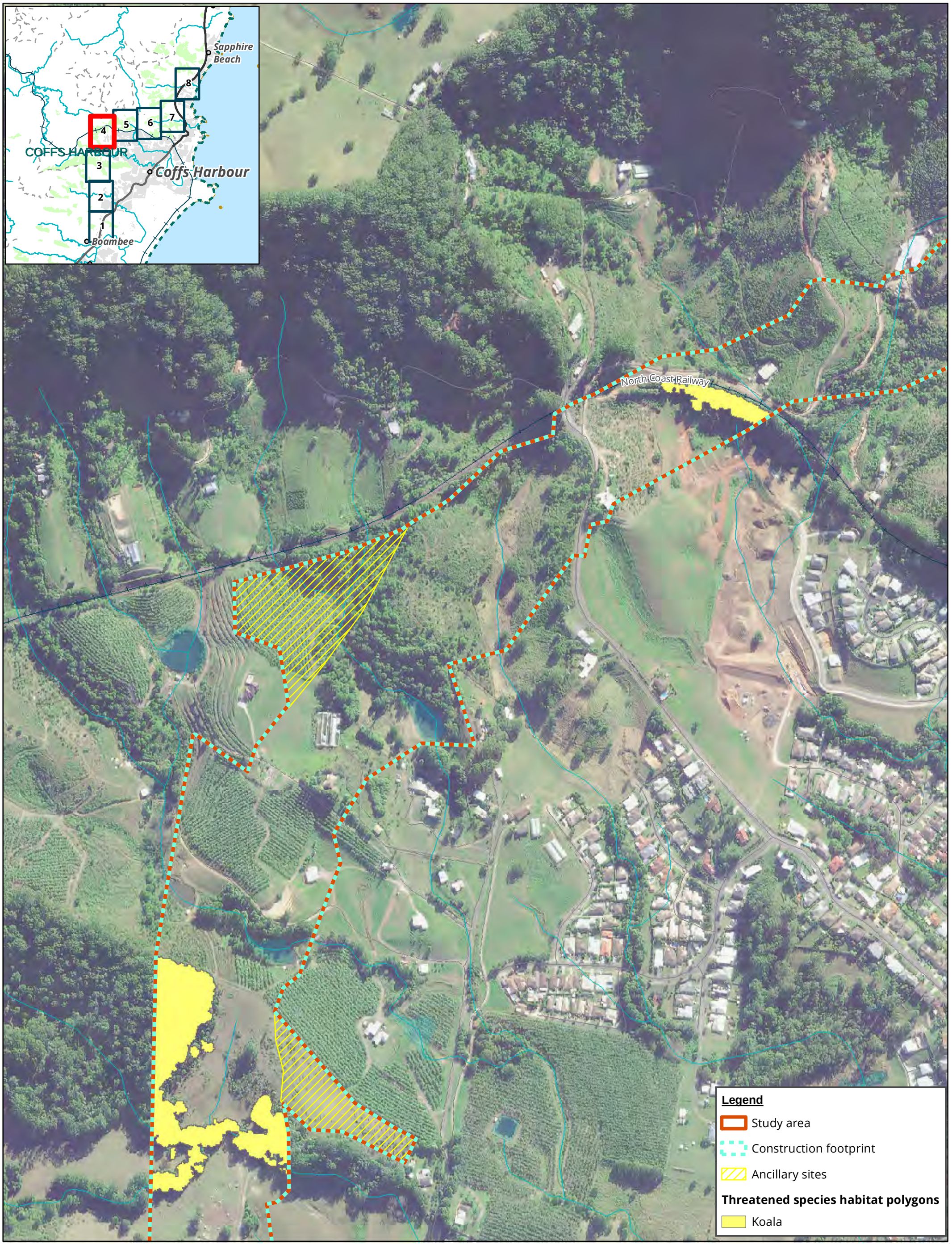


Figure 11.4: Threatened species habitat polygons

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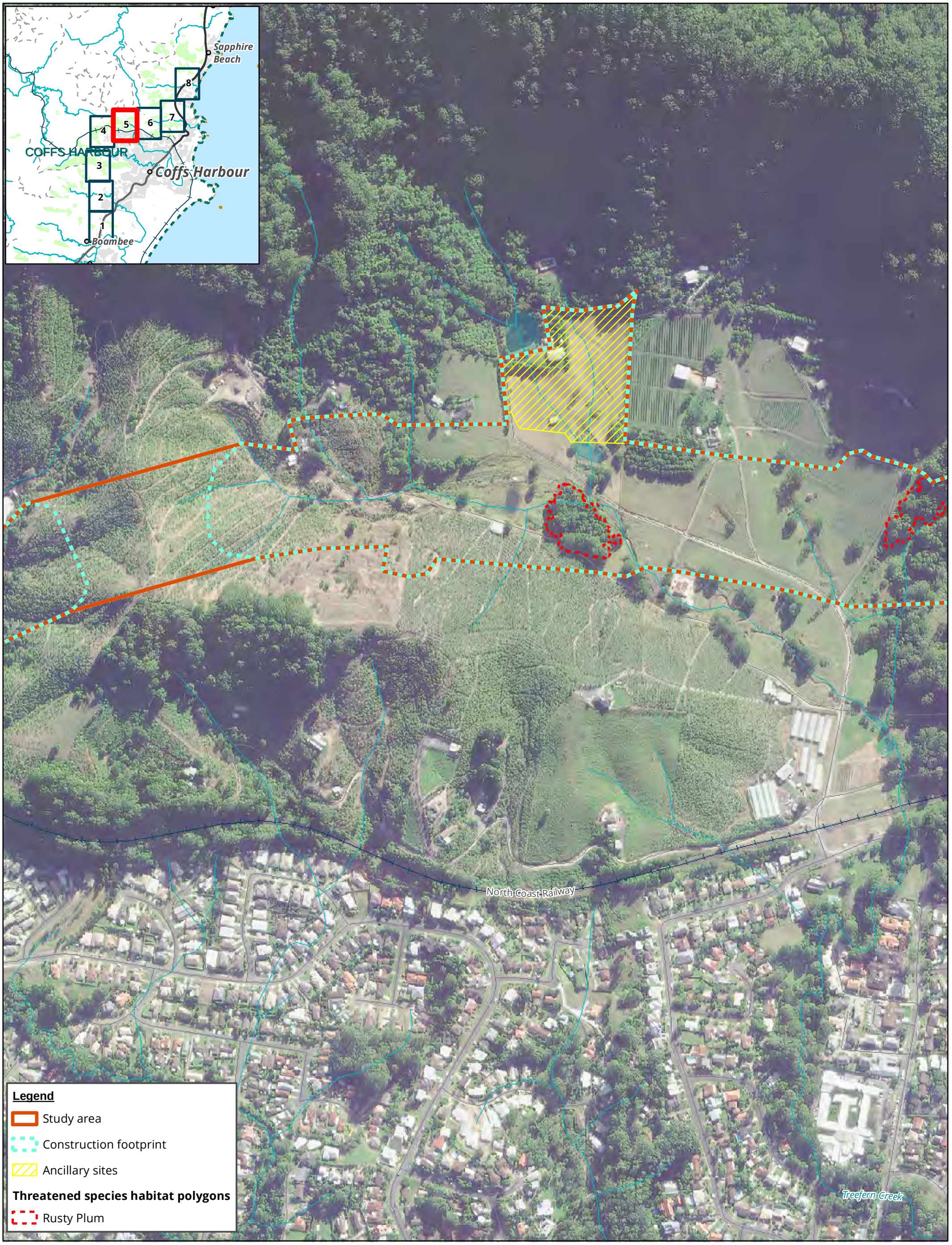


Figure 11.5: Threatened species habitat polygons

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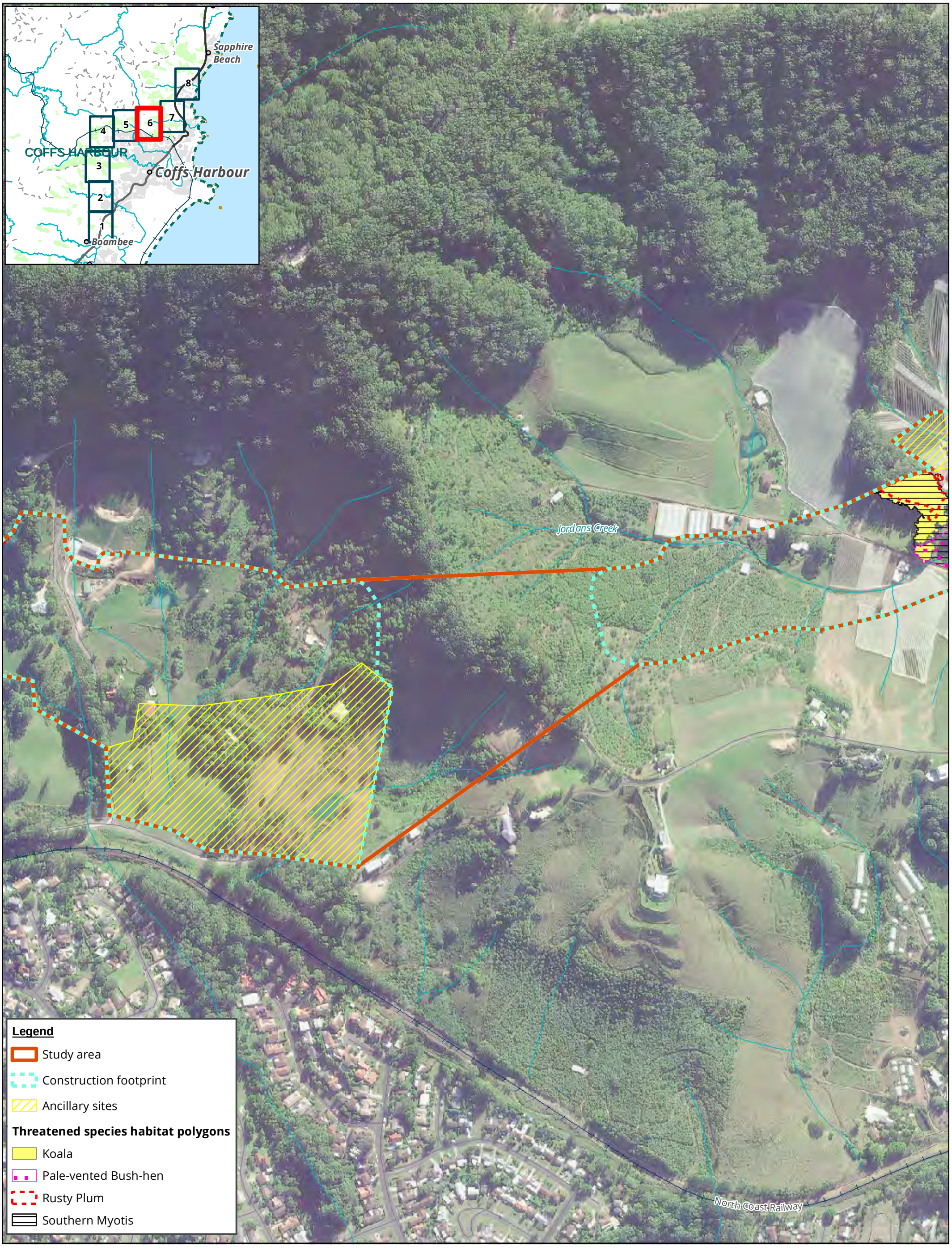


Figure 11.6: Threatened species habitat polygons

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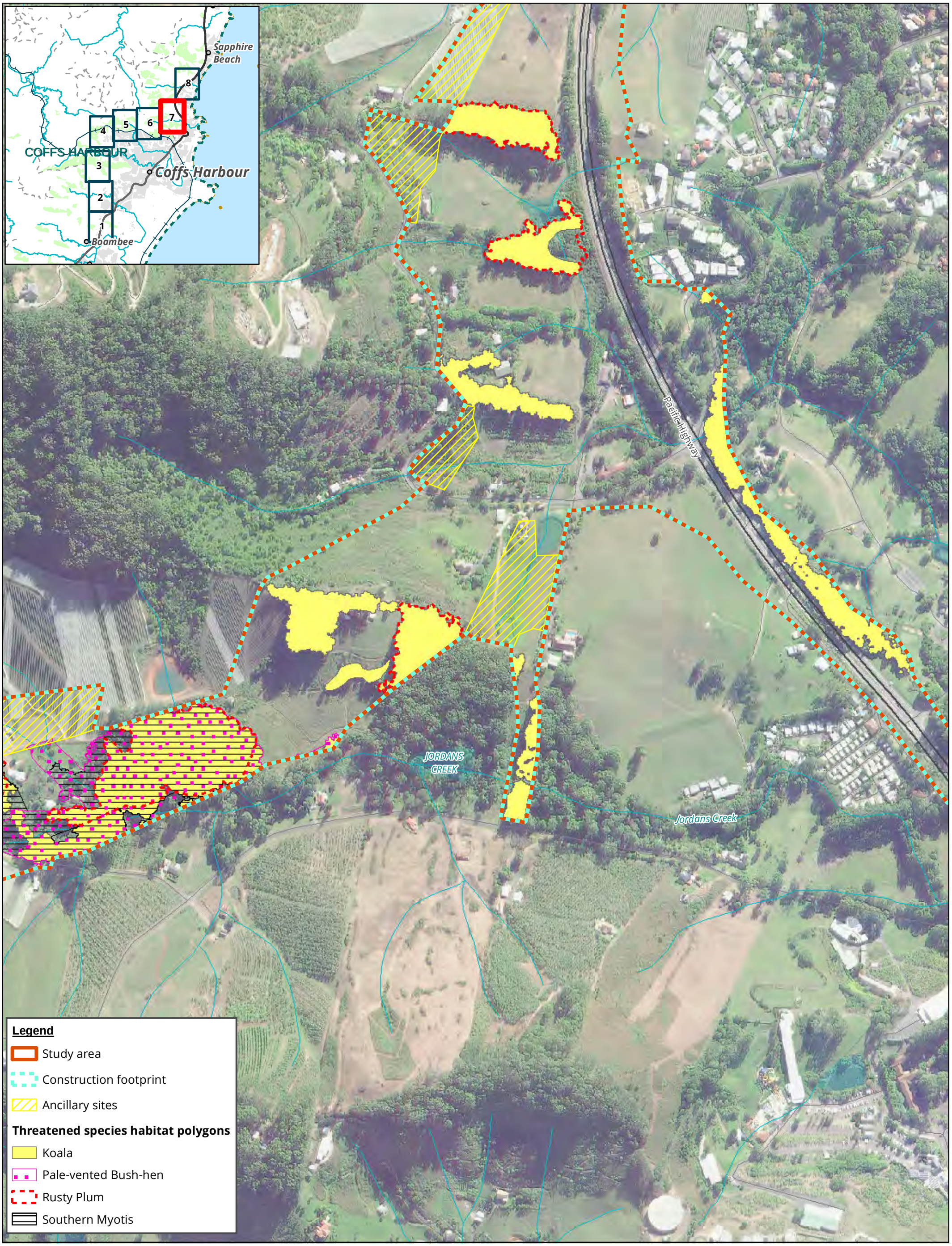


Figure 11.7: Threatened species habitat polygons

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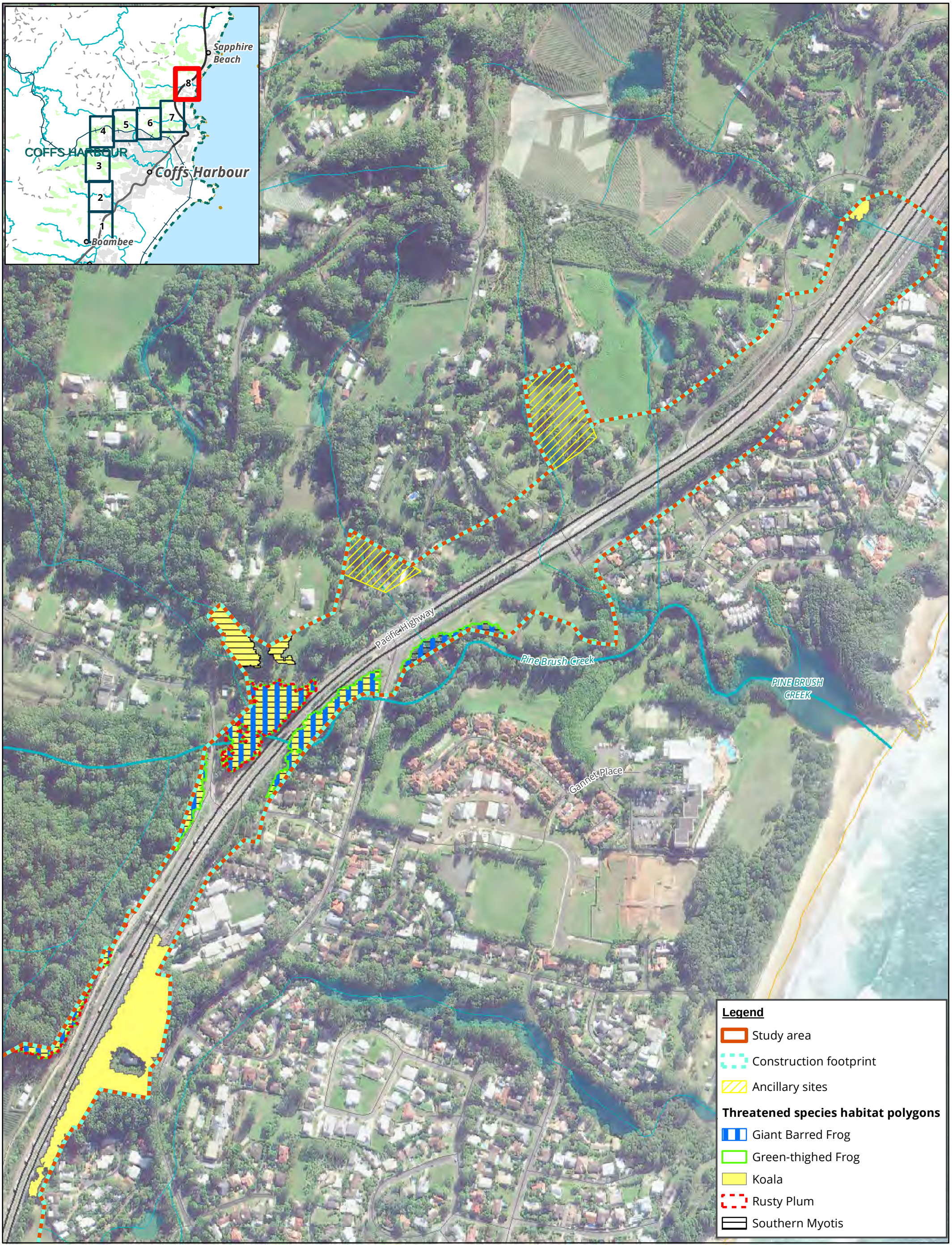


Figure 11.8: Threatened species habitat polygons

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0 50 100 150 200

Metres
Scale 1:5,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

4.3 Aquatic habitat and threatened species

The condition of aquatic habitats within the study area are considered to be typical of degraded coastal streams in NSW. The majority of waterways are subject to existing impacts associated with past land clearing, agriculture, residential and industrial development as well as existing rail and road infrastructure.

The major streams within the study area are variable in condition, with sections of Newports Creek, downstream of the study area, and Pine Brush Creek representing the highest condition waterways due to the relatively limited influence of impacts, degree of intact riparian vegetation and availability of structurally diverse habitat. Sensitive receiving environments have been identified.

4.3.1 Aquatic surveys

Aquatic ecological surveys were undertaken to inform an aquatic assessment of the waterways within the study area. This assessment included the following components:

- Assessment of threatened biota presence/absence or suitable habitat availability and condition.
- Assessment of freshwater fish community occurring within and downstream of the study area using suitable methods including backpack electrofishing and bait trap surveys.
- Assessment of vegetation condition for riparian and aquatic vegetation.
- Surface water quality sampling for a suite of relevant water quality parameters.
- Identification of the effects of the predicted changes to the aquatic environment as a result of the construction and operation of the Project, with consideration of:
- Waterway classification for all waterways within the broader study area according to Section 3 of the Policy and guidelines for fish habitat conservation and management update 2013 (DPI 2013).
- The identification of sensitive receiving environments and areas of high water quality.
- The effect of the potential impacts on aquatic ecological values inclusive of native fish, aquatic habitats and riparian vegetation.
- Best practice mitigation measures that could be practically implemented to minimise potential impacts arising from the Project including the potential for sediment runoff during high rainfall events.

Field investigation

The aquatic survey took place over four days in September 2016 and five days in May 2018. A total of 32 sites were assessed across the Coffs Harbour area (Figure 12 and Table 4.13). Conditions during both seasons were considered nominal for the aquatic systems within the study area and suitable to address potential impacts resulting from the Project. A single round of survey across all parameters was undertaken, the survey was split over two separate survey events due to access requirements.

Table 4.13 Aquatic assessment sites

Site code	Waterway	Latitude (GDA 94)	Longitude (GDA 94)
1	Unnamed	-30.3292	153.08084
2	Unnamed	-30.3132	153.080454
2.1	Newports Creek	-30.3175	153.080561
3	Newports Creek	-30.3093	153.079832
3.1	Unnamed	-30.3078	153.082278
3.2	Unnamed	-30.3072	153.082321
3.3	Unnamed	-30.310203	153.085223
4	Unnamed	-30.306	153.082278
4.1	Unnamed	-30.3077	153.083887
5	Unnamed	-30.3058	153.083233
7	Unnamed	-30.2876	153.081087

Site code	Waterway	Latitude (GDA 94)	Longitude (GDA 94)
7.3	Unnamed	-30.283	153.079006
7.4	Unnamed	-30.2826	153.078619
7.5	Unnamed	-30.2823	153.07907
12	Pine Brush Creek	-30.2515	153.131674
13	North Boambee Creek	-30.3347	153.107491
14	Unnamed	-30.244357	153.14084
14.1	Unnamed	-30.245015	153.142917
15.1	Unnamed	-30.266553	153.131851
15.2	Unnamed	-30.264826	153.130361
15.3	Unnamed	-30.263027	153.130131
17	Unnamed	-30.248572	153.137128
18.1	Unnamed	-30.279626	153.083367
18.2	Unnamed	-30.281385	153.083032
20	Unnamed	-30.301524	153.090703
21.1	Jordans Creek	-30.270721	153.120643
21.2	Jordans Creek	-30.269528	153.127164
22.1	Treefern Creek	-30.274271	153.104054
22.2	Treefern Creek	-30.273225	153.103161
23.1	Unnamed	-30.273644	153.106368
23.2	Unnamed	-30.273936	153.10735
23.3	Unnamed	-30.274439	153.109222

DPI waterway classification

Key fish habitats underpin the approach applied by NSW DPI to ensure effort and resources are focused on habitats that are of a high priority to the conservation of fisheries. Classification involves the visual assessment of waterways based on the TYPE (sensitivity of key fish habitat present) and CLASS (classification of the waterway for fish passage). Description and the classification of key fish habitats were undertaken in accordance with the Guidelines (DPI 2013) (Table 4.14).

Table 4.14 TYPE and CLASS criteria (DPI 2013)

Score	Explanation
TYPE (sensitivity)	
1 - High	• Strapweed *Posidonia australis.* • *Zostera*, *Heterozostera*, *Halophila* and *Ruppia* sp. of seagrass beds >5 m^2 in area • Coastal Saltmarsh > 5 m^2 in area. • Coral communities. • Coastal lakes and lagoons that have a natural opening and closing regime. • Marine Park, an aquatic reserve or intertidal protected area. • Wetlands mapped on (Coastal Management) 2018 SEPP (formerly SEPP 14 wetlands), wetlands recognised under international agreements, wetlands listed in the Directory of Important Wetlands of Australia. • Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 m in length, or native aquatic plants • Any known or expected protected or threatened species habitat or declared 'critical habitat' (FM Act). • Mound springs.
2 - Moderate	• *Zostera*, *Heterozostera*, *Halophila* and *Ruppia* sp. of seagrass beds <5 m^2 in area • Mangroves. • Coastal Saltmarsh <5 m^2 in area. • Marine macroalgae such as *Ecklonia* and *Sargassum* species. • Estuarine and marine rocky reefs.

Score	Explanation
	• Coastal lakes and lagoons that are permanently open or subject to artificial opening via an agreed management arrangements. • Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area. • Stable intertidal sand/mudflats, coastal and estuarine sandy beaches with large populations of in-fauna. • Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1. • Weir pools and dams up to full supply level where the weir or dam is across a natural waterway.
3 - Minimal	• Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna. • Coastal and freshwater habitats not included in TYPES 1 or 2. • Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation.
Not key fish habitat	• First and second order streams on gaining streams. • Farm dams on first and second order streams or unmapped gullies. • Agricultural and urban drains. • Urban or other artificial ponds. • Sections of stream that have been concrete-lined or piped (not including a waterway crossing). • Canal estates.
CLASS (key fish habitat)	
1 - Major	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
2 - Moderate	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.
3 - Minimal	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats.
4 - Unlikely	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present).

The DPI waterway classification relies on simple criteria to classify waterways into necessarily broad categories. Rather than indicating the relative condition of a stream or directly assessing the condition and availability of aquatic habitat within a site. For example, a highly modified dry ephemeral stream may support native aquatic vegetation, which results in a TYPE 1 (highly sensitive key fish habitat), CLASS 2 (moderate key fish habitat) classification. Regardless of the lack of surface water or the poor condition of the stream. Therefore, HABSCORE assessments have also been undertaken, to provide a direct visual assessment of stream condition and aquatic habitat.

HABSCORE assessments

HABSCORE assessments were completed at each site, to provide a direct visual measure of the relative condition and availability of aquatic habitat within the site. HABSCORE assessments are especially useful when the site is dry and no sampling of aquatic biota can be undertaken. Barbour et al. (1999) describes HABSCORE as a 'visually based habitat assessment that evaluates the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community'.

HABSCORE assessments are based on the presence and condition of the following habitat characteristics:

- Pool substrate characterisation.
- Pool variability.
- Channel flow status.
- Bank vegetation (score for each bank).
- Bank stability (score for each bank).
- Width of riparian zone (score for each bank).
- Epifaunal substrate / available cover.

These characteristics provide an indicator of the quality of the waterway even when there is insufficient water for assessments of biotic components. HABSCORE categories are derived from the sum of scores divided by the maximum possible score for the characters assessed and range from 'Poor' to 'Optimal' condition.

Surface water quality monitoring and sampling

Surface water quality results were compared to the ANZECC (2000) criteria for lowland rivers in south eastern Australia and the OEH Bellinger River and Coffs Harbour Water Quality Objectives for aquatic ecosystems (2018).

On-site surface water quality measurements were undertaken using a Horiba U-52 multi-parameter probe. Probe readings were taken from a flowing section of the stream, between the water surface and 0.5 metres depth, where possible. The following parameters relevant to the guideline values identified above are presented in this report:

- Dissolved Oxygen (mg/L and % saturation).
- pH (pH units).
- Electrical conductivity (µs/cm^2).

Nutrient samples were collected at a total of 19 sites, based upon their suitability and availability of water, with samples transferred to a NATA accredited laboratory for analysis of the following parameters:

- Total Phosphorus.
- Total Nitrogen.
- Total Kjeldahl Nitrogen.

The water quality parameters measured above provide a snapshot of conditions at a given point in time. Some of these parameters typically exhibit a high degree of temporal variation and can change substantially over small periods of time (weeks, days and even hours), particularly in response to weather events.

Fish community survey

Freshwater fish community surveys were undertaken at relevant sites within the broader study area that provided potential fish habitat, with a key focus on waterways with woody debris, aquatic vegetation and riparian vegetation. Freshwater fish community surveys were undertaken at eleven sites. The most suitable survey methods were applied at each site, dependent on the prevailing site conditions including habitat availability and water level. The methods applied during the initial survey are detailed below.

Backpack electrofishing was utilised at the majority of sites assessed. Backpack electrofishing was undertaken using a Smith-Root LR-24 backpack electrofishing unit. All electrofishing operations undertaken by Biosis are in accordance with the *Australian Electrofishing Code of Practice 1997*. All staff undertaking electrofishing operations are have completed the U.S Fisheries and Wildlife Electrofishing - Principles and Techniques of Electrofishing or Smith-Root Electrofishing Principals and Safety courses. All fish collected were identified, and inspected for general condition including presence of lesions, Lernaea and other abnormalities. All fish were returned to the water upon completion of electrofishing operations, with the exception of species declared as Noxious under the FM Act. Fish declared Noxious under the FM Act were euthanized using an overdose of Aqui-S, which anesthetises the fish with the overdose continuing to take the individual through to medullary collapse and subsequently death. Large specimens of noxious fish, under our ethics permit, were euthanized using blunt force trauma.

Bait traps were set overnight in areas of suitable habitat at three sites, which were unsuitable for electrofishing due to density of aquatic vegetation. The bait traps used are constructed with 2 millimetre mesh with a 40 millimetre diameter aperture to the entrance.

In order to avoid mortalities of fish and other aquatic fauna via asphyxiation (also frogs/late stage tadpoles via drowning) in such habitats, bait traps were set with part of the trap protruding from the water surface. Thus, the depth range corresponded with the dimensions of the trap: between 15 centimetres (depth required for immersion of entrance funnels) and 25 centimetres (height of trap). Where possible the traps were set at a depth closer to 25 centimetres since this allows for some overnight drop in water levels without exposing entrance funnels.

Placement of traps was restricted to areas with a medium to high density (≥ 20% cover) of vegetation. The vegetation included emergent macrophytes, submerged macrophytes and inundated terrestrial grasses/herbs, but did not include filamentous algae or floating macrophytes.

Survey effort summary

Details of the assessment methodologies applied at each site are provided in Table 4.15. Where waterways intersected by the alignment were not accessible, an assessment was undertaken downstream, wherever possible and necessary. All major waterways within the study area have been assessed, including the majority of smaller waterways. Not all waterways mapped within the project alignment could be individually assessed due to access limitations. Typically, the waterways not assessed are first order tributaries of waterways that themselves have been assessed or are represented in the survey effort by waterways in the same landform or environmental condition. Site selection focused on three criteria, additional to available access. Firstly, assessment of major waterways and associated tributaries. Secondly, waterways representative of landforms and environmental conditions, such as steep gullies and ephemeral streams crossing farmed land. Thirdly, the highest condition waterways, based on the presence of riparian vegetation, water availability, habitat observations, and surrounding sources of impacts. These criteria were initially assessed on aerial imagery and then ground truthed from accessible roads and properties. The level of assessment is considered adequate to address the aims of the survey and represent the aquatic ecological values associated with waterways within the project alignment.

Table 4.15 Aquatic survey methods applied at each site

Site code	Waterway	Assessment method						Rationale
		DPI waterway classification	Backpack electrofishing	Bait trapping	Nutrient water sample	On-site water quality	HABSCORE assessment	
1	Unnamed	X			X		X	Available water allowed nutrient sampling but precluded submersion of a water quality probe.
2	Unnamed	X	X		X	X	X	-
2.1	Newports Creek	X	X	X	X	X	X	-
3	Newports Creek	X		X	X	X	X	-
3.1	Unnamed	X					X	-
3.2	Unnamed	X					X	Dry at the time of survey. Highly modified ephemeral stream crossing farm paddock.
3.3	Unnamed	X	X			X	X	-
4	Unnamed	X	X		X	X	X	-
4.1	Unnamed	X	X		X	X	X	-
5	Unnamed	X		X	X	X	X	-
7	Unnamed	X	X		X	X	X	-
7.3	Unnamed	X			X	X	X	-

Site code	Waterway	Assessment method						Rationale
		DPI waterway classification	Backpack electrofishing	Bait trapping	Nutrient water sample	On-site water quality	HABSCORE assessment	
7.4	Unnamed	X			X	X	X	-
7.5	Unnamed	X			X	X	X	-
12	Pine Brush Creek	X	X		X	X	X	-
13	North Boambee Creek	X			X		X	-
14	Unnamed	X					X	-
14.1	Unnamed	X			X	X	X	-
15.1	Unnamed	X					X	High slope ephemeral stream.
15b	Unnamed				X	X		Dam within the Pacific Bay Resort, receiving water downstream of high slope ephemeral streams within the study area. Only physiochemical parameters are relevant.
15.2	Unnamed	X					X	High slope ephemeral stream.
15.3	Unnamed	X					X	High slope ephemeral stream.
17	Unnamed	X					X	Ephemeral drainage line interrupted by a dam.
18.1	Unnamed	X					X	Ephemeral stream crossing farm paddocks and residential properties.

Site code	Waterway	Assessment method						Rationale
		DPI waterway classification	Backpack electrofishing	Bait trapping	Nutrient water sample	On-site water quality	HABSCORE assessment	
18.2	Unnamed	X			X	X	X	Small modified stream lacking fish habitat. No aquatic fauna observed.
20	Unnamed	X	X			X	X	-
21.1	Jordans Creek	X					X	Moderate slope ephemeral stream.
21.2	Jordans Creek	X			X		X	-
22.1	Treefern Creek	X	X				X	-
22.2	Treefern Creek	X	X		X	X	X	-
23.1	Unnamed	X					X	Moderate slope ephemeral stream crossing cleared land.
23.2	Unnamed	X					X	Moderate slope ephemeral stream crossing cleared land.
23.3	Unnamed	X			X	X	X	Moderate slope, small modified stream draining cleared paddocks. Fish habitat lacking. No aquatic fauna observed.

4.3.2 Aquatic results

The combined results of the aquatic surveys are provided in the sections below.

Waterway classification

The results of the waterway classification according to the *Policy and guidelines for fish habitat conservation and management* DPI (2013) are provided in Table 4.16. Under section 3.2 (Key fish habitat management policies) of the policy, fish habitat sensitivity can be ranked as TYPE 1, 2, or 3 depending on the associated sensitivity classification criteria listed in the guidelines for each TYPE. Waterways can also be assessed according to CLASS characteristics which factor in the functionality of the waterway and its suitability as fish habitat (DPI 2013). The classification results show that waterways within the project alignment range from highly to minimally sensitive key fish habitat and major to unlikely key fish habitat for fish passage.

Table 4.16 Waterway classification

Site	TYPE	CLASS
1	1 - Highly sensitive key fish habitat	2 - Moderate key fish habitat
2	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
2.1	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
3	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
3.1	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
3.2	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
3.3	1 - Highly sensitive key fish habitat	1 - Major key fish habitat
4	1 - Highly sensitive key fish habitat	3 - Minimal key fish habitat
4.1	1 - Highly sensitive key fish habitat	2 - Moderate key fish habitat
5	1 - Highly sensitive key fish habitat	2 - Moderate key fish habitat
7	1 - Highly sensitive key fish habitat	3 - Minimal key fish habitat
7.3	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
7.4	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
7.5	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
12	1 - Highly sensitive key fish habitat	1 - Major key fish habitat
13	1 - Highly sensitive key fish habitat	1 - Major key fish habitat
14	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
14.1	1 - Highly sensitive key fish habitat	1 - Major key fish habitat
15.1	3 - Minimally sensitive key fish habitat	4 - Unlikely key fish habitat
15.2	3 - Minimally sensitive key fish habitat	4 - Unlikely key fish habitat

Site	TYPE	CLASS
15.3	3 - Minimally sensitive key fish habitat	4 - Unlikely key fish habitat
17	3 - Minimally sensitive key fish habitat	4 - Unlikely key fish habitat
18.1	3 - Minimally sensitive key fish habitat	3 - Minimal key fish habitat
18.2	1 - Highly sensitive key fish habitat	2 - Moderate key fish habitat
20	1 - Highly sensitive key fish habitat	2 - Moderate key fish habitat
21.1	3 - Minimally sensitive key fish habitat	4 - Unlikely key fish habitat
21.2	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat
22.1	1 - Highly sensitive key fish habitat	1 - Major key fish habitat*
22.2	1 - Highly sensitive key fish habitat	1 - Major key fish habitat*
23.1	3 - Minimally sensitive key fish habitat	3 - Minimal key fish habitat
23.2	3 - Minimally sensitive key fish habitat	3 - Minimal key fish habitat
23.3	2 - Moderately sensitive key fish habitat	2 - Moderate key fish habitat

***Note: Sites 22.1 and 22.2 were downstream of the construction footprint and Treefern Creek was assigned a Class 4 classification for the section of the waterway under and upstream of the alignment by DPI Fisheries in December 2018.**

HABSCORE

The results of the HABSCORE assessments are provided in Table 4.17. Site categories are described as the following:

- Optimal (76 – 100) - Watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.
- Suboptimal (51 – 75) - Watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought although, become greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.
- Marginal (26 – 50) - Watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.
- Poor (0 – 25) - Watercourses or drainages that only flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

Only two sites recorded optimal aquatic habitat scores, Sites 3.3 (unnamed waterway) and 12 (Pine Brush Creek). These high scores were due to the availability of water and undisturbed nature of riparian vegetation, diverse pool geometries and substrate types. The remaining sites are split evenly between the Suboptimal, Marginal and Poor grades. Sites that scored either marginal or suboptimal aquatic habitat scores reflect impacts to aquatic habitat associated with current and past land use, particularly clearing, grazing and weed ingress. Suboptimal sites typically represent relatively good aquatic habitats which are impacted by pressures such as reduced water availability, homogenised substrates and moderately degraded riparian vegetation. Sites that recorded Poor scores were generally dry at the time of survey. The lack of water at these sites relates to the ephemeral nature of these waterways on steep

slopes with modified riparian vegetation, such as site 14. The lack of water may also relate to the highly disturbed condition of ephemeral waterways located in maintained farm paddocks within lowland sections of the project alignment.

Table 4.17 HABSCORE results

Site name	HABSCORE	Category*
1	25	Poor
2	53	Suboptimal
2.1 (Newports Creek)	69	Suboptimal
3 (Newports Creek)	55	Suboptimal
3.1	13	Poor
3.2	13	Poor
3.3	86	Optimal
4	72	Suboptimal
4.1	59	Suboptimal
5	57	Suboptimal
7	58	Suboptimal
7.3	54	Suboptimal
7.4	54	Suboptimal
7.5	31	Marginal
12 (Pine Brush Creek)	79	Optimal
14	24	Poor
14.1	50	Marginal
15	18	Poor
15.2	25	Poor
15.3	25	Poor
17	14	Poor
18.1	16	Poor
18.2	35	Marginal
20	59	Suboptimal

Site name	HABSCORE	Category*
21.1 (Jordans Creek)	36	Marginal
21.2 (Jordans Creek)	46	Marginal
22.1 (Treefern Creek)	54	Suboptimal
22.2 (Treefern Creek)	52	Suboptimal
23.1	29	Marginal
23.3	50	Marginal

Surface water quality results

The results of the on-site surface water quality monitoring and sampling are shown in Table 4.18 below. Cells have been shaded red where values are outside of guideline values for both the ANZECC (2000) and OEH (2018) water quality criteria. The water quality results recorded during the survey indicate the surface water quality of waterways within the broader study area ranged from moderate to poor. pH and electrical conductivity were within the guideline values for the majority of sites. The exception being site 7.3 which recorded a pH score slightly below guideline values. One round of survey was undertaken over two field campaigns, in September 2016 and May 2018.

Table 4.18 Surface water quality monitoring results

Site	pH	Conductivity (ambient) µS/cm	Dissolved Oxygen (%)	Total Nitrogen (µg/L)	Total Kjeldahl Nitrogen (µg/L)	Total Phosphorus (µg/L)	Rationale
ANZECC (2000)	6.5 – 8.0	85 - 110	125 - 2200	500	-	50	
OEH (2018)	6.5 – 8.5	85 - 110	125 - 2200	350	-	25	
1	-	-	-	13200	13200	1790	Available water allowed nutrient sampling but precluded submersion of a water quality probe.
2	6.96	278	70	400	300	30	-
2.1	7.36	1490	50	1600	1600	200	-
3	7.7	290	54	800	800	80	-
3.3	7.29	153	53				Nutrient water sample already collected for Newports Creek at site 3 approximately 500 m upstream.
4	6.99	277	41	400	400	20	-
4.1	6.15	242	20	200	200	20	-
5	7.78	290	54	600	500	40	-
7	7.44	184	57	1100	500	<10	-
7.3	5.98	395	19	800	200	10	-

Site	pH	Conductivity (ambient) µS/cm	Dissolved Oxygen (%)	Total Nitrogen (µg/L)	Total Kjeldahl Nitrogen (µg/L)	Total Phosphorus (µg/L)	Rationale
7.4	6.97	163	130	300	300	50	-
7.5	7.07	276	77	900	400	30	-
12	7.01	388	11	500	100	<10	-
13	-	-	-	<100	<100	50	Estuarine section of North Boambee Creek. Nutrient readings only required to gauge nutrient processing downstream of the study area.
14.1	7.66	291	71	2200	800	80	-
15b	7.47	201	34	2000	2000	50	Golf course dam.
18.2	7.25	136	68	2600	2600	560	-
21.2	-	-	-	2300	2300	270	Available water allowed nutrient sampling but precluded submersion of a water quality probe.
22.2	7.24	150	49	1300	600	<10	-
23.3	7.82	164	49	400	400	140	-

< Below laboratory limit of reporting

Cells shaded red indicate values outside of guideline values for both the ANZECC (2000) and OEH (2018) water quality criteria

Freshwater fish community results

The Oxleyan Pygmy Perch *Nannoperca oxleyana* (Endangered FM Act) was identified as a species with potential to occur within the study area. DPI Fisheries has not mapped predictive habitat distributions for this species, although the historic range of this species includes the Coffs Harbour area (DPI 2016) Suitable habitat for this species includes swamps, lakes or slow moving creeks on coastal floodplains, with coastal heath vegetation dominated by Banksia's and abundant shelter in the form of undercut banks and aquatic vegetation. The species is generally found in acidic waters with low electrical conductivity values. No suitable habitat for this species, or individuals were recorded during the aquatic surveys.

DPI *predicted* habitat (DPI 2018) for the Purple Spotted Gudgeon *Mogurnda adspersa* (Endangered FM Act) exists along sections of Newports Creek and Coffs Creek within the study area. This species occupies slow flowing streams or billabongs with low turbidities and habitat in the form of aquatic vegetation, undercut banks, leaf litter and large woody debris (DPI 2017). Targeted survey for this species was undertaken along these sections of predicted habitat at aquatic survey sites 3, 3.3 and 7.

Field survey at these sites identified poor condition habitat for this species at sites 3 and 7, primarily due to the presence of barriers to fish passage. Moderate condition habitat was identified at site 3.3, which was limited by the amount of available aquatic vegetation and undercut banks, which are important habitat features for this species. No individuals of this species were recorded during the targeted survey at any of the sites. Two populations of Southern Purple Spotted Gudgeon are described with the coastal eastern population of relevance to this project. The only known extant populations of the eastern population of Southern Purple Spotted Gudgeon occur within the Richmond and Hunter Valley catchments, with few recent records of this species even from targeted survey in locations where this species has previously been known to occur (DPI 2017). The loss of habitat in the form of aquatic vegetation, impacts to stream banks from livestock and associated increases to turbidity, agricultural runoff and siltation are listed as some of the key reasons for the threatened status of this species. These are known factors that occur within or in proximity to the predicted habitat mapped for this species within the study area. Given that no individuals of this species were identified during the targeted survey and the known impacts to habitat for this species within areas of potential habitat, this species is considered to have a low likelihood of occurrence within the study area. As such a significant impact assessment under the FM Act is not considered necessary.

Desktop research identified one record of Eastern Freshwater Cod *Maccullochella ikei* (Endangered, EPBC Act and FM Act) within the Coffs Harbour area from 1966. DPI Fisheries has not mapped predictive habitat distribution for the Eastern Freshwater Cod within the coastal flowing Bellinger catchment, with the species native only to the Richmond and Clarence Rivers (NSW Fisheries 2004). This species was not recorded during the surveys and is not considered likely to occur within the study area.

The results of the freshwater fish community survey are provided in Table 4.19. A total of six native and one exotic species were recorded across the eleven sites assessed. The composition of fish species recorded are considered to be representative of modified coastal freshwater systems. The fish communities within the study area typically exhibited low native fish species richness and abundance, reflecting a range of impacts including riparian vegetation and surrounding land clearing, agriculture, existing road infrastructure and invasion by exotic species. Site 3.3 was an exception, exhibiting a high degree of fish habitat condition and availability and abundant numbers of native fish.

Table 4.19 Freshwater fish community results

Species name	Common name	Collected	Observed
Site 2 – Backpack electrofishing			
Anguilla reinhardtii	Long Finned Eel	14	0
Gobiomorphus australis	Striped Gudgeon	61	10
Hypseleotris compressa	Empire Gudgeon	7	30
Site 2.1 – Bait traps			
None caught			

Species name	Common name	Collected	Observed
Site 2.1 – Backpack electrofishing			
Gambusia holbrooki	Gambusia	11	30
Gobiomorphus australis	Striped Gudgeon	23	0
Hypseleotris compressa	Empire Gudgeon	5	0
Site 3 – Bait traps			
Gambusia holbrooki	Gambusia	1	0
Gobiomorphus australis	Striped Gudgeon	4	0
Hypseleotris compressa	Empire Gudgeon	7	30
Site 3.3 – Backpack electrofishing			
Anguilla reinhardtii	Long Finned Eel	8	15
Gobiomorphus australis	Striped Gudgeon	62	0
Hypseleotris compressa	Empire Gudgeon	54	0
Site 4 – Backpack electrofishing			
Anguilla reinhardtii	Long Finned Eel	0	4
Gobiomorphus australis	Striped Gudgeon	4	0
Hypseleotris compressa	Empire Gudgeon	45	0
Site 4.1 – Backpack electrofishing			
Anguilla reinhardtii	Long Finned Eel	1	2
Gobiomorphus coxii	Cox's Gudgeon	13	0
Hypseleotris compressa	Empire Gudgeon	13	0
Site 5 – Bait traps			
Gambusia holbrooki	Gambusia	32	0
Gobiomorphus australis	Striped Gudgeon	4	0
Hypseleotris compressa	Empire Gudgeon	13	0
Site 7 – Backpack electrofishing			
Anguilla reinhardtii	Long Finned Eel	1	2
Gambusia holbrooki	Gambusia	0	80

Species name	Common name	Collected	Observed
Gobiomorphus australis	Striped Gudgeon	14	0
Hypseleotris compressa	Empire Gudgeon	9	0
Melanotaenia duboulayi	Duboulay's Rainbowfish	1	0
Site 12 – Backpack electrofishing			
Anguilla reinhardtii	Long Finned Eel	31	0
Gobiomorphus australis	Striped Gudgeon	2	0
Hypseleotris compressa	Empire Gudgeon	1	0
Melanotaenia duboulayi	Duboulay's Rainbowfish	2	0
Philypnodon macrostomus	Dwarf Flathead Gudgeon	1	0
Site 22.1 – Backpack electrofishing			
Anguilla reinhardtii	Long Finned Eel	0	4
Gambusia holbrooki	Gambusia	0	85
Gobiomorphus australis	Striped Gudgeon	2	0
Site 22.2 – Backpack electrofishing			
Anguilla reinhardtii	Long Finned Eel	0	6
Gobiomorphus australis	Striped Gudgeon	3	0

4.3.3 Summary

All aquatic environments, due to connection to sensitive receivers (ie. Estuaries, Newports Creek and/or Solitary Islands Marine Park), or lack of resilience (ie. sensitivity to changes in hydolrogy and potential construction impacts), represent areas of high ecological constraint in terms of project construction. A summary of the results of the aquatic survey is provided below.

Surface water quality

Surface water quality within the aquatic environments surveyed generally ranged from moderate to poor. The values recorded are considered to be within the usual range expected to be recorded within an urbanised or semi-urbanised catchment, subject to historic and on-going anthropogenic disturbance.

All estuarine areas and wetlands downstream of the project alignment are considered sensitive receiving environments, as well as the receiving environments of Pine Brush Creek, Jordans Creek, Treefern Creek, and Coffs Creek that flow into the Habitat Protection Zone of the Solitary Islands Marine Park. An additional sensitive receiving environment was identified at site 3.3 along Newports Creek, approximately 250 metres downstream of the project alignment. This site is considered as such due to the presence of a highly abundant native fish community as well as the relative lack of anthropogenic disturbance, undisturbed riparian vegetation and high condition of aquatic habitat.

Riparian condition

The condition of riparian vegetation within the project alignment is moderate to poor and reflects the range of past and present land uses within the broader region. Key impacts to riparian vegetation across the aquatic sites included impacts associated with clearing, grazing and weed ingress. Where riparian vegetation is relatively intact, such as site 3.3 (Newports Creek) and site 12 (Pine Brush Creek)

that recorded Optimal HABSCOREs, a degree of fragmentation on at least one bank was observed with these sites.

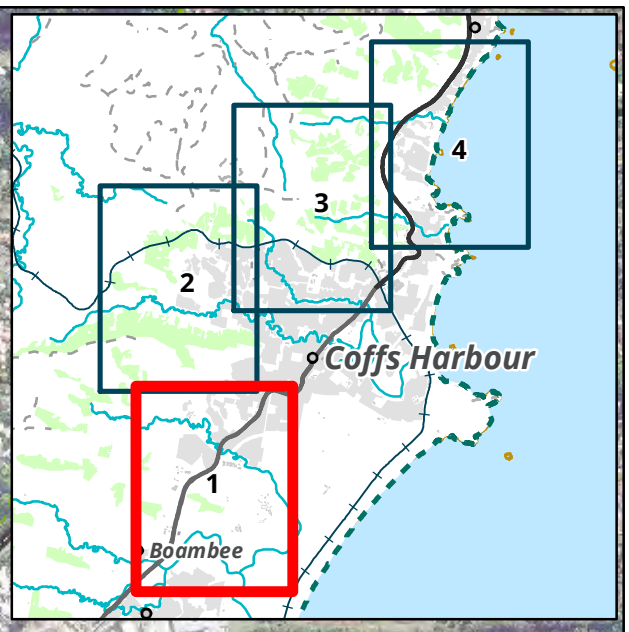
Freshwater fish communities

The fish communities within all the waterways surveyed are considered to be characteristic of modified coastal waterways. No Oxleyan Pygmy Perch individuals were recorded, and no suitable habitat for this species was identified within the study area. While potential habitat for the Southern Purple Spotted Gudgeon was identified within the study area, given no individuals of this species were recorded and considering the impacts present within proximity to these areas, there is a low likelihood of occurrence within the study area.

Site 3.3 along Newports Creek recorded a higher relative abundance of native fish species than other sites assessed in the study area, with no invasive fish species recorded. These findings are associated with the higher quality bed and bank structure and riparian vegetation. Site 12 (Pine Brush Creek), bordering Kororo Nature Reserve, recorded the highest diversity of native fish species (five species recorded), which again is attributed to high quality instream habitats and riparian vegetation.

All waterways surveyed holding water at the time of survey are considered to be Major or Moderate in terms of fish passage (CLASS), with these waterways also being considered Highly or Moderately sensitive key fish habitat (TYPE). Six waterways were classified as being both Highly sensitive and Major key fish habitat. These waterways reflect areas of permanent flow, providing habitat for native fish communities. As such, these sites represent areas of higher aquatic ecological values and should be subject to greater levels of protection and impact minimisation.

4 (Class 3)
5 (Class 2)
3.2 (Class 2)
4.1 (Class 2)
3.1 (Class 2)
3 (Class 2)
3.3 (Class 1)
North Boambee Valley
2 (Class 2)
2.1 (Class 2)
1 (Class 2)
Pacific Highway
Coffs Harbour
Hogbin Drive
Newports Creek
NEWPORTS CREEK
BOAMBEE CREEK
Boambee East
Boambee Creek
Toormina
13 (Class 1)



Legend

- Study area
- Construction footprint
- Ancillary sites
- Threatened fish distribution (DPI 2016)
- Aquatic monitoring site
- NSW Wetlands 2006
- NSW Wetlands 2006 buffer

Watercourses

- NonPerennial
- Perennial

Strahler order

- Strahler order - 1
- Strahler order - 2
- Strahler order - 3
- Strahler order - 4

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Figure 12.1: Aquatic survey coverage

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Matter: 22156
Date: 24 May 2019,
Checked by: CW, Drawn by: SSK, Last edited by: lharley
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Metres
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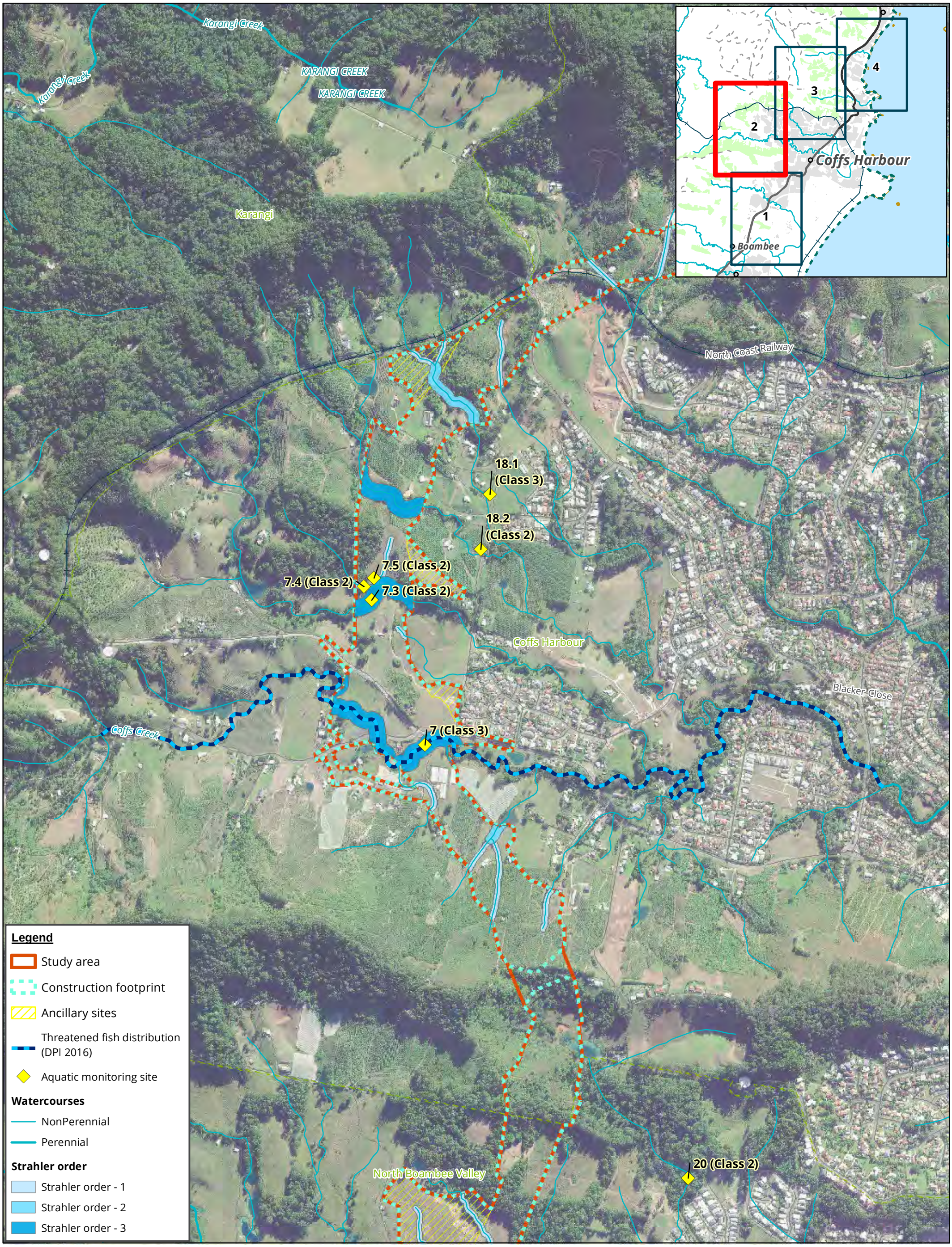


Figure 12.2: Aquatic survey coverage

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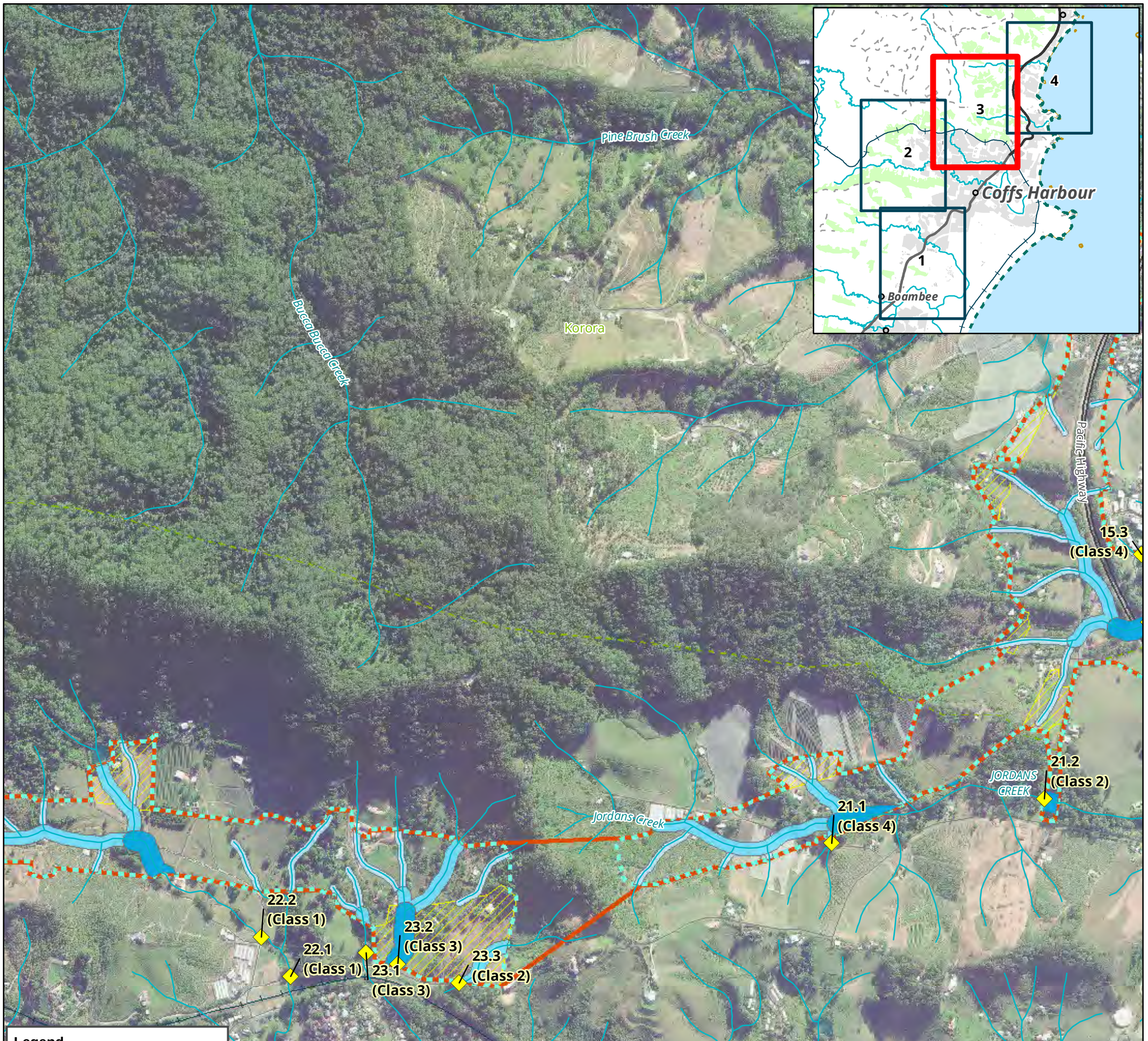


Figure 12.3: Aquatic survey coverage

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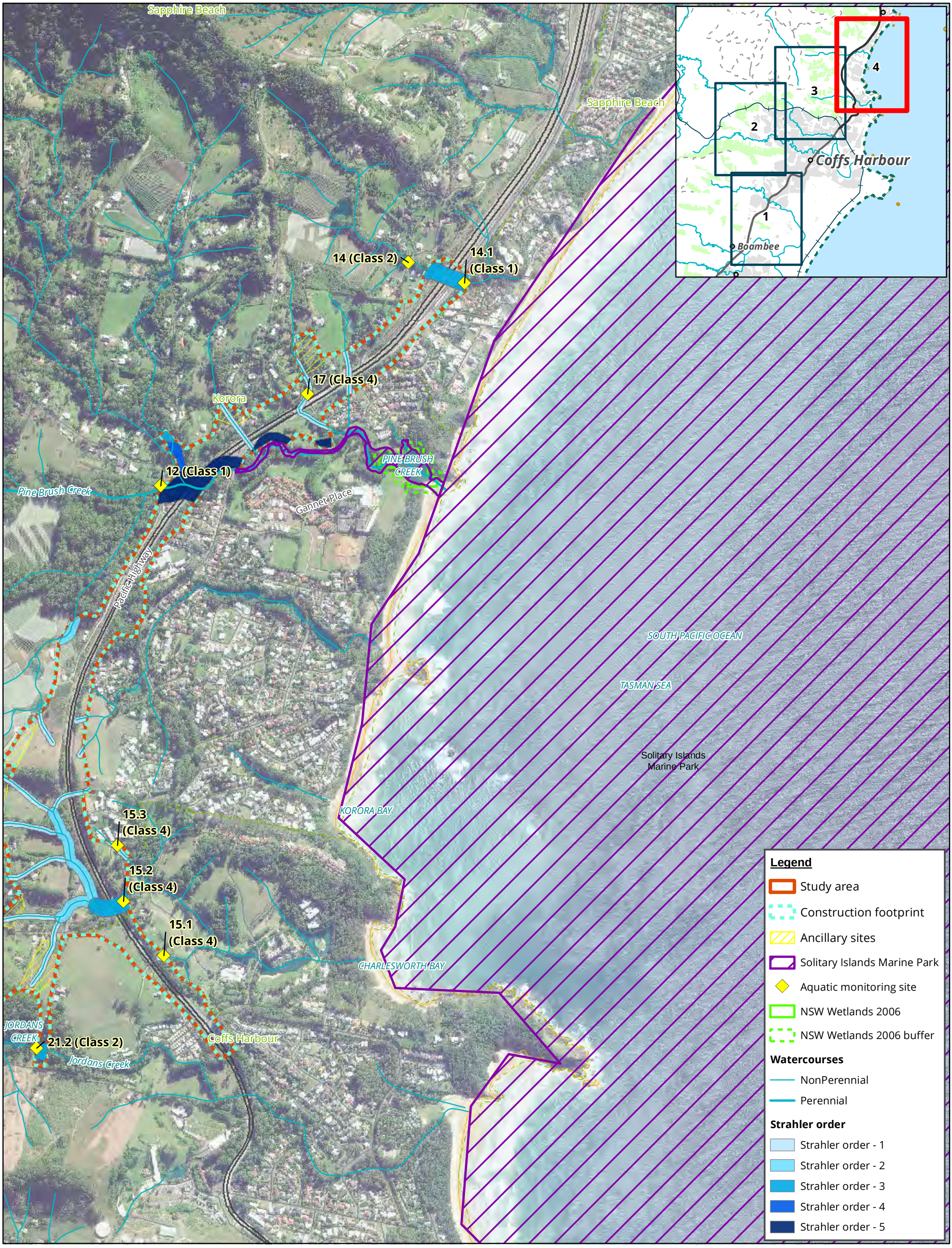


Figure 12.4: Aquatic survey coverage

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Date: 29 May 2019,
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Metres
Scale 1:12,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

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5 Matters of National Environmental Significance

The nine MNES protected under the EPBC Act are:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines)
- A water resource, in relation to coal seam gas development and large coal mining development.

5.1 MNES within the study area

The desktop and field based assessments undertaken for this project (Sections 3 and 4 above) identified the following MNES within the study area:

- Listed threatened flora
- Listed threatened fauna
- Listed migratory species.

The Commonwealth Solitary Islands Marine Park is located more than 50 kilometres offshore and is not expected to be affected by the Project. Other MNES considered to have the potential to occur within the study area include threatened flora and fauna species and one listed threatened community. Table 5.1 provides a list of the MNES recorded, or considered to have the potential (Appendix B) to occur, within the study area. Figure 8 and Figure 9 show the locations of the MNES recorded within the study area. Potential impacts to the MNES identified in the SEARs and Table 8.8 are addressed in Section 8.3.

Table 5.1 MNES recorded or with potential to occur within the study area

MNES	Species	EPBC Act status	Recorded / Potential to occur	Habitat within the study area
Listed threatened flora	Southern Swamp Orchid *Phaius australis*	Endangered	Recorded - One individual was located approximately 700 metres north of North Boambee Road	PCT 695 Blackbutt – Turpentine shrubby open forest. (Recorded habitat) PCT 1064 Paperbark swamp forest (Potential habitat)
Listed threatened fauna	Giant Barred Frog *Mixophyes iteratus*	Endangered	Recorded	PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 1285 Turpentine moist open forest PCT 1244 Sydney Blue Gum open forest PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest Modified riparian vegetation. PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest
Listed threatened fauna	Koala *Phascolarctos cinereus*	Vulnerable	Recorded	PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest PCT 1064 Paperbark swamp forest PCT 1244 Sydney Blue Gum open forest PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest

MNES	Species	EPBC Act status	Recorded / Potential to occur	Habitat within the study area
Listed threatened fauna	Grey-headed Flying-fox *Pteropus poliocephalus*	Vulnerable	Recorded	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 1064 Paperbark swamp forest PCT 1244 Sydney Blue Gum open forest PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest
Listed migratory species	Spectacled Monarch *Symposiachrus trivirgatus*	Migratory	Recorded	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 1302 White Booyong - Fig subtropical rainforest
Listed migratory species	Rufous Fantail *Rhipidura rufifrons*	Migratory	Recorded	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 1064 Paperbark swamp forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest
Listed migratory species	Black-faced Monarch *Monarcha melanopsis*	Migratory	Recorded	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 1064 Paperbark swamp forest PCT 1244 Sydney Blue Gum open forest PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest
Listed migratory species	Wanderer Butterfly *Danaus plexippus*	Migratory	Recorded	Urban and rural areas

MNES	Species	EPBC Act status	Recorded / Potential to occur	Habitat within the study area
Listed threatened fauna	Spotted-tailed Quoll *Dasyurus maculatus maculatus*	Endangered	Potential	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 1064 Paperbark swamp forest PCT 1244 Sydney Blue Gum open forest PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest
Listed threatened fauna	Regent Honeyeater *Anthochaera Phrygia*	Critically endangered	Potential	PCT 1064 Paperbark swamp forest
Listed threatened fauna	Swift Parrot *Lathamus discolor*	Critically endangered	Potential	PCT 1064 Paperbark swamp forest
Listed threatened fauna	Long-nosed Potoroo *Potorous tridactylus tridactylus*	Vulnerable	Potential	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 1064 Paperbark swamp forest PCT 1244 Sydney Blue Gum open forest PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest
Listed threatened flora	Hairy-joint Grass *Arthraxon hispidus*	Vulnerable	Potential	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 1064 Paperbark swamp forest PCT 1244 Sydney Blue Gum open forest PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest

MNES	Species	EPBC Act status	Recorded / Potential to occur	Habitat within the study area
Listed threatened flora	Orara Boronia *Boronia umbellata*	Vulnerable	Potential	PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 1285 Turpentine moist open forest
Listed threatened flora	Clear Milkvine *Marsdenia longiloba*	Vulnerable	Potential	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest PCT 1244 Sydney Blue Gum open forest PCT 1285 Turpentine moist open forest PCT 1302 White Booyong - Fig subtropical rainforest
Listed threatened flora	*Samadera* sp. Moonee Creek (J. King s.n. Nov. 1949)	Endangered	Potential	PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest PCT 1244 Sydney Blue Gum open forest PCT 1285 Turpentine moist open forest
Listed threatened flora	*Tylophora woollsii*	Endangered	Potential	PCT 692 Blackbutt - Tallowwood moist ferny open forest PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest PCT 1244 Sydney Blue Gum open forest PCT 1285 Turpentine moist open forest
Listed ecological community	Lowland Rainforest of Subtropical Australia	Critically endangered	Potential	PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest PCT1302 White Booyong - Fig subtropical rainforest *Note. Vegetation within the study area has been assessed as not meeting the Key Diagnostic Characteristics or Condition Classes for EPBC Act listing.*

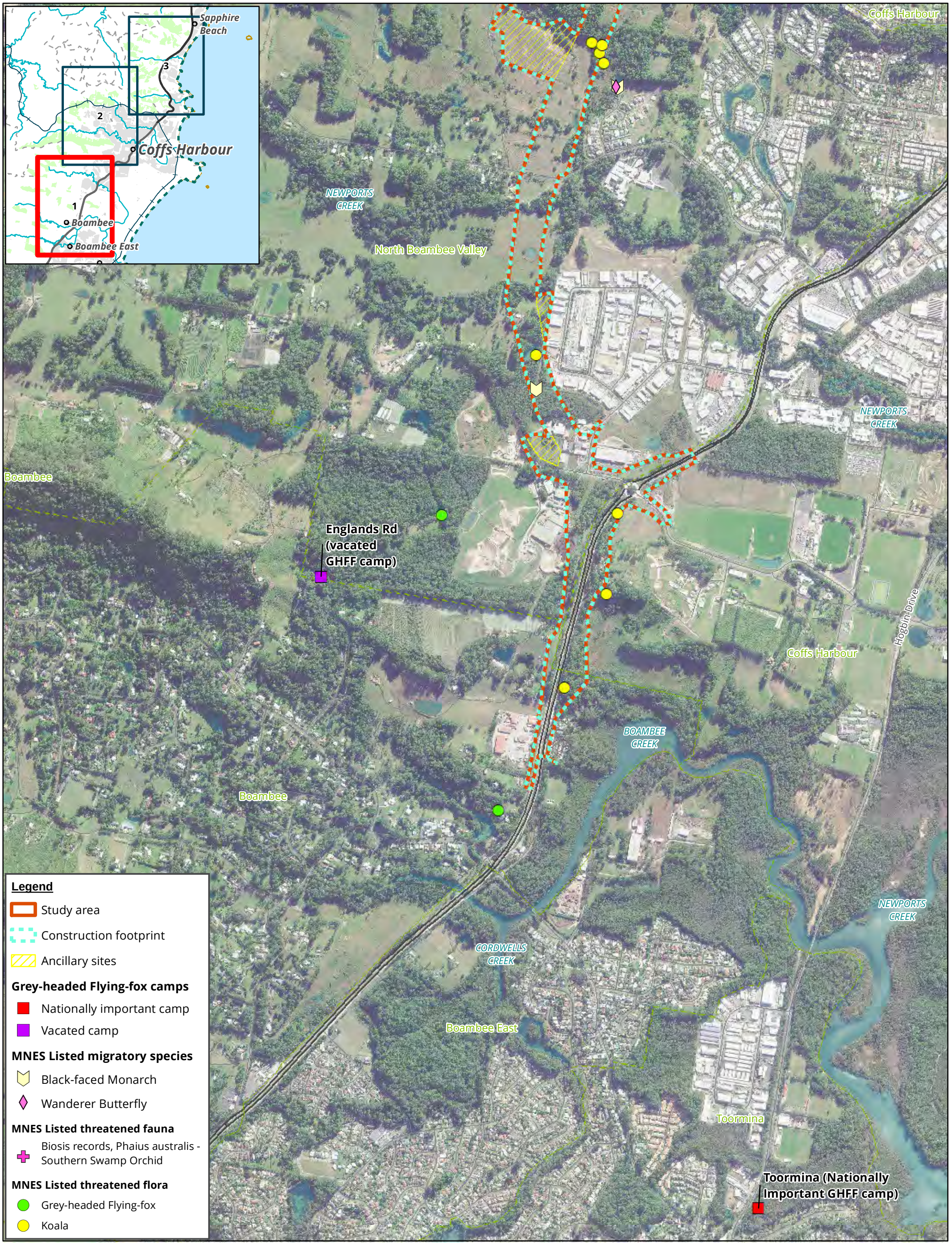


Figure 13.1: MNES recorded within or in the vicinity of the study area

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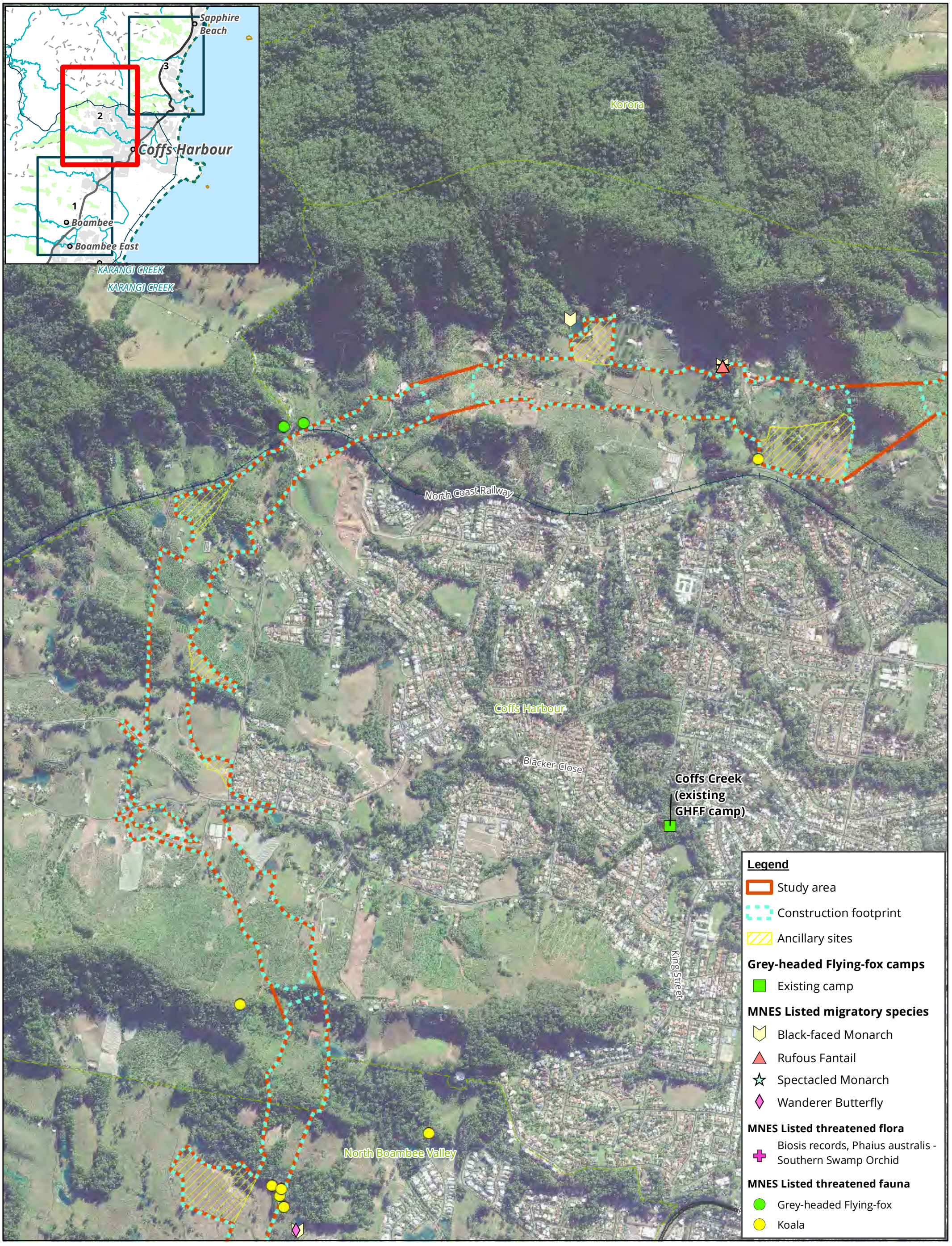


Figure 13.2: MNES recorded within or in the vicinity of the study area

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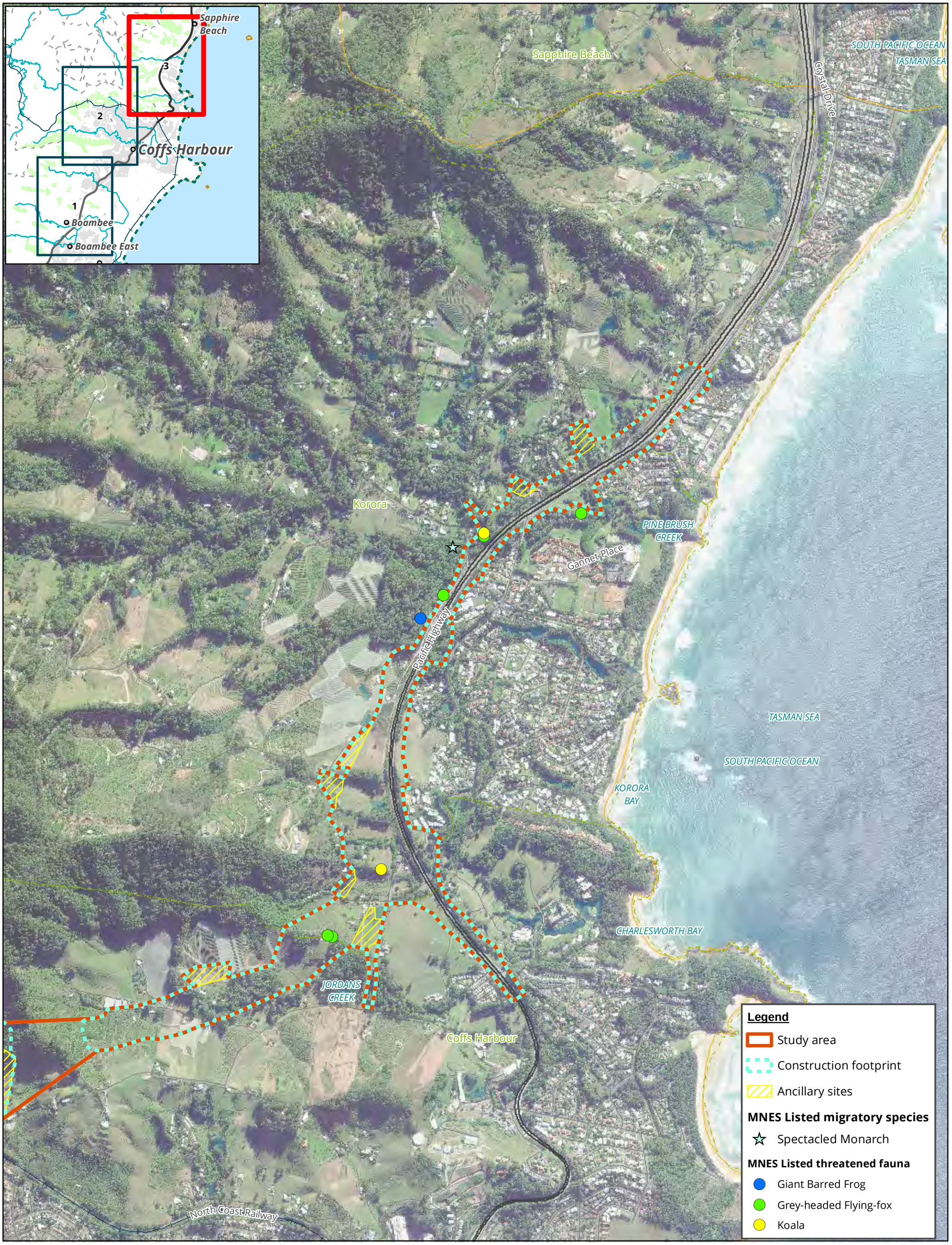


Figure 13.3: MNES recorded within or in the vicinity of the study area

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Metres
Scale 1:15,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56
N

6 Summary of biodiversity values

6.1 Biodiversity values assessed under the FBA

Biodiversity values present within the study area and assessed under the FBA are outlined in Table 6.1. This includes threatened species, populations and communities listed under the TSC Act and EPBC Act.

Table 6.1 Summary of biodiversity values assessed under the FBA

Biodiversity value	Ecosystem or species credit species	Identification method (assumed, recorded, expert report)	Impacted area/individuals within study area
Native vegetation comprising 9 PCTs providing habitat to threatened fauna species.	Ecosystem	Recorded	43.37 hectares
Swamp Sclerophyll Forest EEC	Ecosystem	Recorded	3.65 hectares
Lowland Rainforest EEC	Ecosystem	Recorded	2.42 hectares
Rusty Plum	Species	Recorded	57 individuals
Southern Swamp Orchid	Species	Recorded	1 individual
Coastal Petaltail	Species	Recorded	2.50 hectares
Giant Barred Frog	Species	Recorded	3.28 hectares
Green-thighed Frog	Species	Recorded	1.79 hectares
Koala	Species	Recorded	36.70 hectares
Pale-vented Bush-hen	Species*	Recorded	4.95 hectares
Southern Myotis	Species (Breeding)	Recorded	15.10 hectares
White-bellied Sea-Eagle	Ecosystem	Recorded	43.37 hectares
Square-tailed Kite	Ecosystem	Recorded	43.37 hectares
Olive Whistler	Ecosystem	Recorded	10.48 hectares
Little Bentwing-bat	Ecosystem	Recorded	43.37 hectares
Eastern False Pipistrelle	Ecosystem	Recorded	43.37 hectares
Eastern Freetail-bat	Ecosystem	Recorded	43.37 hectares
Greater Broad-nosed Bat	Ecosystem	Recorded	43.37 hectares
Grey-headed Flying-fox	Ecosystem	Recorded	43.37 hectares

***Note. Species has been updated to an "Ecosystem Credit Species" under the BC Act.**

6.2 Biodiversity values outside the FBA

Biodiversity values present within the study area and not assessed under the FBA are outlined in Table 6.2. This includes migratory species listed under the EPBC Act and groundwater dependent ecosystems.

Table 6.2 Summary of biodiversity values assessed outside the FBA

Biodiversity value	Overview of presence within the study area and identification method (assumed, recorded, expert report)	Area/individuals within study area
Migratory species	Four EPBC Act listed terrestrial migratory species were recorded during fauna surveys.	43.37 ha of native vegetation providing non-limiting forage habitat within species large home ranges.
Groundwater dependent ecosystems	A total of 0.77 ha of high potential GDEs and 45.13 ha of low potential GDEs (BOM 2018) were recorded within the study area.	43.37 ha of potential GDE vegetation within the study area.

7 Avoid and minimise impacts

7.1 Avoidance and minimisation

As outlined in the EIS avoidance and minimisation of impacts to biodiversity values has been achieved by the project as follows.

The construction footprint has been refined and selected based on a staged approach of route selection and alignment revision throughout the Coffs Harbour Highway Planning Strategy (CHHPS) (RTA 2001) through to the refinement of the concept design as part of the current phase of the project.

Chapter 4 of the EIS (Project Development and Alternatives) provides a summary of route option development and identifies alternatives considered during the CHHPS and initial corridor identification. Briefly, two options were considered during the CHHPS including:

- A 'do nothing' alternative originally considered in the Coffs Harbour Highway Planning Strategy – Preferred Option Report (November 2004) and reconsidered more recently during the economic analysis and reviews undertaken in the latest phase of the Project.
- A 'do minimum' alternative that investigated the implementation of clearways on the Pacific Highway through Coffs Harbour for the purpose of improving traffic flow, predominantly during holiday periods. This alternative would retain the 12 sets of traffic lights on the existing highway through Coffs Harbour, but remove parking from the existing highway within the CBD and urban area.

Both of these options were not considered to provide a feasible or realistic alternative.

The initial phase of work for the CHHPS included identification and assessment of corridor options for the future upgrading of the Pacific Highway that were spread across the Coffs Harbour LGA. Four alignment options were considered including:

- Inner Corridor – a bypass about 11 kilometres long skirting the western edge of the existing Coffs Harbour urban area.
- Central Corridor – a longer corridor option of about 25 kilometres passing by the outskirts of Coffs Harbour, and providing a more westerly bypass of the town and surrounding area.
- Outer Corridor – an even wider bypass at its southern section and sharing the same northern section as the Central corridor, about 31 kilometres long.
- Far Western Corridor – a bypass that traverses the Orara Valley and re-joins the existing highway in the north, either at Halfway Creek or to the south of Grafton.

The Far Western, Outer and Central corridors were severely constrained in terms of known and potential habitat for threatened species and severance of numerous wildlife corridors. By contrast, the Inner Corridor had a relatively low impact on biodiversity as it passed through largely cleared lands and any adverse effects on wildlife corridors were anticipated to be mitigated.

An ecological assessment of the preferred Inner Corridor was carried out as part of the CHHPS Strategy Report (RTA 2001). The assessment identified threatened species and communities listed under the TSC Act and the EPBC as having the potential to occur within the study area. Impacts to these State and Commonwealth listed species and ecological communities and potential impacts to fauna habitat connectivity were raised as potential project impacts during these early project phases. Measures to avoid and minimise these impacts have been fully explored throughout the development of the strategic and concept design and will continue to be revisited as project design progresses to detailed design, where reasonable and feasible.

Project design and development of the bypass assessed in the EIS has been iterative. In development of the preliminary concept design, biodiversity constraints were communicated to the design team, which, included identification of high priority areas for avoidance and minimisation of impacts. Impacts to biodiversity were assessed against the preliminary concept design in accordance with the FBA, and further design revisions and refinement has to occurred to reach the current concept design. However, it should be noted that the current assessment is based on a concept design, which still provides for further flexibility and refinement at the final detailed design stage, and allows for avoidance of impacts to biodiversity values during future project stages. Throughout the refinement of the concept design a number of elements have been included to avoid and minimise impacts to biodiversity, including:

- Terrestrial fauna crossings at 16 locations to reduce impacts associated with loss of connectivity for terrestrial fauna.
- Tunnelling at Roberts Hill ridge, Shephards Lane, and Gatelys Road avoiding impacts to Koala connectivity corridors at Roberts Hill and Gatelys Road.
- Bridge structures across both tributaries of Newports Creek to protect Giant Barred Frog habitat and to provide improved terrestrial and aquatic fauna connectivity.
- Bridge crossings, rather than culverts, to minimise impacts on fish passage.
- Bridge design has considered placement of piers and alignment of bridge spans to minimise impacts to existing channel morphology, aquatic habitat and riparian vegetation.
- Reinstatement of minor creeks using natural channel design principles and revegetation to restore aquatic and riparian habitats.
- Earthworks strategy and design that includes batters with low, shallower slopes to allow for revegetation with native species, connecting patches of native vegetation along the wider road corridor.
- Review of flood modelling in the North Boambee Valley, and the corresponding drainage design, to maintain the existing hydrological regime in the area of retained Coastal Petaltail habitat.
- Design options for improvements to the school drop off zone and pedestrian bridge at Kororo Public School to avoid direct impacts to Kororo Nature Reserve.
- Identification of locations for temporary ancillary sites located outside areas of threatened flora and fauna habitat.

Further, review and implementation of the Project's Threatened Species Management Plan (TSMP) (Arup 2019c) will be undertaken during detailed design. The TSMP identifies site-specific mitigation measures and management procedures to be implemented during future design, construction and operation phases to further avoid and/or reduce project impacts on threatened flora and fauna. Further details are provided in EIS Appendix I - Threatened Species Management Plan (Arup 2019c).

8 Impact assessment

8.1 Areas requiring assessment

All areas of native vegetation and threatened species habitat require assessment under the FBA. Thresholds exist as to the level of assessment required, based on whether the impacts fall under one of the following categories:

- Impacts that require further consideration in accordance with Section 9.2 of the FBA.
- Impacts for which offsets are required.
- Impacts for which offsets are not required.

Impacts that require further consideration can include:

- Landscape features, including higher order waterways and their riparian zones, important wetlands and movement corridors.
- Native vegetation, including CEECs, and/or TECs nominated by the SEARs.
- Species and populations, including Critically Endangered species, species not previously recorded within the IBRA subregion, and/or species nominated by the SEARs.

The project will impact upon Pale-vented Bush Hen habitat, which has not previously been recorded within the Coffs Coast and Escarpment subregion and as such requires further consideration in accordance with Section 9.2 of the FBA (refer Section 8.2).

Impacts for which offsets are required include:

- Impacts to native vegetation. PCTs identified as CEEC/EEC for which impacts do not require further consideration under Section 9.2 of the FBA, and PCTs which are associated with threatened species habitat and have a site value score of ≥17.
- Species and populations. Threatened species for which impacts do not require further consideration under Section 9.2 of the FBA, threatened species habitat associated with a PCT in a vegetation zone with a site value score of ≥17.

Sections 8.1.1, 8.1.2 and 8.1.3 address Project impacts which require offsets in accordance with the FBA.

Impacts for which offsets are not required include:

- Impacts to native vegetation. PCTs in a vegetation zone with a site value score of <17, and not identified as a CEEC/EEC, and not associated with threatened species habitats and not identified as a CEEC/EEC.
- Species and populations. Threatened species habitat associated with a PCT in a vegetation zone with a site score of <17, and is not association with a CEEC/EEC, and non-threatened species or populations that do not form part of a CEEC/EEC.

There are no vegetation zones with site values cores of <17 (Table 3.2) and as such all impacts to native vegetation and threatened species habitat associated with the Project require offsets.

8.1.1 Removal of native vegetation

The Project will impact upon a total of 43.37 hectares of native vegetation comprising nine PCTs. Table 8.1 provide details of PCTs impacted including general condition, conservation status and regional extent information. Further detailed information is included in Section 3 above.

Table 8.1 Impacts to native vegetation

PCT	Condition	Status		Percent cleared in CMA	Area to be impacted (ha)
		TSC Act	EPBC Act		
PCT670 - Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion	Moderate/Good Site value scores: 82.67	Lowland Rainforest	n/a	75%	0.51
PCT692 - Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	Moderate/Good Site value scores: 57.33 – 82.00	n/a	n/a	15%	15.40
PCT695 - Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	Moderate/Good Site value scores: 46.67 – 89.33	n/a	n/a	5%	10.47
PCT747 - Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	Moderate/Good Site value scores: 79.33 – 82.00	n/a	n/a	30%	5.82
PCT1064 - Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	Moderate/Good Site value scores: 72.67 – 87.33	Swamp Sclerophyll Forest	n/a	75%	3.65
PCT1244 - Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast	Moderate/Good Site value scores: 82.67	n/a	n/a	60%	0.94
PCT1262 - Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	Moderate/Good Site value scores: 71.33 – 88.00	n/a	n/a	30%	1.62
PCT1285 - Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	Moderate/Good Site value scores: TBC – 76.00	n/a	n/a	55%	3.04
PCT1302 - White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion	Moderate/Good Site value scores: 72.67	Lowland Rainforest	n/a	75%	1.91

8.1.2 Removal of threatened fauna habitat

The removal of 43.37 hectares of native vegetation will result in the loss of fauna habitat features known to support locally occurring threatened fauna species. This includes the loss of potential breeding habitat in the form of hollow-bearing trees, riparian vegetation, dense forest vegetation and swamps, as well as forage habitat in the form of nectar, blossom and fruit producing trees, accumulated leaf litter and large woody debris and open areas of grasslands not supporting native vegetation.

Table 8.2 outlines habitat types and key habitat features to be removed as a result of the project. An assessment is provided as to the proportional impact to each habitat type within the broader locality (10 kilometre radius of the study area) and the associated threatened fauna considered to have a medium or higher likelihood of occurrence within the study area.

Table 8.2 Threatened fauna habitats impacted by the Project

Key habitat features	Area to be impacted	Estimate remaining within 10kms of the study area*[1]	Percentage removed	Threatened fauna associated with habitat type*[2] impacted - Breeding	Threatened fauna associated with habitat type impacted - Foraging
Wet sclerophyll forest vegetation	37.30 ha	10,180 ha	0.4%	Koala *Phascolarctos cinereus*, Common Blossom-bat *Syconycteris australis,* Green-thighed Frog *Litoria brevipalmata*	Spotted-tailed Quoll *Dasyurus maculatus*, Golden-tipped Bat *Kervoula papuensis*, Little Bentwing-bat *Miniopterus australis*, Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*, Yellow-bellied Glider *Petaurus australis*, Koala *Phascolarctos cinereus*, Grey-headed Flying-fox *Pteropus poliocephalus*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Common Blossom-bat *Syconycteris australis*, Regent Honeyeater *Anthochaera phrygia*, Barred Cuckoo-shrike *Coracina lineata*, Square-tailed Kite *Lophoicitinia isura*, Masked Owl *Tyto novaehollandiae*, Stephen's Banded Snake *Hoplogchephalus stephensii*, Green-thighed Frog *Litoria brevipalmata*, Giant Barred Frog *Mixophyes iteratus*
Rainforest vegetation	2.43 ha	1,190 ha	0.2%	Common Blossom-bat *Syconycteris australis*, Green-thighed Frog *Litoria brevipalmata*	Spotted-tailed Quoll *Dasyurus maculatus*, Golden-tipped Bat *Kervoula papuensis*, Little Bentwing-bat *Miniopterus australis*, Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*, Southern Myotis *Myotis macropus*, Yellow-bellied Glider *Petaurus australis*, Grey-headed Flying-fox *Pteropus poliocephalus*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Common Blossom-bat *Syconycteris australis*, Barred Cuckoo-shrike *Coracina lineata*, Wompoo Fruit-dove *Ptilinopus magnificus*, Stephen's Banded Snake *Hoplogchephalus stephensii*, Green-thighed Frog *Litoria brevipalmata*, Giant Barred Frog *Mixophyes iteratus*
Riparian vegetation*[3]	9.73 ha	2,200 ha	0.4%	Koala *Phascolarctos cinereus*, Grey-headed Flying-fox *Pteropus poliocephalus*, Square-tailed Kite *Lophoicitinia isura*, Giant Barred Frog *Mixophyes iteratus*	Golden-tipped Bat *Kervoula papuensis*, Little Bentwing-bat *Miniopterus australis*, Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*, Southern Myotis *Myotis macropus*, Koala *Phascolarctos cinereus*, Grey-headed Flying-fox *Pteropus poliocephalus*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Regent Honeyeater *Anthochaera phrygia*, Giant Barred Frog *Mixophyes iteratus*
Swamp vegetation	3.65 ha	1,018 ha	0.4%	Wallum Froglet *Crinia tinnula*	Coastal Petaltail *Petalura litorea*, Little Bentwing-bat *Miniopterus australis*, Grey-headed Flying-fox *Pteropus poliocephalus*, Common Blossom-bat *Syconycteris*

Key habitat features	Area to be impacted	Estimate remaining within 10kms of the study area*[1]	Percentage removed	Threatened fauna associated with habitat type*[2] impacted - Breeding	Threatened fauna associated with habitat type impacted - Foraging
					australis, Regent Honeyeater *Anthochaera phrygia*, Black-necked Stork *Ephippiorhynchus asiaticus*, Wallum Froglet *Crinia tinnula*
Hollow-bearing trees	87 trees	Up to 64,000 trees	0.2%	Golden-tipped Bat *Kervoula papuensis*, Southern Myotis *Myotis macropus*, Yellow-bellied Glider *Petaurus australis*, Squirrel Glider *Petaurus norfolcensis*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Masked Owl *Tyto novaehollandiae*	n/a
Leaf litter and large woody debris	Up to 43.37 ha	Up to 15,500 ha	0.3%	Spotted-tailed Quoll *Dasyurus maculatus*	Giant Barred Frog *Mixophyes iteratus*
Paddocks / non-vegetated areas	Up to 330 ha	Up to 14,000 ha	2.0%		Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*, Square-tailed Kite *Lophoicitinia isura*, Eastern Grass Owl *Tyto longimembris*

*[1] Estimates remaining are based on equivalent vegetated areas mapped by the Coffs Harbour LGA mapping (OEH 2012) with non-equivalent vegetation types excluded where appropriate. Hollow-bearing tree estimates are based on an equivalent ratio of hollow trees per hectare present within the study area and within the 18,800 ha of native vegetation mapped within 10km of the study area.
*[2] Threatened fauna listed include those species with a moderate or higher likelihood of occurrence within the study area (Appendix B).
*[3] Riparian areas are based on mapped vegetation (Biosis 2018, OEH 2012) either side of watercourses mapped on the 1:25,000 hydro line dataset from the LPI Digital Topographic Database (DTDB).

8.1.3 Removal of threatened flora

Two threatened flora species were recorded as present within the study area during targeted surveyed undertaken in spring 2016 and summer 2017. The details of species recorded are included in Table 8.3 below.

Table 8.3 Threatened flora impacted by the project

Threatened species	Status		Habitat or individuals to be impacted	Habitat or individuals in the study area
	BC Act	EPBC Act		
Rusty Plum *Niemeyera whitei*	V	-	57 individuals	79 individuals recorded within and immediately adjacent to the study area
Southern Swamp Orchid *Phaius australis*	E1	E	1 individual	1 individual

All areas of native vegetation within the study area were considered to support potential habitat for one or more candidate flora species determined in accordance with Section 5 of the FBA. All areas of potential habitat were surveyed during the candidate species' optimal survey periods as provided in the Threatened Species Profile Database, the spring 2016 and summer 2017 field campaign. All surveys were undertaken in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016) and included parallel transect surveys separated by 5 to 10 metres based on vegetation density. No further threatened species were detected within potential habitats present throughout the study area. As such, the Project is considered likely to result in direct impacts to the above two species only.

Indirect impacts to threatened flora habitats will occur as a result of the removal of 45.91 hectares of native vegetation which holds the potential to support threatened species in the future. However, when assessed at a locality scale, impacts to habitat availability for local populations are not considered significant. Table 8.4 provides a comparison of the broad threatened flora habitat types impacted by the Project and those remaining within 10 kilometres of the study area.

Table 8.4 Threatened flora habitats impacted by the Project

Key habitat features	Area to be impacted	Estimate remaining within 10kms of the study area*[1]	Percentage removed	Threatened flora habitat impacted
Wet sclerophyll forest vegetation	37.30 ha	10,180 ha	0.4%	Hairy Jointgrass *Arthraxon hispidus*, Rusty Plum *Niemeyera whitei*, , Orara Boronia *Boronia umbellata*, Big Nellie Hakea *Hakea archaeoides*, Rusty Rose Walnut *Endiandra hayesii*, Slender Marsdenia *Marsdenia longiloba*, Milky Silkpod *Parsonsia dorrigoensis*, Moonee Quassia *Quassia* sp. *Moonee Creek*, Scant Pomaderris *Pomaderris queenslandica*, Rainforest Cassia *Senna acclinis*, Stinky Lily *Typhonium* sp. aff. *Brownie*, Cryptic Forest Twiner *Tylophora woollsii*.

Key habitat features	Area to be impacted	Estimate remaining within 10kms of the study area*[1]	Percentage removed	Threatened flora habitat impacted
Rainforest vegetation	2.43 ha	1,190 ha	0.2%	Hairy Jointgrass *Arthraxon hispidus*, Rusty Plum *Niemeyera whitei*, Red-fruited Ebony *Diospyros mabacea*, Small-leaved Tamarind *Diploglottis campbellii*, Nightcap Oak *Eidothea hardeniana*, Crystal Creek Walnut *Endiandra floydii*, Rusty Rose *Walnut Endiandra hayesii*, Slender Marsdenia *Marsdenia longiloba*, Milky Silkpod *Parsonsia dorrigoensis*, Rainforest Cassia *Senna acclinis*, Stinky Lily *Typhonium* sp. aff. *Brownie*
Riparian areas*[2]	9.73 ha	2,200 ha	0.4%	Red-fruited Ebony *Diospyros mabacea*, Floyd's Grass *Alexfloydia repens*, Hairy Jointgrass *Arthraxon hispidus*, Rusty Plum *Niemeyera whitei*, Orara Boronia *Boronia umbellata*, Big Nellie Hakea *Hakea archaeoides*, Rusty Rose Walnut *Endiandra hayesii*, Slender Marsdenia *Marsdenia longiloba*, Milky Silkpod *Parsonsia dorrigoensis*, Moonee Quassia *Quassia* sp. *Moonee Creek*, Scant Pomaderris *Pomaderris queenslandica*, Rainforest Cassia *Senna acclinis*, Stinky Lily *Typhonium* sp. aff. *Brownie*, Cryptic Forest Twiner *Tylophora woollsii*. Small-leaved Tamarind *Diploglottis campbellii*, Nightcap Oak *Eidothea hardeniana*, Crystal Creek Walnut *Endiandra floydii*, Rusty Rose Walnut *Endiandra hayesii*, Slender Screw Fern *Lindsaea incisa*, Brown Fairy-chain Orchid *Peristeranthus hillii*,
Swamp vegetation	3.65 ha	1,018 ha	0.4%	Floyd's Grass *Alexfloydia repens*, Hairy Jointgrass *Arthraxon hispidus*, Southern Swamp Orchid *Phaius australis*

***[1]** Estimates remaining are based on equivalent vegetated areas mapped by the Coffs Harbour LGA mapping (OEH 2012) with non-equivalent vegetation types excluded where appropriate.
*[2] Riparian areas are based on mapped vegetation (Biosis 2018, OEH 2012) within 20 metres of either side of watercourses mapped on the 1:25,000 hydro line dataset from the LPI Digital Topographic Database (DTDB).

8.1.4 Key threatening processes

A key threatening process (KTP) is defined under the TSC Act (DEC 2005) as an action, activity or proposal that:

- Adversely affects two or more threatened species, populations or ecological communities.
- Could cause species, populations or ecological communities that are not currently threatened to become threatened

There are currently 38 KTPs listed under the TSC Act, 21 KTPs listed under the EPBC Act and eight listed under the FM Act. A number of KTPs are listed under more than one Act. Those relevant to this project are listed in Table 8.5. Mitigation measures to limit the impacts of these KTPs are discussed in Chapter 9.

Table 8.5 Key threatening processes of relevance to the project

Key Threatening Process	Status	Comment
Clearing of native vegetation	TSC Act EPBC Act	A total of 43.37 ha of native vegetation is proposed to be cleared for the Project across 9 PCTs. This total includes 5.09 ha of Swamp Sclerophyll Forest (Endangered BC Act) and 2.43 ha of Lowland Rainforest (Endangered BC Act).
Clearing of hollow-bearing trees	TSC Act	A total of 87 hollow-bearing trees are proposed to be removed for the Project.
Removal of dead wood and dead trees	TSC Act	The vegetation to be removed contains a low-moderate density of dead wood and dead trees similar to that in surrounding habitat to be retained, which would be retained within the study area. Mitigation measures are provided in Section 9 to limit the potential for impacts to native biota as a result of removal of dead wood and dead trees.
Infection of native plants by *Phytophthora cinnamomi*	TSC Act; EPBC Act	Increased visitation and movement of people and vehicles around the study area has the potential to introduce or spread the pathogen *Phytophthora cinnamomi.* Mitigation measures, including the development of a pathogen management plan, are provided in Section 9.
Invasion and establishment of exotic vines and scramblers	TSC Act	Vegetation within the study area has the potential to be invaded by exotic vines and scramblers. Vehicles and plant have the potential to introduce propagules of exotic vines and scramblers, as could soil disturbance during construction activities. The implementation of a weed management plan is recommended in Section 9 to limit the spread of weeds.
Invasion establishment and spread of *Lantana camara*	TSC Act	*Lantana camara* is already present within some sections of the study area. This KTP is likely to be exacerbated on-site without the implementation of weed management. Recommendations to mitigate the establishment and spread of weed species are made in Section 9.
Invasion of plant communities by perennial exotic grasses	TSC Act	Parts of the study area have been subject to previous disturbances (including existing road and rail corridors, agriculture, residential housing and forestry), as a result there are exotic weed species already present in the study area. Weeds may also be introduced due to an increase in edge areas as part of the construction of the road alignment. Vehicles and plant could further spread exotic grass species, as could soil disturbance during vegetation clearing and road construction. There is the potential for perennial exotic grasses to invade retained and nearby native vegetation through project activities. The implementation of a weed management plan as recommended in Section 9 would limit the spread of weeds.

Key Threatening Process	Status	Comment
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Road construction activities have the potential to introduce or spread Myrtle Rust within the study area. Mitigation measures to reduce the potential for the introduction or spread of Myrtle Rust are recommended in Section 9.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	TSC Act; EPBC Act	Road construction activities have the potential to introduce amphibian chytrid to the study area, which could lead to death of frogs and tadpoles. A flora and fauna management plan with specific measures to reduce the potential for the introduction chytrid fungus is recommended in Section 9.
Predation by the European Red Fox	TSC Act; EPBC Act	Evidence of foxes were observed in the study area. The project may lead to an increase in the incidence of this species by providing an increase in access routes through the study area.
Bushrock Removal	TSC Act	Construction activities would remove bushrock identified within the construction footprint. Habitat salvage is recommended in Section 9 to be carried out wherever possible to reduce impacts on bushrock inhabiting biota.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act	The road construction is expected to impact fourteen waterways and a number of their associated tributaries within the study area, which vary from Class 1 to Class 2 waterways (Strahler method). These waterways feed into downstream estuarine waterways to the east of the study area.
Anthropogenic Climate Change	TSC Act EPBC Act FM Act	The project would be constructed utilising primarily diesel powered machinery and plant. While all machinery would be operated and maintained in good operational working order to reduce emissions, the construction of the project would result in the emission of greenhouse gases and would therefore contribute to climate change.
Removal of large woody debris from New South Wales rivers and streams	FM Act	Road construction across waterways may result in the removal of woody debris from waterways within the study area. Mitigation measures to minimise the removal large woody debris and relocate large woody debris during construction are provided in Section 9.
Degradation of native riparian vegetation along New South Wales water courses	FM Act	Road construction and access for project vehicles and plant may require clearing of native riparian vegetation along some sections of waterways within the study area. Recommendations to minimise the clearing of native riparian vegetation have been made in Section 9.
Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams	FM Act	Waterway crossings as part of the road construction may require the placement of temporary or permanent instream structures. Recommendations to mitigate the impacts of such structures have been made in Section 9.

8.2 Matters for further consideration

Section 9.2 of the FBA outlines thresholds for the assessment and offsetting of unavoidable impacts of development and details impacts that must be identified for further consideration by the consent authority. These are impacts that are considered potentially complicated or severe, where a decision will be made by the consent authority on whether it is appropriate for these impacts to occur. The consent authority may determine:

- The Major Project cannot be approved with that particular impact.
- Modifications are required to the Major Project to reduce the severity of the impact.
- The Major Project can be approved but it will require additional offsets, supplementary measures or other actions to be undertaken with respect to that impact (OEH 2014a).

Items to which impacts may require further consideration can include:

- Landscape features. Higher order waterways and their riparian zones, important wetlands and movement corridors.
- Native vegetation. CEECs, and/or TECs nominated by the SEARs.
- Species and populations. Critically Endangered species, species not previously recorded in the IBRA subregion, and/or species nominated by the SEARs.

8.2.1 Landscape features

The project will not substantially reduce the width of vegetation in the riparian buffer zone bordering rivers of streams 4th order or higher, impact state biodiversity links, or impact buffer zones along estuaries.

Two higher order streams occur within the study area, Pine Brush Creek (fifth order) and an unnamed tributary of Newports Creek (fourth order). However, both will be crossed by bridge and impacts will be limited to a narrow section of the riparian corridor, and as such in accoprdance with Section 9.2 of the FBA further consideration is not required. Additional detail on retaining connectivity across the landscape is provided in Sections 8.3and 8.4.3.

The FBA defines an important wetland as a wetland that is listed in the Directory of Important Wetlands of Australia (DIWA, Environment Australia 2001) or a wetland mapped under *State Environmental Planning Policy 14 (Coastal Wetlands)* (SEPP14).

A wetland previous mapped as a SEPP14 wetland (now Coastal Management SEPP) occurs adjacent to the southern extent of the study area surrounding Boambee Creek, however no project works will occur within the wetland, or within the 50 metre wetland buffer, and no impacts are considered likely.

8.2.2 Native vegetation

No CEECs have been recorded within the study area. No other CEECs or EECs were nominated in the SEARs as requiring further assessment in accordance with Section 9.2 of the FBA.

8.2.3 Species and populations

No areas of critical habitat nominated under the TSC Act or critically endangered species will be impacted by the project. No other threatened species or population that is specifically nominated in the SEARS as requiring further assessment in accordance with Section 9.2 of the FBA will be impacted by the Project.

However, Pale-vented Bush Hen has not previously been recorded in the IBRA subregion according to records in the NSW Wildlife Atlas (Bionet) and as such further assessment is required. Table 8.6 outlines the further assessment undertaken.

Table 8.6 Additional information required for impacts to Pale-vented Bush Hen

Key Threatening Process	Comment
(a) the size of the local population directly and indirectly impacted by the development	The size of the local population of Pale-vented Bush-hen is not known. OEH outlines that in NSW, Pale-vented Bush Hens are an apparently uncommon resident from the Queensland border south to the Clarence River, though the species appears to be expanding its range southwards with recent records (2002) as far south as the Nambucca River (OEH 2018c, NSW Scientific Committee 2008). OEH predicts the species occurrence within the Coffs Coast and Escarpments and Macleay Hastings (north of South West Rocks) IBRA subregions (OEH 2018c). The NSW Scientific Committee states that there are no measures of abundance for this species (Marchant & Higgins 1993). The species has been found to be more common and widespread in the Richmond and Tweed Valleys than formerly believed (Stewart & Stewart 1994; Muranyi & Baverstock 1996). In the Tweed Valley there were three pairs in 1 kilometre of creek habitat (Stewart & Stewart 1994), which suggests that the species can reach a high density in suitable habitat. The species is data deficient on number of mature individuals (NSW Scientific Committee 2008). It is considered likely that the species occurs more commonly in the broader locality of the project than would be predicted from records on OEH Bionet. This is based on the cryptic nature of the species and the probable lack of public records captured outside more targeted surveys, such as those undertaken for the current assessment.
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	Given the absence of records for this species in the locality, the narrow linear footprint for the project and the relatively low level of impacts to native vegetation, it is considered unlikely that the project will result in significant direct or indirect impacts to the local population. The species is known to inhabit dense vegetation on the margins of freshwater creeks, rivers and natural or artificial wetlands (including farm dams), from the margins of rainforest to forest regrowth, rank grass or reeds, thickets of weeds, and farmland, and occasionally dense gardens around human habitation. Key elements are dense undergrowth 2-4 metres tall, within 300 metres of water. Habitat tolerance is much broader than that of specialised birds of natural wetlands (e.g. bitterns), and the species is partly terrestrial (NSW Scientific Committee 2008). Based on the information contained in the Threatened Species Profile Database the species has the potential to occur in eight of the nine PCTs (with the exception of PCT 670) recorded within the study area, and as such potential habitat for the species impacted by the Project equates to 45.39 hectares of native vegetation, not considering weed thickets, and farmland. Vegetation comprising these eight PCTs, as mapped by OEH (2012), within a 10 kilometres radius of the study area equates to 7597 hectares. Therefore, impacts to potential habitat are considered only a small portion of potential commensurate specific habitat/vegetation types in the locality, Mitigation measures associated with the project maintaining connectivity to the east and west of the study area are considered to be likely to prevent significant isolation of habitats and large areas of potential breeding habitat will not be impacted in the locality.
(c) the likely impact on the ecology of the local population. At a minimum, address the following: (i) for fauna: – breeding – foraging – roosting, and – dispersal or movement pathways	As outlined above, the project is expected to impact upon a small fraction of potential habitat available for the species in the locality. The species nest is built in thick ground cover near water, sometimes under or near overhanging cover such as a shrub, vine or tree (NSW Scientific Committee 2008). Whilst impacts to potential breeding habitat will occur as a result of the project, large areas of potential breeding habitat will remain within the locality such as in the Ulidarra National Park and large expanses of remnant vegetation within the reserve system as well as low-lying wetlands inclusive of riparian corridors, and mixed forested slopes/hills. Dispersal and movement pathways are generally associated with riparian corridors which will largely be maintained through the connectivity mitigation measures to be implemented by the project including dedicated and combined fauna underpasses, culverts and land bridges. Proposed fauna connectivity structures are further detailed in Section 9.2.

Key Threatening Process	Comment
(d) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development	The species is known to be mobile and partly nomadic or dispersive, as its presence at ephemeral wetlands varies according to water levels. The species' habitat is inferred to have been fragmented by agricultural clearing. The species can live in rank undergrowth up to 300 metres from water, including weedy farmland, and are therefore inferred to be able to move through the agricultural matrix in high-rainfall regions such as the NSW North Coast. (NSW Scientific Committee 2008). As such, movement of birds is not considered likely to be substantially affected by the project, with fragmentation and isolation of the local population minimised through connectivity mitigation measures to be implemented. Proposed fauna connectivity structures are further detailed in Section 9.2.
(e) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range	The relationship of the local population of the species to other populations is difficult to determine due to the lack of records in the local area. However, the NSW Scientific Committee states that the species occurs solitarily, in pairs, or family groups of parents and young, and that the home range extends up to 500 m from a nest (i.e. a home range of less than 80 ha) (NSW Scientific Committee). As such, inter-population dispersal over a wide area is unlikely. The project is not considered likely to impact upon the movement patterns of the local population such that local interactions will be significantly altered leading to a decline in the viability of the population, or significantly interfere with the genetic diversity of the population. The species appears to be near the limit of its range, with the species most common in northern coastal Australia with few unconfirmed records (ie. not listed on the Bionet Atlas) known as far south as the Nambucca Valley (NSW Scientific Committee, NPWS 2002). The NSW Scientific Committee also states that the lack of historical southerly records have been interpreted as absences of the species and therefore possible declines (e.g. early records near Grafton, but none recently). However, the species is cryptic and has recently been found south of Grafton. The scarcity and patchiness (both temporal and geographic) of historical records, and the prevalence of recent records, probably reflect greater observer familiarity with the species and its calls in recent times, and greater targeted survey, and the recent southerly range extension to the Nambucca Valley, may represent an increase in abundance and range, or improving detection rates (NSW Scientific Committee (2008). This supports the conclusion that the lack of previous records within the Coffs Coast and Escarpment IBRA subregion is more likely a lack of targeted survey effort than a range extension of the species or significant outlier population.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The NSW Scientific Committee states threats to the species as: clearing, filling and draining of wetlands; pollution of wetlands from agricultural, urban and industrial run-off (e.g. herbicides and pesticides); weed invasion; loss of the shrub layer in areas developed for human settlements, and predation by foxes and feral cats (NSW Scientific Committee 2008). OEH lists further threats to the species as: alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands; loss of dense and rank understorey vegetation near streams and wetlands with clearing associated with urban and semi-rural developments (OEH 2018c). Mitigation measures to be implemented by the Project and are considered sufficient to prevent substantial activation of potential threats to the species resulting in a decrease of viability of the local population.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.	Given the low level of impacts expected to occur on the local population of Pale-vented Bush Hen no measures to aid in the recovery of the species are proposed.

8.3 Matters of National Environmental Significance

On 22 September 2017 it was determined that the Pacific Highway Upgrade Coffs Harbour Bypass will impact upon the following MNES protected under the EPBC Act:

- Threatened species and communities (section 18 and section 18A).

The project will be assessed in accordance with the NSW Assessment Bilateral Agreement 2015 (the Agreement) and as such is required to be assessed in the manner specified in Schedule 1 to that Agreement. These requirements are a supplement to the updated SEARs issued 30 October 2017 and have been addressed in conjunction with those requirements.

Assessment documentation prepared for the purposes of approval under the EPBC Act must, in addition to providing sufficient information for a decision in accordance with the Agreement, address the matters outlined in Schedule 4 of the *Environment Protection and Biodiversity Conservation Regulations 2000.*

A list of MNES considered likely, or to be at some risk of being significantly impacted by the Project was provided in the SEARs (DPE 2017), based on the Project Referral (Arup 2017) and the DoEE Reporting Tool and is provided below:

MNES considered by DoEE as likely to be significantly impacted by the Project include:

- Koala (Vulnerable – EPBC Act)
- Giant Barred Frog (Endangered – EPBC Act)
- Spotted-tail Quoll (Endangered – EPBC Act)

In addition, MNES considered by DoEE to be at some risk of being significantly impacted by the Project include:

- Lowland Rainforest of Subtropical Australia (Critically Endangered – EPBC Act)
- Clear Milkvine (Vulnerable – EPBC Act)
- Hairy-joint Grass (Vulnerable – EPBC Act)
- Orara Boronia (Vulnerable – EPBC Act)
- Samadera sp. Moonee Creek (J. King s.n. Nov. 1949) (Endangered – EPBC Act)
- Southern Swamp-orchid (Endangered – EPBC Act)
- *Tylophora woollsii* (Endangered – EPBC Act)
- Grey-headed Flying-fox (Vulnerable – EPBC Act)
- Long-nosed Potoroo (Vulnerable – EPBC Act)
- Regent Honeyeater (Critically Endangered – EPBC Act)
- Swift Parrot (Critically Endangered – EPBC Act).

Assessments have been undertaken in accordance with the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (Commonwealth of Australia 2013), for each MNES considered to be potentially impacted by the project. Significant impacts have been assessed as likely to occur to Koala and Giant Barred Frog as a result of the project. These assessments are summarised in Table 8.11 and provided in full in Appendix F.

A total of four migratory species listed under the EPBC Act were recorded during field survey and include:

- Black-faced Monarch (Migratory – EPBC Act)
- Rufous Fantail (Migratory – EPBC Act)
- Spectacled Monarch (Migratory – EPBC Act)
- Wanderer Butterfly (Migratory – EPBC Act)

These species may occur within the study area on occasion, whilst moving through their large home ranges, but are not expected to rely on the study area for important life cycle stages, and as such the potential for impacts to these species as a result of the project is considered low.

8.3.1 MNES potentially impacted by the Project

The MNES were assessed through desktop and field based assessments. The details of the survey methodology and assessment outcomes are outlined in Sections 3 and 4 and Appendix B of this report, with impacts assessed in Appendix F. Following these assessments, those MNES determined as having potential to be impacted by the project include:

- Southern Swamp Orchid (Endangered – EPBC Act)
- Giant Barred Frog (Endangered – EPBC Act)
- Koala (Vulnerable – EPBC Act)
- Grey-headed Flying-fox (Vulnerable – EPBC Act)
- Regent Honeyeater (Critically Endangered – EPBC Act)
- Spotted-tail Quoll (Endangered – EPBC Act)

Details of habitats within the study area known or considered likely to support the above MNES are provided in Table 8.7 below.

Table 8.7 MNES habitats within the study area

MNES	Breeding habitats	Forage habitats	Important populations	Habitat critical for survival
Southern Swamp Orchid	PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest, PCT 1064 Paperbark swamp forest.	N/A	Local population within Coffs Harbour LGA.	Habitat recorded within the study area is not considered to be important to the species (according to critical habitat definition in Commonwealth of Australia (2013)).
Giant Barred Frog	Riparian areas within the study area (Figure 13).	Riparian corridors within the study area.	Local population within Coffs Harbour LGA.	All recorded habitat areas within the study area. The Coffs Harbour – Dorrigo area is noted as supporting a large population and is considered a stronghold for the species (OEH 2018). Given this, habitat within the Project corridor would be considered important to the species long term survival.
Koala	Primary and secondary habitat areas (mapped in Lunney et al 1999) (Figure 13).	Areas containing feed tree species: Tallowwood *Eucalyptus microcorys* (preferred), Swamp Mahogany *E. robusta*, Broad-leaved Paperbark *Melaleuca quinquenervia*, Flooded Gum *E. grandis* and Blackbutt *E. pilularis.* Other habitats are used for resting and shelter.	Local population within Coffs Harbour LGA.	Recorded within study area (habitat assessed according to Commonwealth referral guidelines). Study area contains: • Evidence of Koalas • Primary habitat areas • Areas containing feed trees • Dispersal corridors
Grey-headed Flying-fox	No known camps within the study area – two camps are located within proximity to the study area -one camp is located 856 metres west of the study area and a second camp is located 1.7 kilometres east of the study area (Figure 13).	All vegetated areas of the study area	Local population and individuals considered important.	Known and potential habitat of the study area is fragmented and not considered important to the species.
Spotted-tailed Quoll	No known den sites within the study area.	All vegetated areas of the study area.	None identified within the area.	None recorded (den sites and connectivity between den sites).
Regent Honeyeater	No breeding habitat within the study area.	PCT 1064 Paperbark swamp forest.	None – vagrant for foraging only.	None recorded – no known breeding sites or breeding habitat.

8.3.2 Summary of relevant impacts to MNES

This section provides a summary of relevant impacts to the MNES listed in Table 8.7, resulting from the proposed action. Relevant impacts are those impacts with the potential to significantly impact any matter protected under the EPBC Act. Detailed assessments of potential impacts are provided in the assessments of Significant Impact Criteria provided in Appendix F.

Relevant impacts to MNES form the project have been identified as:

- Direct Loss of habitat/individuals.
- Loss of connectivity.
- Modification of habitat.
- Introduction of disease/pathogens.
- Altered hydrology.
- General disturbance from construction.
- Disturbance to habitat from fire.

These impacts are discussed in greater detail in the sections below.

Direct loss of habitat

The project will remove 43.37 hectares of native vegetation providing habitat for a range of native flora and fauna including MNES. This impact could have both short and long term consequences in the form of direct loss and ongoing decline. These potential consequences are assessed in more detail in Appendix F for each MNES. Direct loss of habitat as a result of the project for MNES includes:

- Southern Swamp Orchid (one individual and 5.77 hectares of known and potential habitat).
- Giant Barred Frog (4.79 hectares of known and potential habitat).
- Koala (43.37 hectares of known and potential habitat).
- Grey-headed Flying-fox (43.37 hectares of known and potential foraging habitat).
- Regent Honeyeater (foraging) (3.65 hectares of potential foraging habitat).
- Spotted-tail Quoll (43.37 hectares of potential habitat).

At the national scale, based on species current distribution and status, this loss of habitat may be important to the following species:

- Giant Barred Frog
- Koala
- Spotted-tail Quoll

Detailed assessment of this loss of habitat for each MNES is provided in Appendix F.

Loss of connectivity

Loss of connectivity as a result of the project will occur through direct loss of habitats and through physical fragmentation and isolation of vegetation and habitats as a result of construction of the bypass. This impact could have both short and long term consequences in the form of direct loss and ongoing decline. The following MNES will be affected:

- Koala – fragmentation of populations and isolation of individuals through construction of physical barrier and removal of habitat.
- Spotted-tail Quoll – potential fragmentation of populations and isolation of individuals through construction of physical barrier and removal of habitat.
- Giant Barred Frog – fragmentation of two known areas of habitat.
- Southern Swamp Orchid – fragmentation of habitats and loss of pollination opportunities.

At the national scale, based on species current distribution and status, loss of connectivity as a result of the project has the potential to be important to the following species:

- Koala
- Spotted-tail Quoll
- Giant Barred Frog.

Modification of habitat

Modification of retained habitats as a result of the project could occur through weed invasion, edge effects and increased accessibility. This impact would occur in the long-term if it is not appropriately managed. The following MNES could be affected:

- Southern Swamp Orchid – potential increase in weed invasion resulting in decline in quality of potential habitats.
- Giant Barred Frog - potential increase in weeds from edge effects resulting in decline in habitat quality.
- Koala – potential increase in woody weeds from edge effects resulting in decline in habitat quality and increased accessibility for people and dogs resulting in mortalities.
- Spotted-tail Quoll - potential increase in weeds from edge effects resulting in decline in habitat quality.

At the national scale, based on species current habitat availability, quality and perceived threats, modification of habitat has the potential to be important to the following species:

- Southern Swamp Orchid
- Giant Barred Frog
- Koala

Introduction of disease/pathogens

Disruption to ecosystems and soil as a result of the project has the potential to introduce or exacerbate pathogens and disease into retained habitats. This impact would have long-term consequences in the form of loss of individuals and loss of habitat if it is not appropriately avoided and mitigated. The following MNES could be affected:

- Giant Barred Frog - potential introduction of Chytrid virus.
- Koala – potential increase in habitat stressors leading to increased cases of Chlamydia or retrovirus, potential introduction of *Phytophthora cinnamomi* leading to decline in habitat health.
- Southern Swamp Orchid – potential introduction of *Phytophthora cinnamomi* leading to decline in habitat health.
- Grey-headed Flying-fox – potential introduction of *Phytophthora cinnamomi* leading to decline in habitat health.
- Regent Honeyeater – potential introduction of *Phytophthora cinnamomi* leading to decline in foraging habitat health.
- Spotted-tail Quoll – potential introduction of *Phytophthora cinnamomi* leading to decline in potential habitat health.

At the national scale, based on species current habitat availability, type of habitat, quality and perceived threats, introduction of pests, diseases or pathogens has the potential to be important to the following species:

- Giant Barred Frog
- Koala
- Southern Swamp Orchid
- Grey-headed Flying-fox
- Regent Honeyeater
- Spotted-tail Quoll.

Altered hydrology

Realignment of sections of six watercourses within the study area where required to maintain drainage and flow characteristics, as well as increased development of roadways, hardstand areas and sedimentation basins as a result of the project could affect local hydrology patterns and associated habitats. This impact could have both short and long term consequences in the form of direct loss of habitat and ongoing decline of habitat suitability. The following MNES could be affected:

- Giant Barred Frog – altered hydrological regimes could affect suitability of habitat.
- Southern Swamp Orchid – altered hydrological regimes could affect suitability of habitat.

At the national scale, based on species current habitat availability, type of habitat, quality and perceived threats, altered hydrology has the potential to be important to the following species:

- Giant Barred Frog

General disturbance from construction

Construction activity has potential to impact fauna and flora populations through increased noise, vibration, artificial lighting, vegetation disturbance, and dust. These impacts would have short-term consequences, for the duration of the project construction. The following MNES could be affected:

- Koala – potential impacts from noise, vibration and lighting.
- Southern Swamp Orchid – potential impacts to viability from increased dust levels.
- Grey-headed Flying-fox - potential impacts from noise, vibration and lighting.
- Spotted-tail Quoll – potential impacts from noise, vibration and lighting.

At the national scale, potential indirect impacts from construction activity are considered unlikely to be of importance to the MNES.

Disturbance to habitat from fire

There is a low risk of unintentional fire resulting from ignition during construction works. Should this occur, there is potential for impact to retained habitats and species. If a significant wildfire resulted from the Project it could have both short term and long term consequences, in the form of direct mortality and habitat loss, and ongoing decline in populations if they fail to recover. MNES that could be affected include:

- Southern Swamp Orchid – loss of individuals, alteration of habitat.
- Giant Barred Frog – loss of individuals, loss of habitat, alteration of habitat.
- Koala – loss of individuals, loss of habitat, alteration of habitat.
- Grey-headed Flying-fox – loss of habitat.
- Regent Honeyeater – loss of habitat.
- Spotted-tail Quoll – loss of individuals, loss of habitat, alteration of habitat.

At the national scale, depending on the scale of the resultant fire, and based on species life requirements and ability to escape fire, wildfire has the potential to be important to the following species:

- Giant Barred Frog
- Koala
- Southern Swamp Orchid
- Spotted-tail Quoll.

Extent and nature of impacts

Table 8.8 provides an overview of the project impacts and their extent, nature and consequence to MNES of the study area.

Table 8.8 Potential impacts to MNES

Project impact	Extent/nature	Habitat or individuals to be impacted	Impact to MNES - consequence
Vegetation removal	Removal of 45.91 ha of native vegetation	Southern Swamp Orchid Giant Barred Frog Koala Grey-headed Flying-fox Regent Honeyeater Spotted-tail Quoll	Short and long term: Loss of individuals Injury or mortality Direct loss of habitat Loss of connectivity Modification of habitat
Construction activities	Indirect impacts: noise, vibration, light, dust, vehicle strike, weed invasion	Giant Barred Frog Koala Grey-headed Flying-fox Regent Honeyeater Spotted-tail Quoll	Short and long term: Introduction of disease/pathogens/ weeds leading to reduced habitat / habitat quality General disturbance from construction Disturbance to habitat from fire
Operation	Physical barrier: dual carriageway approximately 12 km in length	Southern Swamp Orchid Giant Barred Frog Koala Spotted-tail Quoll	Long term: Injury or mortality Loss of connectivity to individuals or habitats Fragmentation of populations Altered hydrology

8.3.3 Measures to avoid and minimise impacts to MNES

Measures to avoid and minimise impacts to MNES within the study area have been proposed for the construction and operational phases of the project. Table 8.9 provides a broad list of proposed measures to be implemented to reduce impacts to MNES. Further details of mitigation measures committed to by the the project are provided in Section 9.

Table 8.9 Measures to avoid and minimise impacts to MNES

Measure to avoid and minimise impacts	Benefit to MNES
Biosecurity and hygiene procedures	Reduction in potential for introduction or spread of disease or pathogens
Pre-clearance surveys	Ensure MNES are not injured or killed during vegetation clearance activities.
Tunnelling of roadway, fauna underpasses, overpasses or crossing structures	Continued connectivity for fauna during operational phase of the bypass
Species-specific installations: Frog-proof fencing Koala-proof fencing	Protection from construction and operation impacts of the bypass including predation and vehicle strike.
Vegetation retention	Vegetation retention wherever possible to provide resources for MNES
Fauna-sensitive road design	Includes design components that assist fauna crossing / escape from roadway

Measure to avoid and minimise impacts	Benefit to MNES
Fauna sensitive construction practices including lighting, dust control, vibration controls	Reduced potential for indirect impacts from lighting, noise etc on MNES in surrounding areas.
Revegetation with native species	Revegetation of areas within the road reserve that can link up with existing vegetative fauna corridors. Revegetation undertaken using locally occurring native species known to provide potential habitat for MNES.

Expected achievability and effectiveness of avoidance and mitigation measures

The potential impacts of the project to habitats have been avoided and minimised through the design process to achieve a balance between the impact and the effectiveness of the works in improving safety for road users. All mitigation, monitoring and management measures proposed in this document and throughout Appendix E and Appendix F have been designed to be achievable throughout the duration of this project. The mitigation measures are achievable, and construction contracts will include clauses to ensure compliance with environmental management requirements of the contract.

Residual impacts remain after all avoidance and mitigation measures have been considered, and these are discussed in Section 9 below. Further assessment of the effectiveness of mitigation measures committed to by the Project is provided in Section 9.

8.3.4 Residual impact to MNES

Residual impacts are unavoidable impacts that remain after avoidance and mitigation measures have been applied to an action. Residual impacts for the MNES are detailed in Table 8.10.

Table 8.10 Residual impacts to MNES

Residual Project impact	Habitat or individuals to be impacted	Impact to MNES
Removal of 45.91 ha of native vegetation	Koala, Southern Swamp Orchid, Spotted-tail Quoll, Giant Barred Frog	Habitat removal, loss of individuals, loss of connectivity
Loss of connectivity – physical barrier	Koala, Spotted-tail Quoll, Giant Barred Frog	Loss of connectivity and removal of habitat corridors leading to isolation of individuals
Vehicle strike during operational phase	Koala, Spotted-tail Quoll	Direct mortality and injury
Predation	Koala	Injury or mortality from dog attacks
Habitat stress	Koala	Habitat reduction and fragmentation leading to increased disease incidence in local population

8.3.5 Offsetting of residual impacts to MNES

Impacts to MNES following implementation of all measures to avoid and minimise will be offset in accordance with the FBA (OEH 2014b) and the NSW Biodiversity Offset Policy for Major Projects (OEH 2014a) under the BC Act, for those matters where a significant impact was determined to be unlikely.

For impacts to MNES determined to be significant in accordance with *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (Commonwealth of Australia 2013) offsets will be in accordance with the FBA and the Biodiversity Offset Scheme, however the offsets may also need to meet the requirements of the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act.

As outlined in Table 8.11 below, the assessment of residual impacts to MNES has concluded that the project is likely to result in a significant impact to Giant Barred Frog and Koala, only. As such offsetting

of residual impacts to these species will require direct offsets that provide a measurable conservation gain for these protected maters in accordance with EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012).

Offsets for Giant Barred Frog and Koala will be secured in relation to the scale of direct and indirect impacts to the species and their habitat within the study area, and calculated in accordance with the FBA and the Biodiversity Offset Scheme. Additional offsets required for indirect impacts to habitats adjacent to the study area are not considered necessary. The most significant and substantial impacts to these species are considered to be the severance of connectivity for both Giant Barred Frog and Koala, as well as potential impacts to water quality and hydrological regimes for Giant Barred Frog (Appendix F).

Mitigation measures committed to for the project (Section 9) include the construction of fauna connectivity structures at 16 key locations along the alignment, and bridging of known Giant Barred Frog habitats at Newports Creek and Pine Brush Creek. Water quality and potential changes to hydrological regimes have been managed through the design phase of the project and will be further mitigated against during the construction phase through implementation of the Construction Environment Management Plan (CEMP) and Threatened Species Management Plan (Arup 2019c) (TSMP). Implementation of these mitigation measures ensures that habitats adjacent to the study area will not be subject to substantial indirect impacts as a result of the project, such that a significant impact to Koala or Giant Barred Frog (or any other MNES) is likely to occur.

Further details on the project's requirements and approach to offsetting are provided in Section 10 and Appendix E.

Table 8.11 Summary of Significant Impact Criteria assessments

EPBC threatened species / ecological community and status	July 2017 referral likelihood assessment (Arup 2017)	SEARs-Bilateral assessment requirements impact summary	Updated likelihood of occurrence based on survey	Potential impacts (see Appendix F for details)	Rationale (see Appendix F for details)	Significant impact self-assessment undertaken and result (see Appendix F for details)
Lowland Rainforest of Subtropical Australia (Critically Endangered)	Potential significant impact.	Potential significant impact.	Does not occur within the study area. None of the four separate patches of rainforest vegetation occurring within the study area are considered to conform to the EPBC Act listing criteria for this community.	No impacts	Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area.	No significant impact.
Clear Milkvine *Marsdenia longiloba* (Vulnerable)	Significant impact unlikely.	Significant impact unlikely to occur.	This species was not recorded within the study area during targeted flora surveys. The potential to occur remains. Approximately 38.10 ha of potential habitat for Clear Milkvine occurs within the study area, with this species recorded within 500 m of the study area.	No impacts considered likely to occur.	The species was not detected during targeted threatened flora searches. An assessment of impacts to potential habitat for this species within the study area has been undertaken.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely given that this species was not recorded during the targeted survey and the nature and scale of impacts to potential habitat for this species are not considered significant.

EPBC threatened species / ecological community and status	July 2017 referral likelihood assessment (Arup 2017)	SEARs-Bilateral assessment requirements impact summary	Updated likelihood of occurrence based on survey	Potential impacts (see Appendix F for details)	Rationale (see Appendix F for details)	Significant impact self-assessment undertaken and result (see Appendix F for details)
Hairy-joint Grass *Arthraxon hispidus* (Vulnerable)	Significant impact unlikely.	Significant impact unlikely to occur.	This species has not previously been recorded within the study area and was not recorded during targeted flora surveys. The potential to occur remains. Approximately 43.37 ha of potential habitat occurs within the study area. A single record of this species exists within the locality.	No impacts considered likely to occur.	The species was not detected during targeted threatened flora searches. An assessment of impacts to potential habitat for this species within the study area has been undertaken.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely given that this species was not recorded during the targeted survey and the nature and scale of impacts to potential habitat for this species are not considered significant.
Orara Boronia *Boronia umbellate* (Vulnerable)	Significant impact unlikely.	Significant impact unlikely to occur.	This species was not recorded during targeted flora surveys, however the potential to occur remains. Approximately 13.51 ha of potential habitat for this species occurs within the study area.	No impacts considered likely to occur.	The species was not detected during targeted threatened flora searches. An assessment of impacts to potential habitat for this species within the study area has been undertaken.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely given that this species was not recorded during the targeted survey and the nature and scale of impacts to potential habitat for this species are not considered significant.

EPBC threatened species / ecological community and status	July 2017 referral likelihood assessment (Arup 2017)	SEARs-Bilateral assessment requirements impact summary	Updated likelihood of occurrence based on survey	Potential impacts (see Appendix F for details)	Rationale (see Appendix F for details)	Significant impact self-assessment undertaken and result (see Appendix F for details)
Samadera sp. Moonee Creek (J king s.n. Nov 1949) (Endangered)	Potential significant impact.	Significant impact has potential to occur.	This species was not recorded during targeted flora surveys, however the potential to occur remains. Approximately 14.45 ha of potential habitat and a large population has previously been recorded in the locality.	No impacts considered likely to occur.	The species was not detected during targeted threatened flora searches. An assessment of impacts to potential habitat for this species within the study area has been undertaken.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely given that this species was not recorded during the targeted survey and the nature and scale of impacts to potential habitat for this species are not considered significant.
Southern Swamp Orchid *Phaius australis* (Endangered)	Potential significant impact.	Significant impact has potential to occur.	Likely to occur within the study area. The species was recorded once during targeted flora surveys. Approximately 2.12 ha of known and a further 3.65 ha of potential habitat for this species occurs within the study area. Previous records also exist for this species within the locality.	The project is considered likely to lead to a long-term decrease in the size of the local Coffs Harbour population and impact the breeding cycle of this population without successful implementation of mitigation measures to translocate the species	The species was detected once during targeted threatened flora searches. An assessment of impacts to potential habitat for this species within the study area has been undertaken.	Significant impact unlikely. Translocation of the species is known to be successful (Andrew Benwell pers. Comm. 2018) and is committed to as a mitigation measure for the project (Section 9). Translocation of the species will be managed through implementation of the Threatened Species Management Plan (Arup 2019c) into an area providing long-term protection for the species. In accordance with the above a significant impact is considered unlikely.

EPBC threatened species / ecological community and status	July 2017 referral likelihood assessment (Arup 2017)	SEARs-Bilateral assessment requirements impact summary	Updated likelihood of occurrence based on survey	Potential impacts (see Appendix F for details)	Rationale (see Appendix F for details)	Significant impact self-assessment undertaken and result (see Appendix F for details)
Cryptic Forest Twiner *Tylophora woollsii* (Endangered)	Potential significant impact.	Significant impact has potential to occur.	Not recorded during surveys. Potential habitat within the study area was targeted during field surveys, with a total of 25.20 ha recorded.	No impacts considered likely to occur.	Not recorded during surveys.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely given that this species was not recorded during the targeted survey and the nature and scale of impacts to potential habitat for this species are not considered significant.

EPBC threatened species / ecological community and status	July 2017 referral likelihood assessment (Arup 2017)	SEARs-Bilateral assessment requirements impact summary	Updated likelihood of occurrence based on survey	Potential impacts (see Appendix F for details)	Rationale (see Appendix F for details)	Significant impact self-assessment undertaken and result (see Appendix F for details)
Giant Barred Frog (Endangered)	Potential significant impact.	Significant impact likely to occur.	This species was recorded once during targeted fauna surveys. Approximately 4.79 ha of potential habitat for this species occurs within the study area.	The project will result in the removal of of 3.22 hectares of known and potential habitat, in two separate locations, and a further 1.51 hectares of potential habitat within the study area. This will result in the removal of 1% of commensurate potential habitat within the locality. The Project has the potential to result in disruptions to the breeding cycle of the local population of the species via the realignment of Newports Creek and its tributaries, and also the potential for fragmentation of habitats in this, and other locations within the study area.	The species was detected once during targeted threatened fauna searches. An assessment of impacts to potential habitat for this species within the study area has been undertaken.	**Significant impact likely to occur.** Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered likely to occur as a result of the Project.

EPBC threatened species / ecological community and status	July 2017 referral likelihood assessment (Arup 2017)	SEARs-Bilateral assessment requirements impact summary	Updated likelihood of occurrence based on survey	Potential impacts (see Appendix F for details)	Rationale (see Appendix F for details)	Significant impact self-assessment undertaken and result (see Appendix F for details)
Grey-headed Flying-fox (Vulnerable)	Significant impact unlikely.	Significant impact has potential to occur.	This species was recorded and is considered likely to occur. The species was recorded during targeted fauna surveys and approximately 43.37 ha of potential habitat occurs within the study area.	Loss of small area of foraging habitat. Potential disturbance from noise or vibration to camp sites and individuals in the locality.	The species was detected during targeted threatened fauna searches. An assessment of impacts to the species and to potential habitat within the study area has been undertaken.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely to occur as a result of the project.
Long-nosed Potoroo (Vulnerable)	Significant impact unlikely.	Significant impact has potential to occur.	This species was not recorded during targeted fauna surveys. The potential to occur remains. Approximately 43.37 ha of potential habitat for Long-nosed Potoroo occurs within the study area.	No impacts considered likely to occur.	The species was not detected during targeted threatened fauna searches. An assessment of impacts to the potential habitat for this species within the study area has been undertaken.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely to occur as a result of the project. The nature and scale of impacts to potential habitat for this species are not considered significant. Any distribution of the species within the study area is not considered an "important population".

EPBC threatened species / ecological community and status	July 2017 referral likelihood assessment (Arup 2017)	SEARs-Bilateral assessment requirements impact summary	Updated likelihood of occurrence based on survey	Potential impacts (see Appendix F for details)	Rationale (see Appendix F for details)	Significant impact self-assessment undertaken and result (see Appendix F for details)
Koala (Vulnerable)	Potential significant impact.	Significant impact has potential to occur.	The species is known to occur within the study area and was recorded during targeted fauna surveys.	The project has the potential to: • Reduce the area of occupancy of the local important population of Koalas. • Result in fragmentation of the Coffs Harbour Koala population. • Impact the breeding cycle of the important population of Koalas in Coffs Harbour. • Modify, isolate and decrease the availability and quality of habitat available. • Result in further habitat loss, fragmentation and road kill for this species. • Indirectly affect the incidence of disease in the local Koala population • Increases invasive species that may restrict Koala movement and tree access	The species was detected during targeted threatened fauna searches. An assessment of impacts to the species and to potential habitat within the study area has been undertaken.	**Significant impact likely to occur.** Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered likely to occur as a result of the project.
Regent Honeyeater (Critically Endangered)	Significant impact unlikely.	Significant impact has potential to occur.	Not recorded during surveys. Potential to occur. Within the locality approximately 175 hectares of potential habitat occurs comprising of PCT 1064. Within the study area 3.65 ha of this PCT exists consisting of potential foraging habitat.	Potential impacts considered unlikely.	Removal of 3.65 ha of potential foraging habitat – within the local area there is more than 175 ha of this habitat.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely to occur as a result of the project.

EPBC threatened species / ecological community and status	July 2017 referral likelihood assessment (Arup 2017)	SEARs-Bilateral assessment requirements impact summary	Updated likelihood of occurrence based on survey	Potential impacts (see Appendix F for details)	Rationale (see Appendix F for details)	Significant impact self-assessment undertaken and result (see Appendix F for details)
Spotted-tail Quoll (Endangered)	Significant impact unlikely.	Significant impact has potential to occur.	Not recorded during surveys. Potential to occur - the Spotted-tailed Quoll has previously been recorded within 820 metres of the study area, and has been recorded on 34 occasions within the locality, with the most recent record in 2014.	The project has the potential to: • Reduce the area of occupancy of the local population. • Result in habitat fragmentation. • Modify, isolate and decrease the availability and quality of habitat available. • Result in further habitat loss, fragmentation and road kill for this species.	Species not recorded within study area. Removal of 43.37 ha of potential habitat equivalent to approximately 0.4% of the estimated equivalent potential habitat for the Spotted-tailed Quoll mapped within the locality (OEH 2012).	Significant impact unlikely. Provided suitable mitigation measures are put in place to reduce the impacts of fragmentation on the Spotted-tailed Quoll the project is considered unlikely to result in a significant impact to this species.
Swift Parrot (Critically Endangered)	Significant impact unlikely.	Significant impact has potential to occur.	Swift parrots were not recorded during surveys within the study area. Within the locality approximately 175 hectares of potential habitat occurs comprising of PCT 1064. Within the study area 3.65 ha of this PCT exist consisting of potential foraging habitat.	Potential impacts considered unlikely.	Removal of 3.65 ha of potential foraging habitat – within the local area there is more than 175 ha of this habitat.	Significant impact unlikely. Assessment undertaken based on best available knowledge and habitat sampling. A significant impact is considered unlikely to occur as a result of the project.

8.4 Other impacts

8.4.1 Aquatic and hydrology impacts

Impacts to waterways and aquatic habitats expected to be associated with the construction of permanent waterway crossings within the study area. Changes to hydrology are also likely to occur as a result of earthworks (both cut and fill) with the coastal floodplain and potential alteration to the existing flow paths of watercourses due to design requirements of the project. Likely impacts include:

- Temporary displacement of fauna:
  - Aquatic fauna may be temporarily displaced during the construction of permanent waterway crossings and proposed creek realignments including; between 40 and 150 metres of Newports Creek and two of its tributaries, approximately 90 metres of Coffs Creek, up to 120 metres of the upper reaches of Treefern Creek, and around 35 metres the northern tributary of Pine Brush Creek. . Recommendations to limit impacts aquatic environments, particularly to fish passage, are detailed in Section 9.1.
  - Loss of riparian and aquatic habitat, including removal or relocation of snags:
  - Impacts to riparian vegetation, including removal, may occur during the construction phase of the project, including road construction and access for machinery or equipment. Recommendations to limit impacts to riparian and aquatic habitats are detailed in Section 9.1.
- Changes to flooding regimes, hydrology, turbidity and sedimentation:
  - Construction of road infrastructure including waterway crossings, as well as waterway realignments, have the potential to result in increased turbidity within waterways and downstream sedimentation. Mitigation measures to protect against impacts associated with erosion and sedimentation are detailed in Section 9.1.
  - Flooding and hydrological regimes within the study have been altered from their natural state through anthropogenic land use and landscape modification. Any changes to flooding regimes or hydrology associated with the project are expected to be associated with flow alteration on floodplains, in particular North Boambee Valley. Floodplain dynamics are considered likely to be further modified as a result of proposed earthworks required to elevate the road above the floodplain. Mitigation measures associated with the design and construction of such structures are detailed in Section 9.1.
  - Potential changes to the hydrological regimes are likely to impact aquatic biodiversity values, as well as terrestrial biota dependent on periodic inundation such as Swamp Sclerophyll Forest vegetation and Coastal Petaltail.
- Temporary obstruction to fish passage, including temporary in-stream structures and/or temporary diversions:
  - No permanent barriers to fish passage are proposed. Fish passage may be temporarily obstructed during the construction of waterway crossings and waterway realignment. Mitigation measures to minimise impacts on aquatic biota, with particular reference to fish passage, are detailed in Section 9.1.
  - Changed hydrology including excessive flow velocities, modified depths of waterways, increase water turbulence, in stream structures, realignment of waterways, alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands, and channelisation, piping, concrete lining or scour protection of waterways:
  - Changes to hydrology associated with the project are expected to be limited to flow alteration around instream waterway crossing structures, and associated with the realignment of sections of Newports Creek and two of its tributaries, Coffs Creek, the upper reaches of Treefern Creek, and the northern tributary of Pine Brush Creek. Any such changes to hydrology are likely to impact upon native fish species and communities through changes in stream velocities and modifications to stream hydraulics, potentially reducing the ability of fish to navigate the steam channel, as well as potential erosion and scour of banks and riparian areas/vegetation. Mitigation measures associated with the design and construction of such structures are detailed in Section 9.1, associated terrestrial impacts are outlined in Section 8.4.3, below.

- Changes in shading regime and temperature:
  - Changes to stream shading may occur as a result of the removal of riparian vegetation associated with road construction. Mitigation measures to minimise the amount of native riparian vegetation during construction are detailed in Section 9.1.

No threatened aquatic species, populations or communities were recorded within the study area and are not considered likely to occur. Monitoring will be undertaken during and post-construction to ensure future impacts to biodiversity values associated with changes to hydrology are recorded, included as part of adaptive management strategies and if appropriate included in the Project's offsets package.

Current and future project design has, and will continue to consider measures to minimise impacts to ecosystems within the broader locality reliant on the existing flooding patterns such as bridging of low lying and regularly inundated areas, minimisation of the alteration and constriction of current flow regimes through drainage design and minimisation of disturbance to groundwater dependent ecosystems. New bridge piers or drainage structures associated with the new road alignment will be located and designed to maintain existing hydrological regimes as far as possible. Particular care will be taken to avoid scour of downstream environments.

8.4.2 Groundwater dependent ecosystems

Impacts to GDEs are likely if there are effects or changes to groundwater flows and depth on groundwater dependent ecosystems. One area of 'High potential GDE – from regional studies' (BOM 2018) reliant on subsurface expression of groundwater has been mapped within the study area. The remainder of the vegetation within the study area is considered to be 'Low potential GDE – from regional studies' as per the GDE Atlas (BOM 2018) (Figure 6).

Direct impacts to GDEs as a result of the project include the removal of 0.77 hectares of 'High potential GDE – from regional studies' and 42.60 hectares 'Low potential GDE – from regional studies' as per the GDE Atlas (BOM 2018).

Impacts to GDEs have been assessed in the Groundwater Assessment Report (EIS Appendix N [Arup 2019b]) which states that lowering of groundwater levels caused by the excavation of cuttings and tunnels which intercept and drain groundwater from the fractured bedrock aquifer has the potential to impact GDEs within the study area. Most GDEs are considered likely to draw groundwater from shallow surficial deposits or alluvial groundwater which occur within a few metres of the surface. It I considered unlikely that GDEs are dependent directly on groundwater from the fractured bedrock aquifer except where it is close to the ground surface, for instance at spring locations.

Since groundwater inflows captured by the Project are from the fractured bedrock aquifer, the potential impact on GDEs and native vegetation communities is expected to be limited. Where native vegetation communities are groundwater dependent, it is likely that they are reliant on water within alluvial aquifers (and perched water within surficial soils), which are predominantly surface water dependent (Groundwater Assessment Report EIS Appendix N [Arup 2019b]).

Potential areas sensitive to alterations to groundwater flow include the SEPP (Coastal Management) 2018 mapped wetland that occurs within 100 metres to the east of the southern extent of the study area, and higher risk biodiversity values such as areas of Swamp Sclerophyll Forest, Lowland Rainforest TECs and habitat for threatened flora and fauna species including Coastal Petaltail and Southern Swamp Orchid. A higher concentration of 'High potential GDE – from regional studies' are mapped on the GDE Atlas to the east of the study area (BOM 2018).

The Groundwater Assessment Report (EIS Appendix N [Arup 2019b]) notes that several low potential GDEs and native vegetation communities, which may be intermittently groundwater dependent are intercepted by the alignment, and that the anticipated zone of drawdown from Type A cuttings also extends to some low potential GDEs further from the study area. No moderate or high potential GDEs are anticipated to be within the zone of drawdown of cuttings and there are no mapped Coastal Management SEPP wetlands within the expected long-term zone of drawdown around any of the cuttings or drained tunnels (Groundwater Assessment Report EIS Appendix N [Arup 2019b]). As such the potential impacts to wetlands and higher risk biodiversity values is not considered substantial. Further detail and assessment is provided in Chapter 20 (Groundwater) of the EIS (Arup 2019b).

Relevant aspects of the final design stages of the Project will include measures to minimise this effect and the resultant indirect impacts to GDEs. Potential impacts will be managed through implementation of a Groundwater Management Plan,

8.4.3 Fragmentation of identified biodiversity links and habitat corridors

The Project is likely to result in increased fragmentation of habitat to the east (on the coastal floodplain) and the west (the escarpment) of the study area. The following categories of connecting links are present within the study area (as detailed in Appendix 5 of the FBA):

- One 'regionally significant biodiversity link' in the form of a fourth order waterway riparian buffer zone associated with a tributary of Newports Creek (Figure 3).
- Several 'local area biodiversity links', including:
    - Riparian vegetation associated with Jordans Creek and tributaries which connect vegetation of the coastal plain with that of the escarpment in the north of the study area.
    - Vegetation running south east from Shephards Lane and following the North Coast Railway.
    - Vegetation connecting vegetation of the escarpment foothills along Roberts Hill to vegetation of the coastal plain in the vicinity of Eyre Road.
    - Riparian vegetation of Newports Creek in the North Boambee Valley (Figure 3).

Seventeen Koala habitat corridors have been mapped that cross the study area where native vegetation links habitats to the east and the west. These corridors have been based on the Local and Regionally significant habitat corridors provided in the Coffs Harbour Koala Plan of Management (Coffs Harbour City Council 1999), as well as the presence of Koala habitat on either side of the study area, the presence of linking vegetation, often associated with waterways and riparian areas, and the presence of Koala records or evidence of activity. The locations of these Koala corridors within the study area is shown on Figure 10.

The majority of these connectivity links will be impacted by the project and will result in fragmentation of habitats to the east and west, however tunnelling of the roadway at Roberts Hill and Gatelys Road, avoids direct impacts, and fauna connectivity features at a further six locations mitigate fragmentation impacts to Koala at these locations.

Loss of connectivity as a result of the project will occur through direct loss of habitats and through physical fragmentation and isolation of vegetation and habitats as a result of construction of the bypass. This impact could have both short and long term consequences in the form of direct loss and ongoing decline. Without mitigation the following threatened species will be most affected at a local scale:

- Koala – fragmentation of populations and isolation of individuals through construction of physical barrier and removal of habitat.
- Spotted-tail Quoll – potential fragmentation of populations and isolation of individuals through construction of physical barrier and removal of habitat.
- Giant Barred Frog and Green-thighed Frog – fragmentation of two known areas of habitat.
- Southern Swamp Orchid – fragmentation of habitats and loss of pollination opportunities.
- Pale-vented Bush Hen – fragmentation of movement corridors associated with riparian vegetation.
- Rusty Plum – fragmentation of existing habitats.

At the national scale, based on species current distribution and status, loss of connectivity as a result of the Project has the potential to be important to the following species:

- Koala
- Spotted-tail Quoll
- Giant Barred Frog.

Mitigation measure are proposed to reduce the impacts of habitat fragmentation of threatened and non-threatened fauna species, these include:

Mitigation of the potential impacts of the project include:

- Fauna crossing structures at 16 locations along the alignment, including retained vegetation and retained ridgelines over tunnels at Roberts Hill, Gatelys Road and Shephards Lane tunnels, culvert underpasses, bridge underpasses and glider poles. Eight fauna connectivity features are targeted to maintaining connectivity at mapped Koala corridors (Figure 14).

- Koala proof fencing to ensure Koalas cannot access the new highway, implemented without preventing dispersal of individuals. Note that Koalas need to be funnelled, they cannot identify alternative safe routes of their own accord.
- Mitigation of the removal of habitat will include the rehabilitation and revegetation and protection of habitat within the road corridor. Revegetation works will be implemented progressively throughout the construction phase.

Further detail on locations and design specifications of fauna connectivity structures is provided in Section 9.2.

Fragmentation impacts to aquatic species and habitats will be managed by ensuring waterway crossings are constructed in accordance with DPI (2013) *Policy and Guidelines for fish habitat conservation and management* and the Pacific Highway Design Guidelines.

8.4.4 Edge effects on adjacent native vegetation and habitat

Vegetation within the study area and broader locality occurs in a patchy mosaic of remnant and re-growth vegetation on hills, in gullies and surrounding watercourses and cleared areas for agriculture and urban / per-urban development. Edge to area ratios are generally high in this patchy landscape, with existing vegetation subject to a high degree of edge effects. The project is not considered likely to substantially increase this ratio, and associated edge effects, for retained vegetation patches adjacent to the construction footprint.

This is supported by the results of the area to perimeter ratio assessment undertaken as part of the Landscape Values assessment under the FBA, with the resultant score, based on the proportional change in ratio before and after development being just 2%.

8.4.5 Injury and mortality of fauna

The project has the potential to increase injury and mortality to fauna both during the construction and operation phases. During the construction phase increased injury/mortality to fauna may occur as a result of:

- Increased vehicle, particularly heavy vehicle, movements in the locality.
- Fauna presence in vegetation being removed.
- Fauna entrapment in excavations.

During the operation phase of the project increased injury/mortality to fauna may occur as a result of:

- Increased risk of road mortality due to new high speed road.
- Increased risk of road mortality due to severance of connecting vegetation.

Threatened fauna species have the potential to be impacted as result of the increased risks listed above, most at risk of road mortality include Koala and Spotted-tail Quoll, with Southern Myotis most at risk of impacts during vegetation removal.

Potential construction phase impacts will be mitigated through implementation of measures such as, two-staged vegetation removal processes (initial removal of non-habitat trees/vegetation, followed by removal of habitat trees under supervison of ecologist spotter-catcher), regular inspections of open excavations, and maintenance of low speed limits and timing of works to be undertaken mainly undertaken during daylight hours where possible.

Potential operation phase impact will be mitigated by providing fauna underpasses, and overbridges and installation of fauna fencing to prevent faun entering the roadway.

Mitigation measures are further discussed in Section 9.

8.4.6 Invasion and spread of weeds

Infestation of habitats by introduced weeds is identified as a threat to many of the threatened species, and ecological communities, known or considered highly likely to occur within the study area (OEH 2018). Patches of vegetation within the study area are significantly impacted by weed species, with many areas showing significant levels of weed invasion due to past clearing practices. Forty-six weed species were recorded during field surveys and have the potential to spread following disturbance associated with the construction phase of the project. However, strict hygiene measures will be implemented to prevent and mitigate the spread of weeds and reduce the potential of negative impacts to threatened species habitats. A Flora and Fauna Management Plan will include measures to ensure

appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

8.4.7 Invasion and spread of pests

The project has the potential to increase the presence of pest species such as the Fox (*Vulpes vulpes*) and feral Cat (*Felis catus*) within the study area. These increases are likely to be driver by clearing of native vegetation during construction and subsequent dispersal of native fauna. Foxes are highly likely to be present within the areas of semi-agricultural land use, with feral cats also likely to occur due to the presence of residential areas within and surrounding the study area. Mitigation measures detailed in Section 9 will be implemented to minimise the potential for any impacts such as introduction and spread of pests as a result of the project.

8.4.8 Invasion and spread of pathogens and disease

Without appropriate mitigation measures, the project may result in the introduction or spread of pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) or Panama disease (*Fusarium oxysporum* f. sp. *cubense*) within the study area. Where present, Phytophthora and Myrtle Rust may cause dieback or modification of native vegetation and consequently damage fauna habitats. Panama disease is already present at some properties within the study area and results in the dieback of infected banana plants. Visitation into pathogen affected areas and subsequent movement of people and vehicles around the study area has the potential to result in the introduction or spread of these pathogens. Given the number of waterways within the study area and the disturbed nature of the catchment, the occurrence and spread of Chytrid fungus (*Batrachochytrium dendrobatidis*) is possible. Chytrid fungus affects both tadpoles and adult frogs and can wipe out entire populations once introduced into an area. Mitigation measures that are recommended to minimise the potential for any impacts associated with these pathogens are detailed in Section 9.

8.4.9 Noise, light and vibration

Although some parts of the study area are subject to increased noise and vibration levels associated with existing roads, the project has the potential to result in additional impacts to native biota as a result of new road construction. The construction and operation of the project would expose new areas of habitat to increased noise and vibration levels, due to construction activities and ongoing vehicle traffic along the project alignment.

Sections of the project alignment are already subject to impacts from artificial lighting associated with the operation of existing roads. The project will include the installation of lighting along section of the new road alignment for traffic safety, in accordance with the Pacific Highway Design Guidelines (Arup 2019b). Therefore, the project is likely to result in a degree of light spill to vegetation immediately adjacent to the new road alignment, concentrated at on / off-ramps and interchanges, and is likely to impact upon native biota within these sections of the study area. Lighting used during construction and operation of the project should be designed as ‘down lights’ (in accordance with AS/NZ 1158 – Lighting for roads and public spaces) and be directed inwards wherever practicable so as to limit light spill into nearby areas of remnant vegetation.

Remnant vegetation immediately adjacent to areas of new road construction within the alignment would experience some artificial lighting impacts. Potential impacts may result from the operation of night time construction works, installation of street lighting and security lighting. Light spill onto areas of remnant vegetation may discourage habitat use and disrupt foraging regimes of nocturnal native species. Disruption to foraging regimes and interference to eyesight of nocturnal native species associated with artificial lighting may increase the susceptibility of these species to predation. The new road construction alignment generally occurs in semi-agricultural areas, with the amount of remnant vegetation in these areas generally being limited to small patches or riparian corridors. Recommendations to avoid and mitigate impacts to such vegetation have been made in Section 9.

Wedge-tailed Shearwaters *Ardenna pacifica,* a listed Migratory species under the EPBC Act, has the potential to be indirectly impacted by the project, The species has a wide distribution in the tropical Pacific and Indian Oceans and regularly visits the east and west coast of Australia for breeding and non-breeding purposes. The species breeds during summer on the east coast of Australia in addition to offshore islands.

The impacts of light pollution to Wedge-tailed Shearwaters is of concern due to the nocturnal activities of the species (Geering et al. 2007). During the fledging periods (late April to early May), juvenile Wedge-tailed Shearwaters are particularly susceptible, as light sources have the potential to act as an attractant for the species (Commonwealth of Australia 2012b), this can result in individuals becoming disorientated and ultimately displaced from their nesting sites.

In addition to this, recent studies suggest that artificial light sources have the potential to impact foraging behaviours of bird species such as the Wedge-tailed Shearwaters which can in turn potentially impact on their energy reserves in preparation for breeding or migration (Thomas et al. 2004).

Within close proximity to the study area, Muttonbird Island Nature Reserve is a known breeding reserve for the Wedge-tailed Shearwater. Impacts to the species on this breeding reserve have previously been recorded as a result of artificial lighting produced from the city of Coffs Harbour. This has caused juvenile Wedge-tailed Shearwaters from this island to become disorientated and displaced within the Coffs Harbour city area (Keen, L. 2019).

As outlined above, the project's lighting scheme has been developed in accordance with the Pacific Highway Design Guidelines (Roads and Maritime Services 2015f) and Category V3 in with AS/NZ 1158 – Lighting for roads and public spaces. This has resulted in lighting being proposed across a number of interchanges, entry and exit ramps and roundabouts.

Mitigating potential impacts can prove difficult as most studies suggest the removal or reduction in use of artificial light sources, which is not applicable to this project for safety reasons. Other potential mitigation methods can include changing the spectral composition of the lights to be less attractive the certain species, although there is minimal evidence to support this (Rodriguez, et al. 2017).

Although the addition of lights may pose a potential indirect impact to the species over time, due to the closer proximity of Coffs Harbour city to Muttonbird Island Nature Reserve and the significantly greater volume of artificial light production, the impact to Wedge-tailed Shearwaters as a result of the light pollution caused be the project is considered likely to be minimal.

Mitigation measures to reduce noise and vibration generated by the project are outlined in Section 9.

8.4.10 Cumulative impacts

Assessment of cumulative impact will include those impacts associated with high integration projects of a similar scale in the NSW North Coast area. Impacts associated with upgrades to other sections of the Pacific Highway will be included.

Assessment of cumulative impacts is provided within Chapter 25 of the EIS (Arup 2019b).

8.5 Impact summary

Table 8.12 provides a summary of impacts detailed above.

Table 8.12 Summary of Project impacts

Impact	Biodiversity values	Nature of impact Direct, indirect, consequential, cumulative	Extent of impact Site based, Local, Regional, State, National	Duration Short term/ Long term, pre, during or post construction	Does the Project constitute or exacerbate a key threatening process?
Removal of native vegetation	Removal of 43.37 hectares of native vegetation	Direct	Local and Regional	Long term	Clearing of native vegetation. Loss of hollow-bearing trees. Removal of dead wood and dead trees.
	Removal of 3.65 hectares of BC Act Swamp Sclerophyll Forest EEC	Direct	Local and Regional	Long term	
	Removal of 2.43 hectares of BC Act Lowland Rainforest EEC	Direct	Local and Regional	Long term	
Removal of threatened fauna species habitat and habitat features	Coastal Petaltail Giant Barred Frog Green-thighed Frog Koala Pale-vented Bush-hen Southern Myotis Grey-headed Flying-fox Little Bentwing-bat (foraging) Eastern False Pipistrelle Eastern Freetail-bat Greater Broad-nosed Bat White-bellied Sea-eagle Olive Whistler Square-tailed Kite	Direct	Local and Regional	Long term	Clearing of native vegetation. Loss of hollow-bearing trees. Removal of dead wood and dead trees.
	87 hollow-bearing trees	Direct	Local	Long term	
Removal of threatened plants	Rusty Plum Southern Swamp Orchid	Direct	Regional	Long term	Clearing of native vegetation.
Culverts spanning waterways	Freshwater ecosystems	Direct	Local	Long term	Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams. Removal of large woody debris from New South Wales rivers and streams.
Bulk earthworks altering floodplain topography	Floodplains and natural river basins	Direct	Local	Long term	Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams.

Impact	Biodiversity values	Nature of impact Direct, indirect, consequential, cumulative	Extent of impact Site based, Local, Regional, State, National	Duration Short term/ Long term, pre, during or post construction	Does the Project constitute or exacerbate a key threatening process?
Increased stormwater run off	Freshwater and marine ecosystems	Indirect	Local	Long term	Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams
Removal of riparian vegetation	Freshwater ecosystems	Indirect	Local	Long term	Degradation of native riparian vegetation along New South Wales water courses
Groundwater dependent ecosystems	Direct impacts to 0.77 hectares of high-potential GDEs, and 42.60 hectares of low potential GDEs within the study area. Potential indirect impacts to GDEs within the anticipated zone of drawdown the drawdown. Potential impacts to threatened and non-threatened flora and fauna species utilising GDEs as habitat.	Direct and indirect	Local	Long term	Clearing of native vegetation
Changes to hydrology including the re-alignment of six waterways	Freshwater ecosystems Terrestrial ecosystems reliant on periodic flooding/inundation Coastal Petaltail habitats outside the Project footprint	Indirect	Local	Long term	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
Fragmentation of identified biodiversity links and habitat corridors	Fragmentation of habitats for the following threatened fauna species by removal of biodiversity corridors: Giant Barred Frog Green-thighed Frog Koala Spotted-tailed Quoll Pale-vented Bush-hen Rusty Plum Non-threatened flora and fauna	Direct	Local and Regional	Long term	Clearing of native vegetation. Loss of hollow-bearing trees. Removal of dead wood and dead trees.

Impact	Biodiversity values	Nature of impact Direct, indirect, consequential, cumulative	Extent of impact Site based, Local, Regional, State, National	Duration Short term/ Long term, pre, during or post construction	Does the Project constitute or exacerbate a key threatening process?
Edge effects on adjacent native vegetation and habitat	Threatened and non-threatened biodiversity values	Indirect	Local	Long term	n/a
Injury and mortality of fauna	Potential increase in road mortality for: Koala Spotted-tailed Quoll Non-threatened fauna	Direct	Local and Regional	Long term (minor) During construction (moderate)	n/a
Invasion and spread of weeds	Native vegetation and fauna habitats.	Indirect	Local and Regional	During construction	Invasion and establishment of exotic vines and scramblers. Invasion, establishment and spread of *Lantana camara.* Invasion of native plant communities by exotic perennial grasses. Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
Invasion and spread of pests	Native fauna and fauna habitats.	Indirect	Local	During construction	Competition and grazing by the feral European Rabbit *Oryctolagus cuniculus*. Competition and habitat degradation by Feral Goats *Capra hircus*. Predation and hybridisation of Feral Dogs *Canis lupus familiaris*. Predation by the European Red Fox *Vulpes vulpes*. Predation by the Feral Cat *Felis catus*. Predation by Plague Minnow or Mosquito Fish *Gambusia holbrooki*. Predation, habitat degradation, competition and disease transmission by Feral Pigs *Sus scrofa*.
Invasion and spread of pathogens and disease	Native flora species and fauna habitats.	Indirect	Local and Regional (potential)	Longterm	Infection of native plants by *Phytophthora cinnamomi* Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae. Infection of frogs by amphibian chytrid causing the disease chytridiomycosis.

Impact	Biodiversity values	Nature of impact Direct, indirect, consequential, cumulative	Extent of impact Site based, Local, Regional, State, National	Duration Short term/ Long term, pre, during or post construction	Does the Project constitute or exacerbate a key threatening process?
Noise, light and vibration	Wedge-tailed Shearwater and other native fauna species.	Direct/indirect	Local	During construction (moderate/ high) Long term (minor)	

9 Mitigation

Following all measures to avoid impacts, mitigation measures have been developed to minimise the effect of any unavoidable impacts on locally occurring biodiversity values. The project will result in direct impacts to biodiversity values present within the construction footprint and indirect impact to biodiversity present outside the construction footprint. These impacts will be mitigated against and minimised by implementation of the measures provided in the tables below.

Section 9.1 provides standard mitigation measures proven effective at managing and minimising impacts to biodiversity on similar projects, as well as more specific mitigation measures tailored to the biodiversity values associated with the project.

Section 9.2 provides measures that have been committed to by Roads and Maritime to reduce the significance of impacts of the project associated with habitat fragmentation and maintain landscape connectivity to the east and west of the project for local species including the Coffs Harbour “important population’ of Koala.

Assessment as to the likely effectiveness of the mitigation measures is provided as well as the proposed timing for implementation.

9.1 Mitigation of impacts to biodiversity

Table 9.1 Mitigation measures

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
General	Preparation of a Construction Environment Management Plan (CEMP) to include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site specific measures and relevant sub-management plans.	Pre-construction	Proven	None
	Ensure all workers are provided with an environmental induction before starting work on-site. This would include information on the ecological values of the subject site and study area and measures to be implemented to protect biodiversity.	Pre-construction and during construction	Proven	None
Removal of native vegetation	Native vegetation and fauna habitat removal would be minimised through detailed design where reasonable and feasible. Particular focus would be given to avoiding and minimising the removal of: • Hollow bearing trees • Native vegetation in riparian zones • Native vegetation from known fauna connectivity corridors and near proposed fauna crossing structures..	Detailed design	Effective	Loss of native vegetation and habitats
	Pre-clearing surveys will be undertaken in accordance with *Guide 1: Pre-clearing process* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Prior to construction	Effective	
	Vegetation removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Effective	
	Measures to minimise the requirement for clearance of native riparian vegetation at bridge locations within the study area should be investigated during detailed design and implemented where practicable and feasible.	During construction	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	The limits of clearing within the construction site will be delineated using appropriate signage and barriers, identified on site construction drawings and during construction staff induction. Vegetation and habitat features to be retained, such as hollow-bearing trees, will be clearly identified and protected by suitable fencing, signage or markings.	During construction	Effective	
	Native vegetation will be re-established via implementation of an Urban Design Management Plan prepared in accordance with *Guide 3: Re-establishment of native vegetation* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011). Re-established vegetation will comprise indigenous vegetation communities that occur within the study area.	Post construction	Effective	
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the construction footprint an assessment of impact will be undertaken to determine what if any additional mitigation measures are required.	During construction	Proven	
Removal of threatened fauna habitat	Native vegetation and fauna habitat removal would be minimised through detailed design where reasonable and feasible. Particular focus would be given to avoiding and minimising the removal of: • Hollow bearing trees • Native vegetation in riparian zones • Native vegetation from known fauna connectivity corridors and near proposed fauna crossing structures.	Detailed design	Effective	Loss of threatened fauna habitat
	Habitat removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction and post construction	Effective	
	Habitat will be replaced or re-instated in accordance with *Guide 5: Re-use of woody debris and bushrock* and *Guide 8: Nest boxes* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Proven	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened fauna, not assessed in the biodiversity assessment, are identified in the construction footprint.	During construction	Proven	
	Pre-clearing surveys will be carried out in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 1: Pre-clearing process*) (RTA 2011).	During construction	Effective	
	Protection and enhancement of vegetated riparian zones would be undertaken to improve opportunities for fauna movement (including Spotted-tailed Quoll and Pale-vented Bush Hen).	During construction	Effective	
	Additional mitigation measures will be implemented to minimise impact to Giant Barred Frog including, bridging areas of known habitat at Newports Creek and its southern tributary, pre-clearance surveys prior to earthworks, and installation of frog proof fences in areas of known and potential habitat.	Detailed design and during construction	Effective	
	The Flora and Fauna Management Plan (FFMP) would be prepared in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) and implemented a part of the CEMP. The FFMP would build upon the strategies outlined in the TSMP and identify detailed site-specific and species-specific mitigation measures and management protocols to be implemented before, during and after all construction activities to further avoid or reduce impacts on threatened biodiversity.	Pre-construction	Effective	
	A Nest Box Management Plan would be prepared and implemented as part of the FFMP in accordance with Guide 8: Nest Boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011). The Plan would include requirements for monitoring and maintenance.	Pre-construction	Effective	
	Investigate opportunities for providing roosting habitat for microbats in new bridge structures where future maintenance issues will not be compromised.	Detailed design	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	The Coffs Harbour Bypass Threatened Species Management Plan (Arup 2019c) (TSMP) would be reviewed and updated as required during detailed design and prior to operation. The purpose of the review would be to address any detailed design and/or construction refinements and to comply with relevant project approval requirements. The Plan would operate in conjunction with the FFMP.	Project duration	Effective	
Removal of threatened flora	Pre-clearing surveys will be undertaken in accordance with *Guide 1: Pre-clearing process* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Proven	Minimised loss of threatened plants
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened flora species, not assessed in the biodiversity assessment, are identified in the study area.	During construction	Proven	
	Mitigate against impact to the local population of Southern Swamp Orchid under the EPBC Act through translocation of the individual(s) present within the study area to a location providing long-term protection to the species (such as a locally occurring offset site established in accordance with the Project's Biodiversity Offset Strategy). Translocation to be managed through implementation of the Coffs Harbour Bypass Threatened Species Management Plan (Arup 2019c).	Prior to construction	Effective	
	Mitigate against the loss of Rusty Plum individuals from the local population by translocation of individuals to be impacted and where feasible seed collection and propagation.	Prior to construction	Effective	
	A Salvage and Re-establishment Plan for Southern Swamp Orchid individual(s) and Rusty Plum would be prepared prior to construction, outlining detailed procedures for the preparation of the re-establishment and receiving sites, plant movement, pre- and post- care of target individuals as well as detailing the objectives, monitoring procedures and contingency measures.	Prior to construction	Effective	
	Implement the Coffs Harbour Bypass Threatened Species Management Plan (Arup 2019c) which will include detailed and addiitoanl adpative mitigation, management and monitoring actions.	Project duration	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Realignment of watercourses (Newports Creek and tributaries, Coffs Creek, Treefern Creek, tributary of Pine Bush Creek)	Creek realignments would be constructed to maintain natural flow conditions and carried out in accordance with the requirements of the DPI *Guidelines for fish conservation and management* (NSW Fisheries 2003). Construction of creek realignments would begin by installing erosion and sediment control measures (including scour protection) around the existing watercourses to avoid erosion impacts. Following the installation of erosion and sediment control measures, the new channel would be constructed (including bulk earthworks) offline from the existing creek alignments. A range of structures such as plunge pools and rock chutes would be installed to control water flow as required.	During construction	Effective	Minimal impacts to species utilising the area of Newports Creek to be realigned.
	Ensure new creek channel is sufficiently stabilised prior to diversion of the water to prevent scour and erosion and sedimentation of high quality aquatic habitats downstream.	During construction	Effective	
	Undertake works in accordance with the requirements of the DPI *Guidelines for fish conservation and management* (NSW Fisheries 2003).	During construction	Effective	
	Pre-clearing surveys to be undertaken prior to undertaking waterway realignments to ensure no direct impacts to Giant Barred Frog population,	During construction	Effective	
	Undertake regular monitoring to allow for adaptive management to ensure the success of the realignment. Successful reestablishment of natural flow conditions and riparian habitats is critical to minimise long-term impacts to Giant Barred Frog.	During construction and ongoing	Effective	
Aquatic impacts	Aquatic habitat would be protected in accordance with Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) and Section 3.3.2 Standard precautions and mitigation measures of the Policy and Guidelines for Fish Habitat Conservation and Management Update 2013 (DPI 2013) and with reference to DPI Office of Water guidelines for controlled activities on waterfront land.	During construction	Effective	Nil
	Any machinery used during instream works should be verified as clean and free of potential weeds and pathogens to avoid biosecurity risk.	During construction	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Culverts spanning waterways	Bridges used to minimise impacts within the riparian corridor where crossing waterways rated Type 1- highly sensitive key fish habitat. Waterway crossings would be designed and constructed in accordance with DPI Fisheries guideline *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries 2003) and would include maintaining existing nominal flow velocity where possible or at less than 0.3 m/sec to prevent damage to aquatic habitats.	Detailed Design	Proven	Shading instream.
Bulk earthworks altering floodplain topography	The project would be designed and consrtucted to maintain hydrologic and geomorphic characteristics of the floodplain where reasonable and feasible.	Detailed Design	Effective	Potential alterations to floodplain dynamics
Increased stormwater run off	Detention basins to be included in designs, with the aim of reducing the volume and velocity of water entering waterways.	Detailed Design	Proven	Depends on design.
Removal of native riparian vegetation	Measures to minimise the requirement for clearance of native riparian vegetation at bridge locations within the construction footprint should be investigated during detailed design and implemented where practicable and feasible.	Detailed design, during construction.	Effective	Loss of habitats
	Vegetation removal should be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Effective	
	Native vegetation should be re-established if/where practicable in accordance with *Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction and post construction	Effective	
	Habitat should be replaced or re-instated in accordance with Guide 5: *Re-use of woody debris and bushrock* (RTA 2011).	During construction and post construction	Effective	
Changes to hydrological regimes	The detailed design should be prepared to minimise changes to existing hydrological regimes, including disturbance to any groundwater dependent ecosystems, and potential Coastal Petaltail habitats outside the Project footprint. New bridge piers or drainage structures associated with the new road alignment should be located and designed to maintain existing hydrological regimes as far as possible. Particular care should be taken to avoid additional scour of downstream environments and impacts to potential Coastal Petialtail habitats.	Detailed design	Effective	Changed hydrological regime

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Turbidity, sedimentation and erosion	The extent of instream works should be kept to the minimum necessary for the Project, and all instream works should be undertaken in a manner that reduces potential for increased turbidity, i.e. that minimises disturbance to and mobilisation of instream substrates, including potential or actual acid sulphate soils.	Detailed design and during construction.	Effective	Small scale increase to turbidity, sedimentation and erosion
	Coffer dams or similar should be used where feasible to contain suspended sediments to the immediate instream works area and prevent or minimise increased turbidity in adjoining areas.	During construction	Effective	
	Surface and groundwater monitoring undertaken in accordance with water quality monitoring program up and downstream of works.	During construction	Effective	
Water pollution	A Soil and Water Quality Management Plan will be prepared in relation to the project.	Detailed design	Effective	Nil
	An acid sulphate soils management plan will be prepared for all excavation (including instream works) in areas identified as potential or actual acid sulphate soils, in accordance with Roads and Maritime's *Guidance for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze* (RTA 2005) and the Soil and Water Quality Management Plan. The ASS (acid sulphate soils) management plan should be accepted by Roads and Maritime before the start of any earthworks.	Detailed design	Effective	
	All instream works should be undertaken in a manner that reduces potential for increased turbidity, ie that minimises disturbance to and mobilisation of instream substrates, including potential or actual acid sulphate soils.	During construction	Effective	
	Fuels, oils and fluids for construction will be stored in bunded areas.	During construction	Effective	
	All construction waste and litter generated on site should be appropriately contained, with particular measures implemented to ensure it is prevented from entering any waterways, before being disposed of at an appropriate offsite facility.	During construction	Effective	
	Drainage structures associated with the new road alignment should be designed to minimise potential for pollutants from road run off entering waterways.	Detailed design	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Temporary waterway crossings during construction	Where required, temporary crossing structures would be designed, constructed and maintained in accordance with the following requirements: • Low-flow conditions will be maintained. • Fish passage will be maintained in accordance with the waterway classification and DPI Fisheries guideline Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003). • Any material used will not result in fine sediment material entering the waterway. • Include erosion and sediment controls in accordance with Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004).	During construction	Effective	Potential minimal impacts to receiving environments
Groundwater dependent ecosystems	Minimise potential impacts to groundwater dependent ecosystems by implementation of management measures in accordance with the groundwater assessment (EIS Chapter 20 [Arup 2019b]).	During construction	Effective	Minimal impacts to GDEs
Changes to hydrology	Changes to existing surface water flows will be minimised through detailed design.	Detailed design	Effective	Minimal impacts to hydrology
Fragmentation of identified biodiversity links and habitat corridors	Connectivity measures will be implemented in accordance with Table 9.2 of this assessment and on design principles outlined in Section 9.2 and finalised during detailed design to minimise impacts to fauna movement. Eight of the sixteen fauna connectivity features are located on mapped Koala movement corridors, with the remainder generally located around waterways that provide movement habitat for aquatic and terrestrial species including Pale-vented Bush Hen, Spotted-tailed Quoll and Giant Barred Frog.	Detailed design, during construction and post construction	Effective	Reduced loss of connectivity for fauna species
	Permanent fauna fencing, including specific fencing for Koala and Giant Barred Frog in areas of known habitat, would be progressively installed as fauna connectivity structures become operational in consultation with a suitably qualified and experienced ecologist. Further details of mitigation measures to minimise fragmentation impacts to Koala are outlines in Section 9.2 below. These mitigations measures will benefit all locally occurring terrestrial fauna species.	Detailed design, during construction and post construction	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	Temporary fauna fencing would be installed if the existing fauna fence at the southern end of the project on the Pacific Highway is removed during construction period.	During construction	Effective	
	Bridges would be installed in areas of known Giant Barred Frog habitat (ie Newports Creek and Pine Brush Creek).	Detailed design, during construction and post construction	Effective	
Edge effects on adjacent native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Effective	Increase in edge effects are expected to be minimal.
Injury and mortality of fauna	Any fauna encountered during construction would be managed in accordance with Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).Fauna fencing will be installed in accordance with the Coffs Harbour Bypass Threatened Species Management Plan (Arup 2019c).	During construction	Effective	Reduces injury to fauna
	A native stingless bee rescue protocol would be developed and implemented to guide relocation of any native bee hives within the construction footprint.	During construction	Effective	
	Ongoing road kill monitoring for adaptive management of fencing and crossing structures.	During and post construction	Effective	
Invasion and spread of weeds, pathogens and disease, and pest animals.	Biosecurity risk and weed species would be managed in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) and Guide 7: Pathogen Management (RTA 2011). Specific protocols would be prepared and implemented to manage, Chytrid fungus, Phytophthora and Myrtle Rust.	During construction	Effective	Low potential biosecurity issues.
Noise, light and vibration	Shading and artificial light impacts on areas of retained native vegetation would be minimised through detailed design where reasonable and feasible.	Detailed design	Effective	Increase in edge effects are expected to be

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	Exclusion measures for microbats would be investigated for culverts identified as having high and medium habitat potential in consultation with a suitably qualified and experienced ecologist. Where required, timing for exclusion measures would be undertaken outside of breeding and winter torpor periods.	Prior to and during construction	Effective	minimal.

9.2 Habitat connectivity measures

Fragmentation of habitats is a considered major risk to local biodiversity values that may result from the project. The following measures have been committed to by Roads and Maritime to reduce the significance of impacts associated with habitat fragmentation and maintain landscape connectivity to the east and west of the project.

Table 9.2 provides details of the fauna habitat connectivity structures to be constructed as part of the project and provides approximate location, target species, connecting habitats and comments as to the chosen locations. Final design details of connectivity structures will be refined during the detailed design phase of the project.

Details relating to the maintenance of habitat connectivity during the construction phase of the project are included in the Coffs Harbour Bypass Threatened Species Management Plan (Arup 2019c).

Table 9.2 Fauna connectivity structures

Site No.	Design chainage	Connectivity structure type	Description, indicative dimensions and target species
1	10150	Dedicated fauna underpass. Glider poles.	Extension of existing arch structure under Pacific Highway (2.8 m high, 5.5 m wide at base, length 83 m). Structure to be retained and extended, with new fauna furniture to be retrofitted and extended through new structure. Target species: Koala, Spotted-tail Quoll, and gliders
2	11100	Combined fauna and drainage underpass.	Culvert crossing across unnamed tributary of Newports Creek (Class 2 waterway) (3 x 3000W x 2700H approx 75 m long). Target species: Koala, Spotted-tail Quoll, Giant Barred Frog, fish
3	11650	Combined waterway bridge incorporated fauna underpass.	Bridge crossing across unnamed tributary of Newports Creek (Class 2 waterway) (80 m length x 24.5 m width). Target species: Koala, Spotted-tail Quoll, Giant Barred Frog, Pale-vented Bush Hen, and fish
4	12000	Combined waterway bridge incorporated fauna underpass.	Bridge crossing Newports Creek (Class 2 waterway) (90 m length x 25 m width). Target species: Koala, Spotted-tail Quoll, Giant Barred Frog, Pale-vented Bush Hen, and fish
5	12150	Combined road bridge incorporating fauna underpass.	Bridge crossing of North Boambee Road (99 m length x 23 m width). Target species: Koala, and Spotted-tail Quoll
6	12400	Combined waterway bridge incorporated fauna underpass.	Bridge crossing across unnamed tributary of Newports Creek (Class 2 waterway) (66 m length x 24 m width). Target species: Koala, Spotted-tail Quoll, Giant Barred Frog, Pale-vented Bush Hen, and fish
7	12800	Dedicated fauna underpass.	Vegetation corridor identified for terrestrial fauna movement (1 x 3000W x 3000H RCBC approx 89 m long). Target species: Koala, Spotted-tail Quoll, and Pale-vented Bush Hen
8	13750	Retained ridgeline over tunnel overpass	Roberts Hill ridgeline, 190 m ridgeline retained Target species: Koala, Spotted-tail Quoll, and Pale-vented Bush Hen
9	14600	Combined waterway bridge incorporated fauna underpass.	Bridge crossing across unnamed tributary waterway (Class 2) (64 m length x 25.5 m width). Target species: Koala, Spotted-tail Quoll, Pale-vented Bush Hen, and fish

Site No.	Design chainage	Connectivity structure type	Description, indicative dimensions and target species
10	16600	Combined rail bridge incorporating fauna underpass	Bridge crossing over North Coast Rail Line. Vegetated corridor along rail verge (180 m length x 28.5 m width). Target species: Koala and Spotted-tail Quoll
11	17200	Retained ridgeline over tunnel overpass	Shephards Lane tunnel, 360 m ridgeline retained Target species: Highly mobile threatened and non-threatened fauna
12	17800	Combined road bridge incorporating fauna underpass.	Fauna passage included with access road underpass (30 m length x 24.5 m width). Target species: Koala, and Spotted-tail Quoll
13	19000	Retained ridgeline over tunnel overpass	Gatelys Road tunnel, 450 m ridgeline retained Target species: Koala, Spotted-tail Quoll, and Pale-vented Bush Hen.
14	19750	Combined road bridge incorporating fauna underpass.	Bridge underpass under West Korora Road (34 m length x 27 m width). Target species: Koala, Spotted-tail Quoll, and Pale-vented Bush Hen
15	20150	Combined fauna and drainage underpass.	Culvert crossing across tributary of Jordans Creek (Class 3) (1 x 3000W x 3000H, approx 60 m long). Target species: Koala, Spotted-tail Quoll, Pale-vented Bush Hen, and fish
16	22450	Combined waterway bridge incorporated fauna underpass.	Bridge underpass under Pine Brush Creek (Class 1) (60 m length x 27 m width). Target species: Koala, Spotted-tail Quoll, Pale-vented Bush Hen, Giant Barred Frog, and Green-thighed Frog.

9.2.1 Connectivity measures design principles

Table 9.3 provides the design principles and criteria that will guide the design of the fauna connectivity structures during the detailed design phase of the project (Arup 2019c). Best practice and known effective design criteria and principles will be followed to ensure the structures are used by the target fauna species and successfully mitigate against the impacts to connectivity resulting from the construction and operation of the project.

Table 9.3 Fauna connectivity structure design principles

Fauna connectivity structure design principles
Retained ridgelines over tunnel overpass
The existing vegetation communities on the ridges will be retained where feasible (there may be need for some minor clearing associated with utilities/associated tunnel infrastructure).
Fauna exclusion fencing, with appropriate mechanisms to prevent climbing and burrowing animals, is to be installed on both sides of the tunnel approaches, extending above both portals and tying into the fauna fencing along the road corridor. The design of any barriers must not cause a barrier to the movement of any of the target fauna species.
Clearing of native vegetation is to be minimised as much as practicable on either side of the approaches to the tunnels. Areas where existing native vegetation has been removed during the construction of the project and is located within the fauna exclusion fencing area shall be revegetated with native vegetation.
Waterway bridges incorporating fauna underpass
Clearance of vegetation adjacent to bridges across waterways is to be minimized. Design and construction methodology is to retain as much vegetation within the riparian zone of the waterway as is practicable.
Bridges are the preferred crossing structure for identified Class 1 waterways (Major Fish Habitat), preferably being

Fauna connectivity structure design principles
single- span or multi-span bridges with the pylons/piers located outside the main channel.
Where feasible and reasonable, the design is to avoid placing piers in permanent water channels and on stream banks, to minimise alteration to water flow and/or damage to stream bank vegetation. This is important for the identified Class 1 waterways.
Bridges should be designed with a natural substrate at the abutment, such as soil or vegetation, where feasible and reasonable. Scattered rocks could be included.
Bridges should be designed to allow unimpeded water flow, stream bank and riparian vegetation, preferably on both sides of the water course
Any scour protection associated with the entries and exits to waterway bridges should accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible, and have minimal gaps between the rocks.
A minimum width of 3 m is to be retained between the toe of the scour protection and the top of bank to maintain fauna passage below the bridge on both sides. For effective connectivity, the 3 m passage should consist of a natural substrate or other surface type that will not hinder fauna movement. Note: location of piers should not restrict the designated fauna passage area or the width of the passage should be widened to accommodate the pier.
Bridges should be designed (height, carriageway separation) to allow sufficient light and moisture to encourage growth of vegetation between twin bridge structures. A minimum height of 1.5 m should be allowed for in areas proposed for terrestrial fauna passage.
The design of bridges (and culverts) is to ensure physical, hydraulic and behavioural barriers are minimised for aquatic fauna movements. Impacts should be minimised by ensuring that: • The natural system flow and velocity is maintained or mimicked as closely as possible. • Habitat within a culvert is to be as natural as possible (eg allow rocks and bed materials to infill the culvert base).
Revegetation works should be completed as soon as practicable following bridge construction and include restoration of a natural, riparian zone vegetation community underneath the bridge structure. Revegetation works on the entry/exit side of the structure are to provide for a continuous strip of native vegetation and habitat from each side of the bridge. Where possible, the vegetation community created as part of the revegetation works is to match the plant community type (PCT) of the retained vegetation communities. Planting underneath the bridge structures should include the use of groundcovers, with shrubs to be used when the height and light penetration allow for larger species to establish. All plant species are to be known to occur in the relevant PCT retained on either side of the bridge.
Where the bridges cross areas of habitat identified for threatened frog species the creek channels are to be reinstated to include habitat elements to support these species, including consideration for fringing riparian vegetation, emergent aquatic vegetation, suitable instream habitats to support species-specific life cycles.
The approaches to the fauna passage on each side of the bridge is to include fauna fencing that ties into the abutments to funnel fauna towards the crossing and to exclude fauna from the road infrastructure.
Road bridges incorporating fauna underpasses
Bridges should be designed with a natural substrate at the abutment, such as soil or vegetation, where feasible and reasonable.
Any scour protection associated with the entries and exits to bridges should accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks.
A minimum width of 3 m is to be retained between the toe of the scour protection or the abutment and the edge of the road to maintain fauna passage below the bridge on one side. For effective connectivity, the 3 m passage should consist of a natural substrate where possible.
Bridges should be designed (height, carriageway separation) to allow sufficient light and moisture to encourage growth of vegetation between the structures. A minimum height of 1.5 m should be allowed for in areas proposed for terrestrial fauna passage
Revegetation works should be completed as soon as practicable following bridge construction and include restoration of a natural, vegetation community underneath the bridge structure. Revegetation works on the entry/exit side of the

Fauna connectivity structure design principles
structure are to provide for a continuous strip of native vegetation and habitat from each side of the bridge. Where possible, the vegetation community created as part of the revegetation works is to match the PCT of the retained vegetation communities. Planting underneath the bridge structures should include the use of groundcovers, with shrubs to be used when the height and light penetration allow for larger species to establish. All plant species are to be known to occur in the relevant PCT retained on either side of the bridge.
The approaches to the fauna passage on each side of the bridge is to include fauna fencing that ties into the abutments to funnel fauna towards the crossing and to exclude fauna from the road infrastructure.
Rail bridges incorporating fauna underpass
Bridges should be designed with a natural substrate at the abutment, such as soil or vegetation, where feasible and reasonable. Scattered rocks could be included.
Any scour protection associated with the entries and exits to bridges should accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks.
A minimum width of 3 m is to be retained between the toe of the scour protection or the abutment and the edge of the road to maintain fauna passage below the bridge on both sides. For effective connectivity, the 3m passage should consist of a natural substrate with refuge areas (scattered rocks, logs) and landscaping of the habitat corridor approach, not consisting of all rock and not consisting of scour protection.
Bridges should be designed (height, carriageway separation) to allow sufficient light and moisture to encourage growth of vegetation under the structures. A minimum height of 1.5 m should be allowed for in areas proposed for terrestrial fauna passage
Revegetation works should be completed as soon as practicable following bridge construction and include restoration of a natural, vegetation community underneath the bridge structure. Revegetation works on the entry/exit side of the structure are to provide for a continuous strip of native vegetation and habitat from each side of the bridge. Where possible, the vegetation community created as part of the revegetation works is to match the PCT of the retained vegetation communities. Planting underneath the bridge structures should include the use of groundcovers, with shrubs to be used when the height and light penetration allow for larger species to establish. All plant species are to be known to occur in the relevant PCT retained on either side of the bridge.
Clearance of vegetation adjacent to bridges across waterways is to be minimized. Design and construction methodology is to retain as much vegetation within the riparian zone of the waterway as is practicable.
Dedicated fauna underpasses (culverts)
Crossings should provide an unobstructed view, for fauna using the underpass, of the horizon or habitat on either side of the structure. The location of underpasses on embankment fills should be optimized to provide these views
Plan for minimum 3mby 3m culvert size in wildlife corridors, as well as habitat identified as supporting threatened species where feasible and reasonable where culvert lengths are less than 50m long. This is dependent on available fill heights and the sensitivity of vegetation, for example additional impacts to endangered ecological communities should be minimised.
Culvert size is dependent on the target species. However, standard underpass size is 3m x 3m when length is greater than 50m and maybe smaller is some circumstances, but not less than 2.4 m x 2.4 m.
Culvert underpass structures that exceed 50 m in length shall be a minimum 3 x 3 m (height x width) box culvert. Culvert structures that are less than 50 m length shall be a minimum 2.4 m x 2.4 m box culvert should fill embankments heights not permit 3 x 3 m box culvert. Approach grades to the underpass structures would be no steeper than 3H:1V.
Dedicated underpasses to have a natural substrate, such as soil or mulch. Sandy loam is preferable to prevent the generation of a mud substrate
In order to achieve dry passage in dedicated underpasses, the following design principles apply: • Dedicated underpasses are to be located above flow lines, gullies and depressions. • Basin outlets should not lead to or run to dedicated underpasses. • Basins should not be located in front of underpass structures. • Locations are to be ground-truthed to ensure the correct conditions. • Underpasses are to be designed with a longitudinal grade and to be free draining to reduce frequency and levels of

Fauna connectivity structure design principles
any ponding water within the culverts. • Fauna furniture is to be incorporated into dedicated structure design and around the entrance. • Place horizontal logs for passage as high above the base of the opening as practical, allowing 0.6 m ceiling clearance for fauna passage. • Outside and within the culvert provide refuge poles (3 m tall and 200 mm diameter, with a forked top) are effective where introduced (feral) predators are likely to attack Koalas. It is important to ensure that the poles are located at least three metres away from Koala exclusion fencing.
Minimise clearing of existing native vegetation at the entry/exit points of the underpasses.
The approaches to the underpasses on either side of the road should be subject to revegetation works to connect the entry/exit points to areas of retained native vegetation and corridors.
Combined fauna and drainage underpasses (culverts)
The underpass combines drainage or property access requirements with fauna passage requirements, in some cases including fish passage.
Relocation or adjustment of the stream bed is to be avoided, where feasible and reasonable
Combined crossings must be located and installed so that entrance slopes are not steeper than 3H:1V nor rocky and must provide suitable fauna passage.
Combined underpass floors and exit / entry points that are designed to cater for terrestrial fauna passage must provide dry fauna passage during a 1 in 1 year ARI 3 day storm event and must not have wet sections that retain water for longer than three days. A dry ledge or similar within combined underpasses to maintain dry passage maybe used. Minimum ledge width of 1.2 m.
For aquatic species, the natural width, depth and gradient of the watercourse is to be maintained within the culvert, with no vertical drops created at the entrance or exit. All designs should be in accordance with NSW Fisheries Guideline “Why do Fish Need to Cross the Road” (now incorporated into DPI 2013).
Ensure that pathways to fauna underpasses are not affected by noise mounds or ancillary sites or rest areas.
Any scour protection associated with the entries and exits to combined drainage / fauna crossings must accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks.
Where feasible and not affecting the hydrological performance of the drainage structure, fauna furniture is to be installed in combined structures that have been designed to provide for terrestrial fauna movement, with consideration for raised ledges, shelter rocks and resting poles. Furniture is to be designed and located so to obstruct movement of the target fauna species through the underpass.

9.2.2 Mitigation of impacts to Koala

Specific measures to mitigate the Project’s impact to the local Coffs Harbour “important population’ of Koala have been developed and are provided below.

Mitigation of the potential impacts of the Project include:

- Koala proof fencing to ensure Koalas cannot access the new highway during operation, implemented without preventing dispersal of individuals. Note that Koalas need to be funnelled, they cannot identify alternative safe routes of their own accord.
- Mitigation of the removal of habitat will include the rehabilitation and revegetation and protection of habitat within the road corridor. Revegetation works will be progressively implemented throughout the construction phase.
- Monitoring the use of connectivity structures to ensure adaptive management and maintenance can be achieved and potential long-term fragmentation impacts are minimised.

Eight of the 16 fauna connectivity features are located on mapped Koala movement corridors, with the remainder generally located around waterways that provide movement habitat for other aquatic and terrestrial species. Mitigation of fragmentation impacts include:

- Three retained ridgeline over tunnel overpasses
- Two dedicated fauna underpasses
- Two combined fauna and drainage underpasses
- Five combined waterway bridges incorporating fauna underpasses
- Three combined road bridges incorporating fauna underpasses
- One combined rail bridge incorporating fauna underpass
- One set of glider poles.

Furnished underpasses are to be designed and located based on the information in Table 9.2 and Table 9.3 above.

Further detail on mitigation of impacts to Koala are provided in the Coffs Harbour Bypass Threatened Species Management Plan (Appendix I of the EIS [Arup 2019c]).

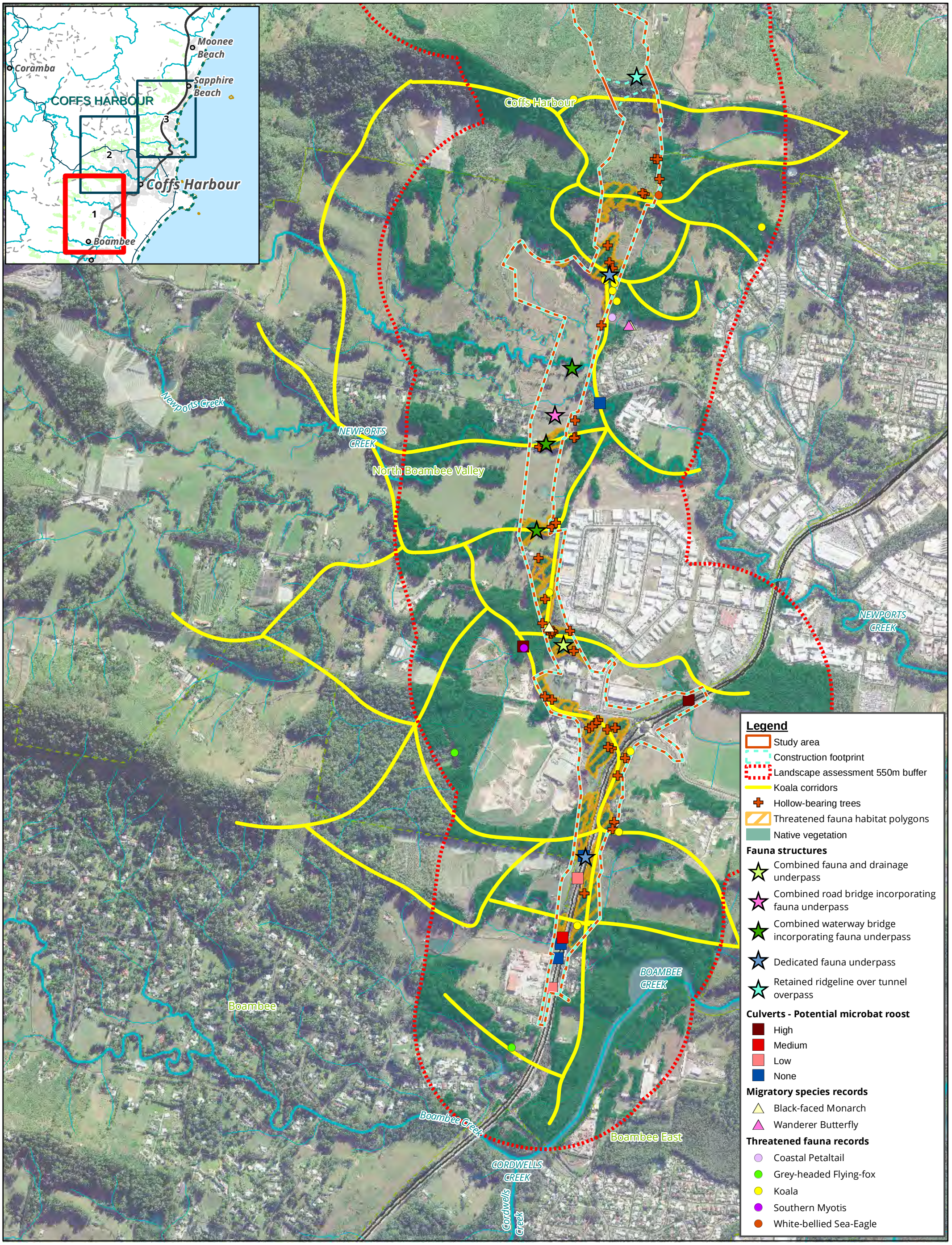


Figure 14.1: Fauna structures

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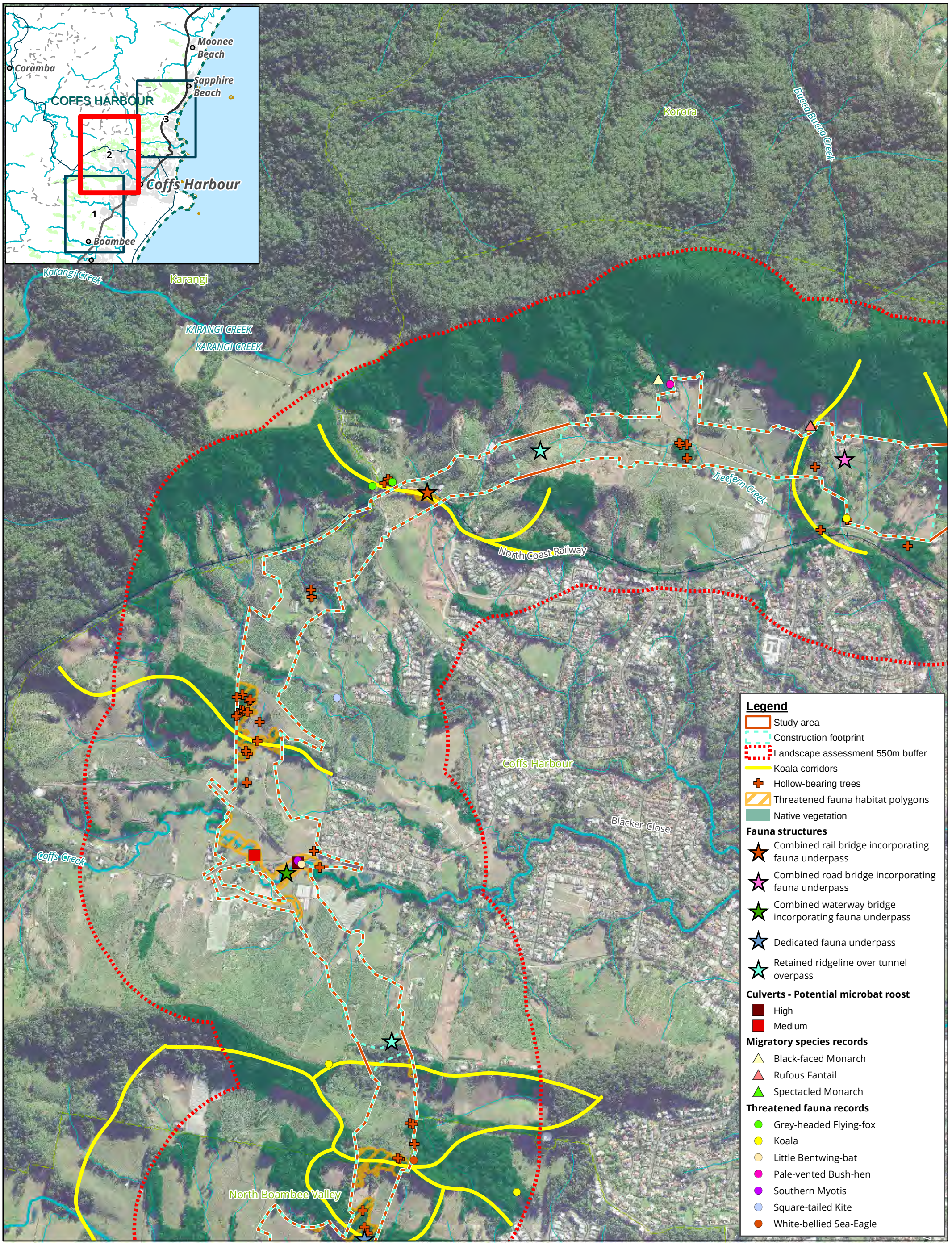


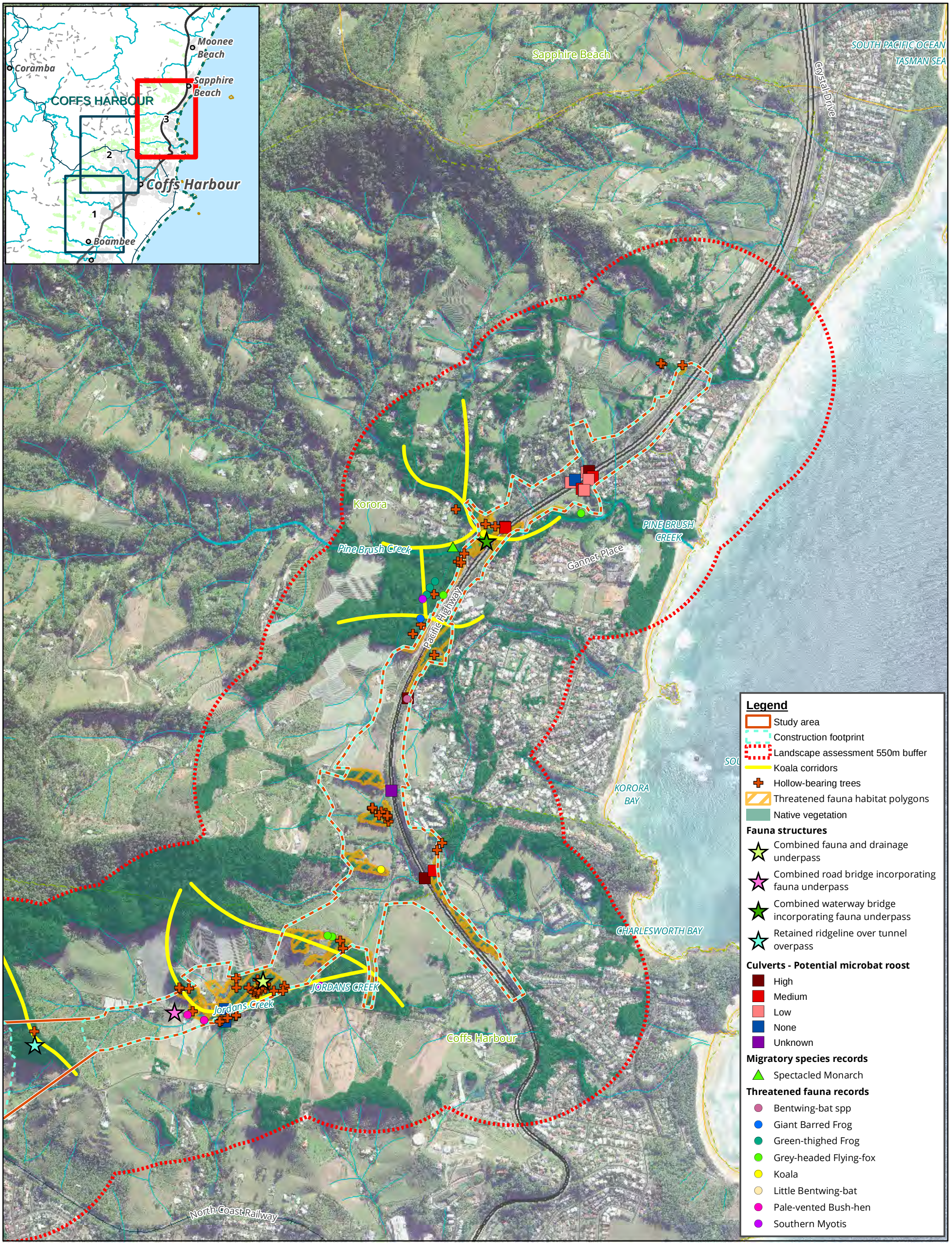
Figure 14.2: Fauna structures

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Figure 14.3: Fauna structures

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10 Offsetting required

This section provides the biodiversity credits required from impacts on the biodiversity values within the concept design for the project (i.e. the construction footprint), following consideration of measures to avoid, minimise and mitigate impacts. Table 10.1 provides a summary of ecosystem credits required for each PCT impacted by the Project. Table 10.2 outlines the total number of species credits required for impacts to threatened species credit species.

The Final Credit Reports are provided in Appendix C.

As a result of impacts to Koala and Giant Barred Frog being deemed significant in accordance with *Matters of National Environmental Significance Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2013) (refer Section 8 and Appendix F), offsets secured in accordance with the FBA (OEH 2014b) and the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a) may also likely be required to meet the additional criteria outlined in the Commonwealth EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012).

No offsetting is required for impacts to aquatic biodiversity under the FM Act.

Table 10.1 Ecosystem credits summary

Veg Zone	PC type code	Plant community type name	Management zone area (ha)	Ecosystem credits required
1	NR280	White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion	0.51	35
2	NR120	Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	11.27	754
3	NR120	Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	3.39	136
5	NR122	Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	6.26	438
6	NR120	Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	0.74	36
8	NR258	Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast	0.94	64
9	NR138	Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	2.48	149
10	NR217	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	0.89	61
11	NR217	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	1.15	80
12	NR217	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	1.23	79
13	NR122	Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	0.15	11
14	NR122	Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	4.07	167
15	NR263	Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	0.73	43

Veg Zone	PC type code	Plant community type name	Management zone area (ha)	Ecosystem credits required
16	NR217	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	0.38	27
17	NR280	White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion	1.91	109
100	NR263	Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	0.89	57
101	NR274	Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	1.42	87
102	NR138	Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	3.35	216
103	NR274	Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	1.61	97
TOTAL			**43.37**	**2646**

Further details of the sub-component scores of the Project's ecosystem credit requirement (ie. loss in site values score and EEC / threatened species multipliers) are provided in Appendix C below.

Table 10.2 Species credits summary

Scientific name	Common name	TS offset multiplier	Loss of habitat (ha) or individuals	Species credits required
Niemeyera whitei	Rusty Plum, Plum Boxwood	1.5	57 individuals	855
Phaius australis	Southern Swamp Orchid	1.3	1 individual	13
Petalura litorea	Coastal Petaltail	7.7	2.50 ha	192
Mixophyes iteratus	Giant Barred Frog	7.7	3.28 ha	253
Litoria brevipalmata	Green-thighed Frog	1.3	1.79 ha	23
Phascolarctos cinereus	Koala	2.6	36.70 ha	954
Amaurornis moluccana	Pale-vented Bush-hen	1.3	4.95 ha	64
Myotis macropus	Southern Myotis	2.2	15.10 ha	332
TOTAL				**2686**

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Appendix A – Species recorded

Flora species recorded

Family	Scientific Name	Common Name	EPBC Act	BC Act	PT_1	PT_2	PT_3	PT_4	PT_5	PT_6	PT_7	PT_8	PT_9	PT_10	PT_11	PT_12	PT_13	PT_14	PT_15	PT_16	PT_17	PT_18	PT_19	PT_20	PT_21	PT_22	PT_23
Fabaceae (Mimosoideae)	Acacia longifolia	Sydney Golden Wattle																									
Fabaceae (Mimosoideae)	Acacia longissima	Long-leaf Wattle																			3						
Fabaceae (Mimosoideae)	Acacia maidenii	Maiden's Wattle											1		6										1		
Fabaceae (Mimosoideae)	Acacia parramattensis	Parramatta Wattle																									
Cunoniaceae	Ackama paniculosa	Soft Corkwood										1									1					2	
Myrtaceae	Acmena smithii	Lilly Pilly										1		4													1
Myrtaceae	Acmena sp												3														
Rutaceae	Acronychia oblongifolia	White Aspen								2			1	1			1										
Rutaceae	Acronychia octandra	Doughwood												1													
Adiantaceae	Adiantum formosum	Giant Maidenhair												500													
Adiantaceae	Adiantum hispidulum	Rough Maidenhair												1					50			10	10			4	
Alliaceae	Agapanthus sp	Lily of the Nile													1												
Asteraceae	Ageratina adenophora	Crofton Weed			5				3	2				10	1				50		1	5	2				
Asteraceae	Ageratina riparia	Mistflower											5														
Asteraceae	Ageratum houstonianum						50																				
Akaniaceae	Akania bidwillii	Turnipwood																1									
Euphorbiaceae	Alchornea ilicifolia	Native Holly												5													
Sapindaceae	Alectryon coriaceous	Beach Alectryon																									
Casuarinaceae	Allocasuarina littoralis	Black She-Oak																									
Casuarinaceae	Allocasuarina torulosa	Forest Oak																		7			1	4			
Araceae	Alocasia sp	Cunjevoi																2									
Rhamnaceae	Alphitonia excelsa	Red Ash											1							1				1			
Zingiberaceae	Alpinia caerulea	Native Ginger										2			1			1			2	1	4			5	4
Poaceae	Andropogon virginicus	Whisky Grass															100										
Myrtaceae	Angophora costata	Sydney Red Gum																				2	2	2			
Basellaceae	Anredera cordifolia	Madeira Vine													5												
Araucariaceae	Araucaria cunninghamii	Hoop Pine																	1								
Apocynaceae	Araujia sericifera	Moth Vine									10		100		1						5						
Fabaceae (Mimosoideae)	Archidendron grandiflorum	Pink Lace Flower																							1		
Myrtaceae	Archirhodomyrtus beckleri	Rose Myrtle								8	1											10	8				
Arecaceae	Archontophoenix cunninghamiana	Bangalow Palm						2	1		5	1	4	10				50	6				1				1
Arecaceae	Archontophoenix sp	Alexandra Palm																									
Myrsinaceae	Ardisia crenata	Coralberry																									
Iridaceae	Aristea ecklonii														20												
Asparagaceae	Asparagus aethiopicus	Asparagus Fern																					1				

Flora species recorded

Family	Scientific Name	Common Name	EPBC Act	BC Act	PT_24	PT_25	PT_26	PT_27	PT_28	PT_29	PT_30	PT_31	PT_32	PT_33	PT_34	PT_35	PT_36	PT_37	PT_38	PT_39	PT_40	PT_41	PT_42	PT_43
Fabaceae (Mimosoideae)	Acacia longifolia	Sydney Golden Wattle																			2			
Fabaceae (Mimosoideae)	Acacia longissima	Long-leaf Wattle																						
Fabaceae (Mimosoideae)	Acacia maidenii	Maiden's Wattle												1			1						1	
Fabaceae (Mimosoideae)	Acacia parramattensis	Parramatta Wattle																			3	1		
Cunoniaceae	Ackama paniculosa	Soft Corkwood					1	15																
Myrtaceae	Acmena smithii	Lilly Pilly					5		2				1	10	1			1	10	2		10		1
Myrtaceae	Acmena sp																							
Rutaceae	Acronychia oblongifolia	White Aspen			3									4										
Rutaceae	Acronychia octandra	Doughwood																						
Adiantaceae	Adiantum formosum	Giant Maidenhair									50								10	100				20
Adiantaceae	Adiantum hispidulum	Rough Maidenhair			10			20	10			2		10	100	50								
Alliaceae	Agapanthus sp	Lily of the Nile																						
Asteraceae	Ageratina adenophora	Crofton Weed				20	50					10		5			100			10		2	10	5
Asteraceae	Ageratina riparia	Mistflower												100										
Asteraceae	Ageratum houstonianum											20											10	3
Akaniaceae	Akania bidwillii	Turnipwood																						
Euphorbiaceae	Alchornea ilicifolia	Native Holly													6									
Sapindaceae	Alectryon coriaceous	Beach Alectryon																10						1
Casuarinaceae	Allocasuarina littoralis	Black She-Oak																3			50	4		
Casuarinaceae	Allocasuarina torulosa	Forest Oak								2														
Araceae	Alocasia sp	Cunjevoi																						
Rhamnaceae	Alphitonia excelsa	Red Ash									2													1
Zingiberaceae	Alpinia caerulea	Native Ginger			100	8		3		4	7		20		5	6								
Poaceae	Andropogon virginicus	Whisky Grass																						
Myrtaceae	Angophora costata	Sydney Red Gum																			1			
Basellaceae	Anredera cordifolia	Madeira Vine																						
Araucariaceae	Araucaria cunninghamii	Hoop Pine																2						
Apocynaceae	Araujia sericifera	Moth Vine				100		2				2		3			1	20						
Fabaceae (Mimosoideae)	Archidendron grandiflorum	Pink Lace Flower																						
Myrtaceae	Archirhodomyrtus beckleri	Rose Myrtle					2		10															
Arecaceae	Archontophoenix cunninghamiana	Bangalow Palm								1	2	5		3	2	3		3	4	20				3
Arecaceae	Archontophoenix sp	Alexandra Palm																						
Myrsinaceae	Ardisia crenata	Coralberry									1					2								
Iridaceae	Aristea ecklonii																							
Asparagaceae	Asparagus aethiopicus	Asparagus Fern																	10					

Flora species recorded

Family	Scientific Name	Common Name	EPBC Act	BC Act	PT_1	PT_2	PT_3	PT_4	PT_5	PT_6	PT_7	PT_8	PT_9	PT_10	PT_11	PT_12	PT_13	PT_14	PT_15	PT_16	PT_17	PT_18	PT_19	PT_20	PT_21	PT_22	PT_23
Asparagaceae	Asparagus asparagoides	Bridal Creeper																		2	2						
Asparagaceae	Asparagus scandens	Asparagus Fern																									
Aspleniaceae	Asplenium australasicum	Bird's Nest Fern																					4				
Araliaceae	Astrotricha latifolia																				1						
Myrtaceae	Austromyrtus acmenoides	Scrub Ironwood								12																	
Asteraceae	Baccharis halimifolia	Groundsel Bush													1												
Myrtaceae	Backhousia citriodora																										
Myrtaceae	Baeckea linifolia	Weeping Baeckea				2																					
Euphorbiaceae	Baloghia inophylla	Brush Bloodwood																									
Restionaceae	Baloskion tetraphyllum					1000																					
Cyperaceae	Baumea acuta						20																				
Cyperaceae	Baumea juncea					1																					
Lauraceae	Beilschmiedia elliptica	Grey Walnut																									
Asteraceae	Bidens pilosa	Cobbler's Pegs																									
Blechnaceae	Blechnum cartilagineum	Gristle Fern								500	500	1	15								50		100	10		501	100
Blechnaceae	Blechnum indicum	Swamp Water Fern				100																					
Phyllanthaceae	Breynia oblongifolia	Coffee Bush					10			2												1				1	1
Acanthaceae	Brunoniella australis	Blue Trumpet																		100							
Crassulaceae	Bryophyllum pinnatum	Resurrection Plant													10												
Arecaceae	Calamus muelleri	Southern Lawyer Cane										2		1					2								
Cunoniaceae	Callicoma serratifolia	Black Wattle												2													
Cunoniaceae	Callicoma sp	Black Wattle															3										
Myrtaceae	Callistemon citrinus	Crimson Bottlebrush																									
Myrtaceae	Callistemon salignus	Willow Bottlebrush				5										100	15										
Dicksoniaceae	Calochlaena dubia	Rainbow Fern			10				50				20	150		50	500		10	500	10	50		500		50	
Bignoniaceae	Campsis radicans	Trumpet Vine					100																				
Brassicaceae	Cardamine hirsuta	Common Bittercress			4																						
Cyperaceae	Carex maculata				100								3														
Cyperaceae	Carex sp	Tall Sedge												20													
Lauraceae	Cassytha filiformis					10																					
Fabaceae (Faboideae)	Castanospermum australe	Black Bean																									
Casuarinaceae	Casuarina glauca	Swamp Oak															2										
Vitaceae	Cayratia clematidea	Native Grape						4	2						3										5		
Ulmaceae	Celtis sinensis	Japanese Hackberry												1													
Apiaceae	Centella asiatica	Indian Pennywort					0										20										

Flora species recorded

Family	Scientific Name	Common Name	EPBC Act	BC Act	PT_24	PT_25	PT_26	PT_27	PT_28	PT_29	PT_30	PT_31	PT_32	PT_33	PT_34	PT_35	PT_36	PT_37	PT_38	PT_39	PT_40	PT_41	PT_42	PT_43
Asparagaceae	Asparagus asparagoides	Bridal Creeper																						
Asparagaceae	Asparagus scandens	Asparagus Fern				3																		
Aspleniaceae	Asplenium australasicum	Bird's Nest Fern																						
Araliaceae	Astrotricha latifolia																							
Myrtaceae	Austromyrtus acmenoides	Scrub Ironwood																						
Asteraceae	Baccharis halimifolia	Groundsel Bush																						
Myrtaceae	Backhousia citriodora																	4						
Myrtaceae	Baeckea linifolia	Weeping Baeckea																						
Euphorbiaceae	Baloghia inophylla	Brush Bloodwood																8						
Restionaceae	Baloskion tetraphyllum																							
Cyperaceae	Baumea acuta																							
Cyperaceae	Baumea juncea																							
Lauraceae	Beilschmiedia elliptica	Grey Walnut											1											
Asteraceae	Bidens pilosa	Cobbler's Pegs																		1				
Blechnaceae	Blechnum cartilagineum	Gristle Fern			20		500	100	100	500	100	100	100		100	500	5			20		1		
Blechnaceae	Blechnum indicum	Swamp Water Fern																						
Phyllanthaceae	Breynia oblongifolia	Coffee Bush				5						1				1					1			
Acanthaceae	Brunoniella australis	Blue Trumpet																						
Crassulaceae	Bryophyllum pinnatum	Resurrection Plant																						
Arecaceae	Calamus muelleri	Southern Lawyer Cane														10						5		
Cunoniaceae	Callicoma serratifolia	Black Wattle												1					5			2		
Cunoniaceae	Callicoma sp	Black Wattle																						
Myrtaceae	Callistemon citrinus	Crimson Bottlebrush																			20	20		
Myrtaceae	Callistemon salignus	Willow Bottlebrush																						
Dicksoniaceae	Calochlaena dubia	Rainbow Fern			2				10	10				20			15	50	1		4	20		
Bignoniaceae	Campsis radicans	Trumpet Vine																						
Brassicaceae	Cardamine hirsuta	Common Bittercress																						
Cyperaceae	Carex maculata																							
Cyperaceae	Carex sp	Tall Sedge																						
Lauraceae	Cassytha filiformis																							
Fabaceae (Faboideae)	Castanospermum australe	Black Bean																1						
Casuarinaceae	Casuarina glauca	Swamp Oak																						
Vitaceae	Cayratia clematidea	Native Grape			3	2		3					5										2	
Ulmaceae	Celtis sinensis	Japanese Hackberry																						
Apiaceae	Centella asiatica	Indian Pennywort																						

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Poaceae	Chloris gayana	Rhodes Grass													20												
Anthericaceae	Chlorophytum comosum	Spider Plant													15												
Cyperaceae	Chorizandra sp																50										
Cyperaceae	Chorizandra cymbaria					incidental																					
Thelypteridaceae	Christella dentata	Binung			1					1			20	5				3	5								
Lauraceae	Cinnamomum camphora	Camphor Laurel			1			1						2		1	3	10	10	2	2	1	3	3			
Vitaceae	Cissus antarctica	Water Vine										2		20	3						1						
Vitaceae	Cissus hypoglauca	Giant Water Vine									1	3	100	50					2					20			6
Pittosporaceae	Citriobatus pauciflorus	Orange Thorn								5			15		8				3		3				1		
Rutaceae	Citrus limon																	1									
Rutaceae	Citrus sp	Finger Lime													1												
Euphorbiaceae	Claoxylon australe	Brittlewood						1		1													1				
Ranunculaceae	Clematis aristata	Old Man's Beard																									
Ranunculaceae	Clematis glycinoides	Headache Vine																									
Ranunculaceae	Clematis sp	Old Man's Beard																									50
Lamiaceae	Clerodendrum floribundum									1											1						2
Lamiaceae	Clerodendrum tomentosum	Hairy Clerodendrum					1								1			1					1				
Rubiaceae	Coffea arabica	Coffee																	1						1		
Araceae	Colocasia esculenta	Taro						4				4			11												
Araceae	Colocasia sp	Taro												2													
Commelinaceae	Commelina cyanea	Native Wandering Jew			5								3	100													
Sterculiaceae	Commersonia bartramia	Brown Kurrajong							1			1															
Asteraceae	Conyza bonariensis	Fleabane					1																				
Asteraceae	Conyza sp																										
Asteliaceae	Cordyline australis	Cabbage Tree																									
Asteliaceae	Cordyline sp	Cabbage Tree													20		2										
Asteliaceae	Cordyline stricta	Narrow-leaved Palm Lily							5	3	5	5	2	4		2			3		10		3			6	4
Myrtaceae	Corymbia intermedia	Pink Bloodwood									7	1			2					2	1						
Euphorbiaceae	Croton verreauxii	Green Native Cascarilla												1					6								
Lauraceae	Cryptocarya glaucescens	Jackwood								15		5									13					3	3
Lauraceae	Cryptocarya micronerua	Murrogun						1	1	1			5	1	1				2		2						
Lauraceae	Cryptocarya obovata	Pepperberry											20													1	
Lauraceae	Cryptocarya rigida	Forest Maple									30											1	3				5
Lauraceae	Cryptocarya sp.1																										
Lauraceae	Cryptocarya triplinervis	Three-veined Cryptocarya																									
Lauraceae	Cryptocarya williwilliana	Small-leaved Laurel																									
Orchidaceae	Cryptostylis erecta	Tartan Tongue Orchid																		10							

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Poaceae	Chloris gayana	Rhodes Grass																				5		
Anthericaceae	Chlorophytum comosum	Spider Plant																						
Cyperaceae	Chorizandra sp																							
Cyperaceae	Chorizandra cymbaria																							
Thelypteridaceae	Christella dentata	Binung										2		incidental			10							
Lauraceae	Cinnamomum camphora	Camphor Laurel				5	1	1	3	3		2	2	5	6	3	4	5	4	3	6		5	10
Vitaceae	Cissus antarctica	Water Vine						20			2	3	5	2		3	5		3				50	
Vitaceae	Cissus hypoglauca	Giant Water Vine					10		8	4		4	1										50	5
Pittosporaceae	Citriobatus pauciflorus	Orange Thorn				1						2			15									
Rutaceae	Citrus limon												1											
Rutaceae	Citrus sp	Finger Lime																						
Euphorbiaceae	Claoxylon australe	Brittlewood								1														
Ranunculaceae	Clematis aristata	Old Man's Beard										1												
Ranunculaceae	Clematis glycinoides	Headache Vine								50														
Ranunculaceae	Clematis sp	Old Man's Beard								1	5													
Lamiaceae	Clerodendrum floribundum										1													
Lamiaceae	Clerodendrum tomentosum	Hairy Clerodendrum							1		1		1			1			2					
Rubiaceae	Coffea arabica	Coffee						3																
Araceae	Colocasia esculenta	Taro											1				1							
Araceae	Colocasia sp	Taro																						
Commelinaceae	Commelina cyanea	Native Wandering Jew												2				1				10	1	
Sterculiaceae	Commersonia bartramia	Brown Kurrajong																						
Asteraceae	Conyza bonariensis	Fleabane															1							
Asteraceae	Conyza sp						1																	
Asteliaceae	Cordyline australis	Cabbage Tree																2						
Asteliaceae	Cordyline sp	Cabbage Tree																						
Asteliaceae	Cordyline stricta	Narrow-leaved Palm Lily			20	3					5		5		3	5			1	3				50
Myrtaceae	Corymbia intermedia	Pink Bloodwood				2				1							4		6					
Euphorbiaceae	Croton verreauxii	Green Native Cascarilla						3					1		1									
Lauraceae	Cryptocarya glaucescens	Jackwood							1	5	14	8	3			2								
Lauraceae	Cryptocarya micronerua	Murrogun			1			10		1	1		6		10									4
Lauraceae	Cryptocarya obovata	Pepperberry																						
Lauraceae	Cryptocarya rigida	Forest Maple			20	5		1		2		1			2									
Lauraceae	Cryptocarya sp.1																		10					
Lauraceae	Cryptocarya triplinervis	Three-veined Cryptocarya			1	1																		
Lauraceae	Cryptocarya williwilliana	Small-leaved Laurel																	1					
Orchidaceae	Cryptostylis erecta	Tartan Tongue Orchid																						

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Sapindaceae	Cupaniopsis anacardioides	Tuckeroo					3																	1			
Cyatheaceae	Cyathea australis	Rough Treefern																					12				
Cyatheaceae	Cyathea cooperi	Straw Treefern																2	1								
Cyatheaceae	Cyathea sp	Rough Treefern											1														
Poaceae	Cymbopogon refractus	Barbed Wire Grass																				1					
Cyperaceae	Cyperus eragrostis	Umbrella Sedge					3																				
Cyperaceae	Cyperus imbecillis																										
Cyperaceae	Cyperus involucratus	Umbrella Plant												1													
Cyperaceae	Cyperus reflexus														4												
Cyperaceae	Cyperus sp																								5		
Cyperaceae	Cyperus trinervis							5																			
Amaranthaceae	Deeringia amaranthoides																										
Fabaceae (Faboideae)	Derris involuta														1												
Fabaceae (Faboideae)	Desmodium brachypodum	Large Tick-trefoil																									
Fabaceae (Faboideae)	Desmodium intortum	Green-leaved Desmodium													2												
Fabaceae (Faboideae)	Desmodium rhytidophyllum																					2	2				
Fabaceae (Faboideae)	Desmodium sp	Thorny Pea																				4					
Phormiaceae	Dianella caerulea	Blue Flax-lily				1				3						5	4							10		2	
Phormiaceae	Dianella caerulea var. producta													2	8												
Convolvulaceae	Dichondra repens	Kidney Weed										100															
Iridaceae	Dietes grandiflora	Wild Iris																									
Poaceae	Digitaria diffusa	Open Summer-grass																									
Poaceae	Digitaria parviflora	Small-flowered Finger Grass																									
Rubiaceae	Diodia sp																										
Dioscoreaceae	Dioscorea sp	Native Yam							5			100			5				1			10	20		3		
Dioscoreaceae	Dioscorea transversa	Native Yam									100		1													20	
Ebenaceae	Diospyros fasciculosa	Grey Ebony																									
Ebenaceae	Diospyros sp	Black Plum																									
Athyriaceae	Diplazium australe	Austral Lady Fern																100									
Sapindaceae	Diploglottis australis	Native Tamarind									1	2		3				2	4		1						4
Sapindaceae	Dodonaea triquetra	Large-leaf Hop-bush																		2							
Blechnaceae	Doodia aspera	Prickly Rasp Fern								100		100		50	500				100		50		500		100	50	100
Blechnaceae	Doodia caudata	Small Rasp Fern											50														
Monimiaceae	Doryphora sassafras	Sassafras												Incidental				1									
Droseraceae	Drosera spatulata															50											
Meliaceae	Dysoxylum mollissimum	Red Bean																					1				
Meliaceae	Dysoxylum rufum	Hairy Rosewood						4				20			1			3	4								

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Sapindaceae	Cupaniopsis anacardioides	Tuckeroo															6	5	1	1	3			
Cyatheaceae	Cyathea australis	Rough Treefern						10											3	10			5	
Cyatheaceae	Cyathea cooperi	Straw Treefern													5									
Cyatheaceae	Cyathea sp	Rough Treefern							2															
Poaceae	Cymbopogon refractus	Barbed Wire Grass																						
Cyperaceae	Cyperus eragrostis	Umbrella Sedge																						
Cyperaceae	Cyperus imbecillis												20											
Cyperaceae	Cyperus involucratus	Umbrella Plant																						
Cyperaceae	Cyperus reflexus																							
Cyperaceae	Cyperus sp																							20
Cyperaceae	Cyperus trinervis																							
Amaranthaceae	Deeringia amaranthoides																							
Fabaceae (Faboideae)	Derris involuta															1								
Fabaceae (Faboideae)	Desmodium brachypodum	Large Tick-trefoil				3																		
Fabaceae (Faboideae)	Desmodium intortum	Green-leaved Desmodium														1								
Fabaceae (Faboideae)	Desmodium rhytidophyllum																							
Fabaceae (Faboideae)	Desmodium sp	Thorny Pea																						
Phormiaceae	Dianella caerulea	Blue Flax-lily				1			8	10	1								3	5	2			1
Phormiaceae	Dianella caerulea var. producta						2	4								1	4							
Convolvulaceae	Dichondra repens	Kidney Weed			50	100						20												
Iridaceae	Dietes grandiflora	Wild Iris																20						
Poaceae	Digitaria diffusa	Open Summer-grass																			100			
Poaceae	Digitaria parviflora	Small-flowered Finger Grass				5																		
Rubiaceae	Diodia sp												50											
Dioscoreaceae	Dioscorea sp	Native Yam						10								10								
Dioscoreaceae	Dioscorea transversa	Native Yam									2									1			1	10
Ebenaceae	Diospyros fasciculosa	Grey Ebony												1										
Ebenaceae	Diospyros sp	Black Plum			20	1																		
Athyriaceae	Diplazium australe	Austral Lady Fern																						
Sapindaceae	Diploglottis australis	Native Tamarind						3		1		5	1		3	3				10				
Sapindaceae	Dodonaea triquetra	Large-leaf Hop-bush																						
Blechnaceae	Doodia aspera	Prickly Rasp Fern			500	50			50		1													
Blechnaceae	Doodia caudata	Small Rasp Fern																						
Monimiaceae	Doryphora sassafras	Sassafras												1										
Droseraceae	Drosera spatulata																							
Meliaceae	Dysoxylum mollissimum	Red Bean									1			1										
Meliaceae	Dysoxylum rufum	Hairy Rosewood											3		10	5	3							

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Elaeocarpaceae	Elaeocarpus grandis	Blue Quandong																									
Elaeocarpaceae	Elaeocarpus reticulatus	Blueberry Ash									1								1	4				4			
Sapindaceae	Elattostachys nervosa	Beetroot Tree																									
Myrsinaceae	Embelia australiana																										
Lauraceae	Endiandra crassiflora	Dorrigo Maple																									
Lauraceae	Endiandra discolor	Rose Walnut										3															
Lauraceae	Endiandra muelleri	Green-leaved Rose Walnut											1														
Lauraceae	Endiandra sieberi	Hard Corkwood																									
Lauraceae	Endiandra sp	White Bark								1										2				2			
Lauraceae	Endiandra virens	White Apple								30																14	
Poaceae	Entolasia marginata	Bordered Panic				10	50																				
Poaceae	Entolasia stricta	Wiry Panic				10														13							
Myrtaceae	Eucalyptus acmenoides	White Mahogany																									
Myrtaceae	Eucalyptus carnea	Thick-leaved Mahogany													1												
Myrtaceae	Eucalyptus fibrosa	Red Ironbark													3												
Myrtaceae	Eucalyptus grandis	Flooded Gum							1			1															
Myrtaceae	Eucalyptus microcarpa	Western Grey Box																									
Myrtaceae	Eucalyptus microcorys	Tallowwood										1								2	1	5	1	2		6	
Myrtaceae	Eucalyptus pilularis	Blackbutt							1						3					2	6	5	3				3
Myrtaceae	Eucalyptus propinqua	Small-fruited Grey Gum										1			6												
Myrtaceae	Eucalyptus resinifera	Red Mahogany																									
Myrtaceae	Eucalyptus robusta	Swamp Mahogany			1	20	8									3											
Myrtaceae	Eucalyptus saligna	Sydney Blue Gum											3														
Myrtaceae	Eucalyptus sclerophylla	Hard-leaved Scribbly Gum																					1				
Myrtaceae	Eucalyptus siderophloia	Grey Ironbark																				1					
Eupomatiaceae	Eupomatia laurina	Bolwarra								15	10	2		1								3	2		2	12	8
Anacardiaceae	Euroschinus falcatus	Ribbonwood																									
Luzuriagaceae	Eustrephus latifolius	Wombat Berry							2	5			1	5	10		3		1	500	20	10	10	20			10
Santalaceae	Exocarpos cupressiformis	Cherry Ballart																									
Moraceae	Ficus coronata	Creek Sandpaper Fig			5				1	2		1	0	15	6			4	10				2				
Moraceae	Ficus spp.																										
Moraceae	Ficus watkinsiana	Strangling Fig												1					1								
Flagellariaceae	Flagellaria indica	Whip Vine																									

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Elaeocarpaceae	Elaeocarpus grandis	Blue Quandong														1								
Elaeocarpaceae	Elaeocarpus reticulatus	Blueberry Ash						2		1		1												
Sapindaceae	Elattostachys nervosa	Beetroot Tree											1											
Myrsinaceae	Embelia australiana										2		1			4								
Lauraceae	Endiandra crassiflora	Dorrigo Maple																						4
Lauraceae	Endiandra discolor	Rose Walnut																						
Lauraceae	Endiandra muelleri	Green-leaved Rose Walnut									3													
Lauraceae	Endiandra sieberi	Hard Corkwood													2	1								50
Lauraceae	Endiandra sp	White Bark																						
Lauraceae	Endiandra virens	White Apple							15															5
Poaceae	Entolasia marginata	Bordered Panic																						
Poaceae	Entolasia stricta	Wiry Panic								5	10						1							
Myrtaceae	Eucalyptus acmenoides	White Mahogany																2						
Myrtaceae	Eucalyptus carnea	Thick-leaved Mahogany																						
Myrtaceae	Eucalyptus fibrosa	Red Ironbark																						
Myrtaceae	Eucalyptus grandis	Flooded Gum					2			2	1	2	2										6	2
Myrtaceae	Eucalyptus microcarpa	Western Grey Box																						4
Myrtaceae	Eucalyptus microcorys	Tallowwood			1							4	2						4		2	4		
Myrtaceae	Eucalyptus pilularis	Blackbutt			4	0				2											20	5	1	
Myrtaceae	Eucalyptus propinqua	Small-fruited Grey Gum			3	5					11													
Myrtaceae	Eucalyptus resinifera	Red Mahogany							6															
Myrtaceae	Eucalyptus robusta	Swamp Mahogany																				5		
Myrtaceae	Eucalyptus saligna	Sydney Blue Gum							1															
Myrtaceae	Eucalyptus sclerophylla	Hard-leaved Scribbly Gum																						
Myrtaceae	Eucalyptus siderophloia	Grey Ironbark				6																		
Eupomatiaceae	Eupomatia laurina	Bolwarra			3	2			3															20
Anacardiaceae	Euroschinus falcatus	Ribbonwood																						
Luzuriagaceae	Eustrephus latifolius	Wombat Berry			5	10		10		2		4	2		2		1				4			
Santalaceae	Exocarpos cupressiformis	Cherry Ballart																			2			
Moraceae	Ficus coronata	Creek Sandpaper Fig					4	5	1	1		1	2	15	2	2	5	3		10			1	10
Moraceae	Ficus spp.																	1	1					
Moraceae	Ficus watkinsiana	Strangling Fig																						
Flagellariaceae	Flagellaria indica	Whip Vine																		1		1		

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Rutaceae	Flindersia brayleyana																										
Cyperaceae	Gahnia aspera	Rough Saw-sedge																									
Cyperaceae	Gahnia clarkei	Tall Saw-sedge			5	1000	100	1							2	500	50										
Cyperaceae	Gahnia sieberi						5																				
Luzuriagaceae	Geitonoplesium cymosum	Scrambling Lily					100				50		10		3	1				1000	10	10	20		2	3	
Gleicheniaceae	Gleichenia dicarpa	Pouched Coral Fern				1											500										
Phyllanthaceae	Glochidion ferdinandi	Cheese Tree												4			2			1							
Fabaceae (Faboideae)	Glycine sp																								1		
Fabaceae (Faboideae)	Glycine tabacina	Variable Glycine																									
Apocynaceae	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush																			1					1	
Haloragaceae	Gonocarpus chinensis						100																				
Haloragaceae	Gonocarpus micranthus															20											
Haloragaceae	Gonocarpus tetragynus	Poverty Raspwort															2										
Haloragaceae	Gonocarpus teucrioides	Germander Raspwort				20							6														
Goodeniaceae	Goodenia hederacea	Ivy Goodenia														10											
Goodeniaceae	Goodenia paniculata					1																					
Proteaceae	Grevillea robusta	Silky Oak																									
Sapindaceae	Guioa semiglauca										1			6					1								1
Araceae	Gymnostachys anceps	Settler's Twine										1			4						3						
Fabaceae (Faboideae)	Hardenbergia violacea	False Sarsaparilla																					1				
Zingiberaceae	Hedychium gardnerianum	Ginger Lily													50												
Sterculiaceae	Heritiera trifoliolata	White Booyong																2									
Dilleniaceae	Hibbertia aspera	Rough Guinea Flower														4											
Dilleniaceae	Hibbertia obtusifolia	Hoary Guinea Flower																						5			
Dilleniaceae	Hibbertia scandens	Climbing Guinea Flower											1		2	15	2					2		1			
Dennstaedtiaceae	Histiopteris incisa	Bat's Wing Fern																									
Euphorbiaceae	Homalanthus populifolius	Bleeding Heart, Native Poplar																1					1			incidental	
Violaceae	Hybanthus stellarioides																										
Apiaceae	Hydrocotyle sp																										
Pittosporaceae	Hymenosporum flavum	Native Frangipani										50															
Acanthaceae	Hypoestes phyllostachya																										
Dennstaedtiaceae	Hypolepis muelleri	Harsh Ground Fern						20					20														

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Rutaceae	Flindersia brayleyana																		3					
Cyperaceae	Gahnia aspera	Rough Saw-sedge			1																			
Cyperaceae	Gahnia clarkei	Tall Saw-sedge																						
Cyperaceae	Gahnia sieberi																							
Luzuriagaceae	Geitonoplesium cymosum	Scrambling Lily			2	20	15			1	5	4					2	10	3	2	10	2		20
Gleicheniaceae	Gleichenia dicarpa	Pouched Coral Fern																						
Phyllanthaceae	Glochidion ferdinandi	Cheese Tree			2	2								1								1		
Fabaceae (Faboideae)	Glycine sp						1																	
Fabaceae (Faboideae)	Glycine tabacina	Variable Glycine																				1		
Apocynaceae	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush															1							
Haloragaceae	Gonocarpus chinensis																							
Haloragaceae	Gonocarpus micranthus																							
Haloragaceae	Gonocarpus tetragynus	Poverty Raspwort																						
Haloragaceae	Gonocarpus teucrioides	Germander Raspwort																						
Goodeniaceae	Goodenia hederacea	Ivy Goodenia																						
Goodeniaceae	Goodenia paniculata																							
Proteaceae	Grevillea robusta	Silky Oak																	10					
Sapindaceae	Guioa semiglauca						1		1							3	6		5					
Araceae	Gymnostachys anceps	Settler's Twine			2	20				1		1	6											
Fabaceae (Faboideae)	Hardenbergia violacea	False Sarsaparilla				1																		
Zingiberaceae	Hedychium gardnerianum	Ginger Lily																		20				10
Sterculiaceae	Heritiera trifoliolata	White Booyong																						
Dilleniaceae	Hibbertia aspera	Rough Guinea Flower																						
Dilleniaceae	Hibbertia obtusifolia	Hoary Guinea Flower																						
Dilleniaceae	Hibbertia scandens	Climbing Guinea Flower					2			1						1				1				
Dennstaedtiaceae	Histiopteris incisa	Bat's Wing Fern										3												
Euphorbiaceae	Homalanthus populifolius	Bleeding Heart, Native Poplar								1							1	1		1				2
Violaceae	Hybanthus stellarioides					2																		
Apiaceae	Hydrocotyle sp																					1	5	20
Pittosporaceae	Hymenosporum flavum	Native Frangipani												1										
Acanthaceae	Hypoestes phyllostachya										5			10										
Dennstaedtiaceae	Hypolepis muelleri	Harsh Ground Fern												3		100								

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Poaceae	Imperata cylindrica	Blady Grass					500								1	8	50			500	20	20	2	500			
Convolvulaceae	Ipomoea cairica	Coastal Morning Glory			3										3												
Convolvulaceae	Ipomoea indica	Morning Glory																						20			
Poaceae	Ischaemum australe					1																					
Sapindaceae	Jagera pseudorhus													2				3	5						5	1	
Sapindaceae	Jagera pseudorhus var. pseudorhus	Foambark Tree																									
Juncaceae	Juncus sp															1											
Juncaceae	Juncus usitatus																50										
Fabaceae (Faboideae)	Kennedia prostrata	Running Postman																			50						
Sapindaceae	Koelreuteria sp																										
Verbenaceae	Lantana camara	Lantana					6	100	500	5	4	50	15	5	10	1	20		50	0		4	5	50	100	3	6
Dryopteridaceae	Lastreopsis acuminata	Shiny Shield Fern																10	5								
Dryopteridaceae	Lastreopsis decomposita	Trim Shield Fern													3												
Dryopteridaceae	Lastreopsis microsora	Creeping Shield Fern																	50						10		
Dryopteridaceae	Lastreopsis munita	Naked Shield Fern																									
Cyperaceae	Lepidosperma forsythii					4																					
Cyperaceae	Lepidosperma laterale	Variable Sword-sedge																				2	3				
Cyperaceae	Lepidosperma sp									1																	
Zamiaceae	Lepidozamia peroffskyana																						20				
Zamiaceae	Lepidozamia sp																										
Myrtaceae	Leptospermum sp																										
Myrtaceae	Leptospermum trinervium	Slender Tea-tree				10																					
Oleaceae	Ligustrum sinense	Small-leaved Privet			1						3		1000	3			10								10	2	
Arecaceae	Linospadix monostachyos	Walking-stick Palm																	1								
Arecaceae	Linospadix sp	Walking-stick Palm																									
Lauraceae	Litsea australis	Brown Bolly Gum									10																
Lauraceae	Litsea reticulata	Bolly Gum												2													
Arecaceae	Livistona chinensis	Chinese fan palm																									
Lobeliaceae	Lobelia anceps																										
Lobeliaceae	Lobelia gibbosa	Tall Lobelia																		1							
Lomandraceae	Lomandra cylindrica																			50							
Lomandraceae	Lomandra filiformis	Wattle Matt-rush									1		3			2					6	2	1	50			
Lomandraceae	Lomandra hystrix														4												
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush											5		1	5					3	2	2	1		5	13
Lomandraceae	Lomandra multiflora	Many-flowered Mat-rush																								4	
Lomandraceae	Lomandra spicata																										

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Poaceae	Imperata cylindrica	Blady Grass				500	10									5								
Convolvulaceae	Ipomoea cairica	Coastal Morning Glory															50					5		
Convolvulaceae	Ipomoea indica	Morning Glory						1							3	3		20	1		10		10	
Poaceae	Ischaemum australe																							
Sapindaceae	Jagera pseudorhus						4	1	1	2	1	1	2			1			4					
Sapindaceae	Jagera pseudorhus var. pseudorhus	Foambark Tree																1						
Juncaceae	Juncus sp																							
Juncaceae	Juncus usitatus																							
Fabaceae (Faboideae)	Kennedia prostrata	Running Postman																						
Sapindaceae	Koelreuteria sp																	3	4					
Verbenaceae	Lantana camara	Lantana			50	50	500	10	1	4	20	5	3	5		15	100	5	3	4	10	20	20	5
Dryopteridaceae	Lastreopsis acuminata	Shiny Shield Fern																						
Dryopteridaceae	Lastreopsis decomposita	Trim Shield Fern											20											
Dryopteridaceae	Lastreopsis microsora	Creeping Shield Fern					50																	
Dryopteridaceae	Lastreopsis munita	Naked Shield Fern													20									
Cyperaceae	Lepidosperma forsythii																							
Cyperaceae	Lepidosperma laterale	Variable Sword-sedge								1														
Cyperaceae	Lepidosperma sp																							
Zamiaceae	Lepidozamia peroffskyana																							
Zamiaceae	Lepidozamia sp														5									
Myrtaceae	Leptospermum sp																				1			
Myrtaceae	Leptospermum trinervium	Slender Tea-tree																						
Oleaceae	Ligustrum sinense	Small-leaved Privet					10		1	1	1			2000		10				1				2
Arecaceae	Linospadix monostachyos	Walking-stick Palm																						
Arecaceae	Linospadix sp	Walking-stick Palm			1																			
Lauraceae	Litsea australis	Brown Bolly Gum												10										
Lauraceae	Litsea reticulata	Bolly Gum												2										
Arecaceae	Livistona chinensis	Chinese fan palm																1	3			1		
Lobeliaceae	Lobelia anceps																							
Lobeliaceae	Lobelia gibbosa	Tall Lobelia																						
Lomandraceae	Lomandra cylindrica																							
Lomandraceae	Lomandra filiformis	Wattle Matt-rush								3														
Lomandraceae	Lomandra hystrix									4					10	2	3							
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush			1	3	5		5			3		10							2	4		2
Lomandraceae	Lomandra multiflora	Many-flowered Mat-rush				4															1			
Lomandraceae	Lomandra spicata										1													

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Myrtaceae	Lophostemon confertus	Brush Box						2	4		2	2	2	2	2				1		1	1				6	
Myrtaceae	Lophostemon suaveolens	Swamp Box					3																				
Loranthaceae	Loranthaceae indeterminate	Mistletoes																									
Loranthaceae	Loranthaceae sp	Mistletoes											1														
Moraceae	Maclura cochinchinensis	Cockspur Thorn							3			4							10						20		
Moraceae	Maclura sp	Cockspur Thorn																			1						
Zamiaceae	Macrozamia sp	Burrawang																				1					
Zamiaceae	Macrozamia spp.																										
Apocynaceae	Marsdenia liisae	Large-flowered Milk Vine								10																	
Apocynaceae	Marsdenia rostrata	Milk Vine										4														1	
Apocynaceae	Marsdenia sp	Doubah																					1				
Myrtaceae	Melaleuca linariifolia	Flax-leaved Paperbark			5	50																					
Myrtaceae	Melaleuca nodosa																										
Myrtaceae	Melaleuca quinquenervia	Broad-leaved Paperbark			100		27																	1			
Myrtaceae	Melaleuca sieberi					50	2																				
Melastomataceae	Melastoma affine	Blue Tongue				1										5											
Rutaceae	Melicope elleryana	Pink-flowered Doughwood															2										
Rutaceae	Melicope micrococca	Hairy-leaved Doughwood																									
Poaceae	Melinis minutiflora	Molasses Grass																									
Poaceae	Melinis repens	Red Natal Grass																									
Apocynaceae	Melodinus acutiflorus											1															
Apocynaceae	Melodinus australis	Southern Melodinus											1														
Polypodiaceae	Microsorum scandens	Fragrant Fern																20									
Sapindaceae	Mischocarpus pyriformis										1																
Loganiaceae	Mitrasacme paludosa															1											
Araceae	Monstera deliciosa	Fruit Salad Plant													5												
Rubiaceae	Morinda jasminoides	Sweet Morinda						4	20	50	500	20	1000	20				4	5	1				20	5	20	100
Moraceae	Morus alba	White Mulberry																									
Rutaceae	Murraya paniculata											1						1						1	1		
Myrsinaceae	Myrsine variabilis																						2				
Lauraceae	Neolitsea australiensis	Green Bolly Gum																									
Lauraceae	Neolitsea dealbata	Hairy-leaved Bolly Gum							1			5		2				2	8					1	2		6
Davalliaceae	Nephrolepis sp	Fishbone Fern													50												
Fabaceae (Mimosoideae)	Neptunia gracilis	Sensitive Plant																				1					
Sapotaceae	Niemeyera whitei	Rusty Plum, Plum Boxwood		V								2						1	3								1
Oleaceae	Notelaea longifolia	Large Mock-olive													1				2	5					3	1	1

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Myrtaceae	Lophostemon confertus	Brush Box			4	2	20	20	2	1	1		7	2		4		4	4		20			3
Myrtaceae	Lophostemon suaveolens	Swamp Box																						
Loranthaceae	Loranthaceae indeterminate	Mistletoes																						
Loranthaceae	Loranthaceae sp	Mistletoes																						
Moraceae	Maclura cochinchinensis	Cockspur Thorn				1					2	1	3			1	20		6	10				1
Moraceae	Maclura sp	Cockspur Thorn																						
Zamiaceae	Macrozamia sp	Burrawang																						
Zamiaceae	Macrozamia spp.																			1				
Apocynaceae	Marsdenia liisae	Large-flowered Milk Vine																						
Apocynaceae	Marsdenia rostrata	Milk Vine																						2
Apocynaceae	Marsdenia sp	Doubah			2																			
Myrtaceae	Melaleuca linariifolia	Flax-leaved Paperbark																						
Myrtaceae	Melaleuca nodosa																					1		
Myrtaceae	Melaleuca quinquenervia	Broad-leaved Paperbark																						
Myrtaceae	Melaleuca sieberi																							
Melastomataceae	Melastoma affine	Blue Tongue																						
Rutaceae	Melicope elleryana	Pink-flowered Doughwood									1													
Rutaceae	Melicope micrococca	Hairy-leaved Doughwood													1									
Poaceae	Melinis minutiflora	Molasses Grass																			100		1000	
Poaceae	Melinis repens	Red Natal Grass																			50			
Apocynaceae	Melodinus acutiflorus																							
Apocynaceae	Melodinus australis	Southern Melodinus																		2				50
Polypodiaceae	Microsorum scandens	Fragrant Fern																						
Sapindaceae	Mischocarpus pyriformis																							
Loganiaceae	Mitrasacme paludosa																							
Araceae	Monstera deliciosa	Fruit Salad Plant																						
Rubiaceae	Morinda jasminoides	Sweet Morinda			10	1	2		1	100	50	100	50	3	50	20								
Moraceae	Morus alba	White Mulberry																						1
Rutaceae	Murraya paniculata											1					1							
Myrsinaceae	Myrsine variabilis											1	1											
Lauraceae	Neolitsea australiensis	Green Bolly Gum													6									
Lauraceae	Neolitsea dealbata	Hairy-leaved Bolly Gum			1					3	6	20	4		10	4				10				
Davalliaceae	Nephrolepis sp	Fishbone Fern																						
Fabaceae (Mimosoideae)	Neptunia gracilis	Sensitive Plant																						
Sapotaceae	Niemeyera whitei	Rusty Plum, Plum Boxwood		V						8			2											
Oleaceae	Notelaea longifolia	Large Mock-olive			3	4					3					1		2	2	20				5

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Oleaceae	Notelaea venosa	Veined Mock-olive									2										1					1	
Ochnaceae	Ochna serrulata	Mickey Mouse Plant										1		4	3				10		1				10		1
Poaceae	Oplismenus aemulus	Australian Basket Grass			6								50	1	1			10	50						5		
Poaceae	Oplismenus imbecillis	Creeping Beard Grass					100	500	500	100	50	500	50	100	20			1000	1000	1000	1000	2	500	20	100	50	100
Asteraceae	Ozothamnus diosmifolius	White Dogwood																									
Bignoniaceae	Pandorea pandorana	Wonga Wonga Vine					2													2	6						
Bignoniaceae	Pandorea pandorana subsp. Pandorana	Wonga Wonga Vine																									
Poaceae	Panicum sp	Giant Panic Grass														20											
Apocynaceae	Parsonsia straminea	Common Silkpod			100	20	2							52		3	3	5		2							
Poaceae	Paspalidium sp																										
Poaceae	Paspalum dilatatum	Paspalum				1														50							
Poaceae	Paspalum distichum	Water Couch																									
Poaceae	Paspalum mandiocanum	Broadleaf Paspalum						10	500				50	100	5	5	1000		50			10	10	500	1000	20	
Poaceae	Paspalum sp									20																	
Passifloraceae	Passiflora aurantia	Blunt-leaved Passionfruit																									
Passifloraceae	Passiflora edulis	Common Passionfruit											1														
Passifloraceae	Passiflora herbertiana																										
Passifloraceae	Passiflora sp	Blunt-leaved Passionfruit															1										
Passifloraceae	Passiflora spp.									1																	
Passifloraceae	Passiflora subpeltata	White Passionflower					0	2	1			10	1		3				3		6		3			1	
Poaceae	Pennisetum purpureum	Elephant Grass													1												
Polygonaceae	Persicaria dichotoma				50									1													
Polygonaceae	Persicaria strigosa																5										
Phyllanthaceae	Phyllanthus gunnii																										
Phyllanthaceae	Phyllanthus similis																					6	10				
Piperaceae	Piper novae-hollandiae	Giant Pepper Vine																									
Pittosporaceae	Pittosporum revolutum	Rough Fruit Pittosporum							20										1				1		2	1	1
Pittosporaceae	Pittosporum undulatum	Sweet Pittosporum												4		1				2	1	7	4				
Polypodiaceae	Platycerium superbum	Staghorn												1				1	1								
Poaceae	Poa labillardierei	Tussock grass																					20				
Poaceae	Poa sieberiana	Snowgrass																				10					
Araliaceae	Polyscias elegans	Celery Wood																									
Araliaceae	Polyscias sambucifolia	Elderberry Panax								1						10											

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Oleaceae	Notelaea venosa	Veined Mock-olive																						
Ochnaceae	Ochna serrulata	Mickey Mouse Plant			1	1				1	20	10		20			50	20	3					
Poaceae	Oplismenus aemulus	Australian Basket Grass						20				2					100							
Poaceae	Oplismenus imbecillis	Creeping Beard Grass			100	1000	100			500	100	500	100	50	100	20	100	100		20	5	10		5
Asteraceae	Ozothamnus diosmifolius	White Dogwood																						
Bignoniaceae	Pandorea pandorana	Wonga Wonga Vine								3														
Bignoniaceae	Pandorea pandorana subsp. Pandorana	Wonga Wonga Vine																	1					
Poaceae	Panicum sp	Giant Panic Grass																						
Apocynaceae	Parsonsia straminea	Common Silkpod																	2					
Poaceae	Paspalidium sp																				1			
Poaceae	Paspalum dilatatum	Paspalum										10										100		
Poaceae	Paspalum distichum	Water Couch																						
Poaceae	Paspalum mandiocanum	Broadleaf Paspalum				3	50	20		1	50				100	100	100	10		500	100	1000	1000	10
Poaceae	Paspalum sp													20										
Passifloraceae	Passiflora aurantia	Blunt-leaved Passionfruit				1																		
Passifloraceae	Passiflora edulis	Common Passionfruit												1						1				
Passifloraceae	Passiflora herbertiana																					1		
Passifloraceae	Passiflora sp	Blunt-leaved Passionfruit																						
Passifloraceae	Passiflora spp.																							
Passifloraceae	Passiflora subpeltata	White Passionflower				5	10	6			4					3	50	10		2	10	2	5	10
Poaceae	Pennisetum purpureum	Elephant Grass																						
Polygonaceae	Persicaria dichotoma																							
Polygonaceae	Persicaria strigosa																							
Phyllanthaceae	Phyllanthus gunnii																							
Phyllanthaceae	Phyllanthus similis					6																		
Piperaceae	Piper novae-hollandiae	Giant Pepper Vine						10																
Pittosporaceae	Pittosporum revolutum	Rough Fruit Pittosporum			4				1	1			1			1								
Pittosporaceae	Pittosporum undulatum	Sweet Pittosporum				1			6	2		2	10		2				3	10				1
Polypodiaceae	Platycerium superbum	Staghorn				1									3	4								
Poaceae	Poa labillardierei	Tussock grass																						
Poaceae	Poa sieberiana	Snowgrass				20																		
Araliaceae	Polyscias elegans	Celery Wood				1										1		3	50					
Araliaceae	Polyscias sambucifolia	Elderberry Panax				50																		

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Rubiaceae	Pomax umbellata	Pomax														2											
Araceae	Pothos longipes																	20									
Lobeliaceae	Pratia puberula	Trailing Pratia																						10			
Lobeliaceae	Pratia purpurascens	Whiteroot			5	2	50			5										10			2		4		2
Asparagaceae	Protasparagus plumosus	Climbing Asparagus Fern													6												
Acanthaceae	Pseuderanthemum variabile	Pastel Flower						10	5	20	5			5	2				10	1	50	5	20	50	10	10	100
Psilotaceae	Psilotum nudum	Skeleton Fork-Fern																									
Dennstaedtiaceae	Pteridium esculentum	Bracken					50																5				
Fabaceae (Faboideae)	Pultenaea villosa	Hairy Bush-pea																									
Polypodiaceae	Pyrrosia rupestris	Rock Felt Fern											1														
Ranunculaceae	Ranunculus inundatus	River Buttercup															4										
Myrtaceae	Rhodamnia rubescens	Scrub Turpentine																			1						
Ripogonaceae	Ripogonum discolor	Prickly Supplejack												1													
Ripogonaceae	Ripogonum fawcettianum	Small Supplejack							4		100	4	1	15					4						5	50	
Phytolaccaceae	Rivina humilis	Coral Berry																									
Rosaceae	Rubus nebulosus	Green-leaved Bramble																									
Rosaceae	Rubus parvifolius	Native Raspberry													2		1						20	4			
Rosaceae	Rubus rosifolius	Rose-leaf Bramble												20													
Poaceae	Sacciolepis indica	Indian Cupscale Grass					20																				
Menispermaceae	Sarcopetalum harveyanum	Pearl Vine											2														
Araliaceae	Schefflera actinophylla	Umbrella Tree													5												
Cunoniaceae	Schizomeria ovata	Crabapple																									
Cyperaceae	Schoenus apogon	Fluke Bogrush					3									15	50										
Flacourtiaceae	Scolopia braunii	Flintwood																									
Selaginellaceae	Selaginella uliginosa	Swamp Selaginella				1																					
Fabaceae (Caesalpinioideae)	Senna floribunda																										
Fabaceae (Caesalpinioideae)	Senna pendula					1	2		10	2	2		20	5		2	2	3	5	100	1		1		4	3	1
Fabaceae (Caesalpinioideae)	Senna pendula var. glabrata				10			3							20							6		50			
Fabaceae (Caesalpinioideae)	Senna septemtrionalis	Arsenic Bush						1																			
Poaceae	Setaria palmifolia	Palm Grass						50				3															
Poaceae	Setaria parviflora						0																				
Poaceae	Setaria pumila	Pale Pigeon Grass													10												
Poaceae	Setaria sphacelata	South African Pigeon Grass																									

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Rubiaceae	Pomax umbellata	Pomax																						
Araceae	Pothos longipes																							
Lobeliaceae	Pratia puberula	Trailing Pratia																						
Lobeliaceae	Pratia purpurascens	Whiteroot				4				1	3			5							3			
Asparagaceae	Protasparagus plumosus	Climbing Asparagus Fern																						
Acanthaceae	Pseuderanthemum variabile	Pastel Flower					20	5		10	20		100			2								6
Psilotaceae	Psilotum nudum	Skeleton Fork-Fern						1																
Dennstaedtiaceae	Pteridium esculentum	Bracken					20								10		3			2	2	5		
Fabaceae (Faboideae)	Pultenaea villosa	Hairy Bush-pea																			2			
Polypodiaceae	Pyrrosia rupestris	Rock Felt Fern																						
Ranunculaceae	Ranunculus inundatus	River Buttercup																						
Myrtaceae	Rhodamnia rubescens	Scrub Turpentine								1							1							
Ripogonaceae	Ripogonum discolor	Prickly Supplejack													20	20								
Ripogonaceae	Ripogonum fawcettianum	Small Supplejack			4		20		6	20	50	20	4		10	10								
Phytolaccaceae	Rivina humilis	Coral Berry																	2					
Rosaceae	Rubus nebulosus	Green-leaved Bramble									1				2	2								
Rosaceae	Rubus parvifolius	Native Raspberry																			1			
Rosaceae	Rubus rosifolius	Rose-leaf Bramble												50										
Poaceae	Sacciolepis indica	Indian Cupscale Grass																						
Menispermaceae	Sarcopetalum harveyanum	Pearl Vine					2		1		1													
Araliaceae	Schefflera actinophylla	Umbrella Tree													1	2	1	1	100	1	1			1
Cunoniaceae	Schizomeria ovata	Crabapple											1											
Cyperaceae	Schoenus apogon	Fluke Bogrush																						
Flacourtiaceae	Scolopia braunii	Flintwood																1	5		1			
Selaginellaceae	Selaginella uliginosa	Swamp Selaginella																						
Fabaceae (Caesalpinioideae)	Senna floribunda									1														
Fabaceae (Caesalpinioideae)	Senna pendula				5	10	15	6	5	2	1	2		20			20	1	3	1	10	20	20	50
Fabaceae (Caesalpinioideae)	Senna pendula var. glabrata																							
Fabaceae (Caesalpinioideae)	Senna septemtrionalis	Arsenic Bush																						
Poaceae	Setaria palmifolia	Palm Grass															3							
Poaceae	Setaria parviflora																							
Poaceae	Setaria pumila	Pale Pigeon Grass																						
Poaceae	Setaria sphacelata	South African Pigeon Grass																				100		

Flora species recorded

Family	Scientific Name	Common Name	EPBC Act	BC Act	PT_1	PT_2	PT_3	PT_4	PT_5	PT_6	PT_7	PT_8	PT_9	PT_10	PT_11	PT_12	PT_13	PT_14	PT_15	PT_16	PT_17	PT_18	PT_19	PT_20	PT_21	PT_22	PT_23
Malvaceae	Sida rhombifolia	Paddy's Lucerne							1												1						
Elaeocarpaceae	Sloanea australis	Maiden's Blush											1					1									
Elaeocarpaceae	Sloanea woollsii	Yellow Carabeen																									
Smilacaceae	Smilax australis	Lawyer Vine							2	2	5		50	15	2			3		20	20			3	3	3	3
Smilacaceae	Smilax glyciphylla	Sweet Sarsparilla				1				10			10			3				100	6			10		2	10
Solanaceae	Solanum campanulatum													2													
Solanaceae	Solanum mauritianum	Wild Tobacco Bush							1	1							3										
Solanaceae	Solanum nigrum	Black-berry Nightshade			1														1								
Asteraceae	Sonchus oleraceus	Common Sowthistle					1																				
Poaceae	Sorghum leiocladum	Wild Sorghum																									
Proteaceae	Stenocarpus sinuatus	Firewheel Tree																									
Poaceae	Stenotaphrum secundatum	Buffalo Grass														2											
Menispermaceae	Stephania japonica	Snake vine								5		20	10	3	1		3				20	4	3	1	4	3	10
Arecaceae	Syagrus romanzoffiana	Cocos Palm													3						1	1		2	3		
Symplocaceae	Symplocos stawellii	White Hazelwood						1																			
Symplocaceae	Symplocos thwaitesii	Buff Hazelwood																	1								
Myrtaceae	Syncarpia glomulifera	Turpentine								3	5				1					2	5	1	2			5	
Myrtaceae	Syncarpia sp	Turpentine																						2			
Meliaceae	Synoum glandulosum	Scentless Rosewood								3	1	10			1					1	2	15	9	10		6	8
Myrtaceae	Syzygium australe	Brush Cherry																	2								
Myrtaceae	Syzygium oleosum	Blue Lilly Pilly																									
Myrtaceae	Syzygium smithii										1																
Myrtaceae	Syzygium sp																										
Apocynaceae	Tabernaemontana pandacaqui	Banana Bush								1		2	4						2						2	1	
Vitaceae	Tetrastigma nitens																										
Poaceae	Themeda australis	Kangaroo Grass												1													
Poaceae	Themeda triandra						1									100				20							
Commelinaceae	Tradescantia fluminensis	Wandering Jew						20						50				100							10		
Uvulariaceae	Tripladenia cunninghamii																		5		20	20	20		5		8
Myrtaceae	Tristaniopsis laurina	Kanooka																									
Ericaceae	Trochocarpa laurina	Tree Heath													1	1					2		1			1	1
Moraceae	Trophis scandens	Burny Vine							3				2	15	2			5									1
Apocynaceae	Tylophora paniculata	Thin-leaved Tylophora																									
Asteraceae	Vernonia cinerea																										
Violaceae	Viola banksii												5	10							1		500				
Violaceae	Viola hederacea	Ivy-leaved Violet			500																						

Flora species recorded

Family	Scientific Name	Common Name	EPBC Act	BC Act	PT_24	PT_25	PT_26	PT_27	PT_28	PT_29	PT_30	PT_31	PT_32	PT_33	PT_34	PT_35	PT_36	PT_37	PT_38	PT_39	PT_40	PT_41	PT_42	PT_43
Malvaceae	Sida rhombifolia	Paddy's Lucerne																			1		5	
Elaeocarpaceae	Sloanea australis	Maiden's Blush																						
Elaeocarpaceae	Sloanea woollsii	Yellow Carabeen													2									
Smilacaceae	Smilax australis	Lawyer Vine			20	10	10	4		2	5	1	1	2		2	2	1		4				10
Smilacaceae	Smilax glyciphylla	Sweet Sarsparilla				1	10		6	500	1		1	1	2	7			2			1	1	1
Solanaceae	Solanum campanulatum																							
Solanaceae	Solanum mauritianum	Wild Tobacco Bush												1			5							
Solanaceae	Solanum nigrum	Black-berry Nightshade					1										1				1		1	
Asteraceae	Sonchus oleraceus	Common Sowthistle																						
Poaceae	Sorghum leiocladum	Wild Sorghum																				20		
Proteaceae	Stenocarpus sinuatus	Firewheel Tree													1			10						
Poaceae	Stenotaphrum secundatum	Buffalo Grass																						
Menispermaceae	Stephania japonica	Snake vine			20	50		3	1	4	3	5	2	5			5			2	1			5
Arecaceae	Syagrus romanzoffiana	Cocos Palm			1	2													4		4	1		
Symplocaceae	Symplocos stawellii	White Hazelwood																						
Symplocaceae	Symplocos thwaitesii	Buff Hazelwood																						
Myrtaceae	Syncarpia glomulifera	Turpentine			2	6			4	5						3								
Myrtaceae	Syncarpia sp	Turpentine																						
Meliaceae	Synoum glandulosum	Scentless Rosewood			5	8	7	4	2	3	6	50	10		10	10	10	4	10	3	1	2		10
Myrtaceae	Syzygium australe	Brush Cherry																1						
Myrtaceae	Syzygium oleosum	Blue Lilly Pilly									4													
Myrtaceae	Syzygium smithii																							
Myrtaceae	Syzygium sp															4								
Apocynaceae	Tabernaemontana pandacaqui	Banana Bush			1	1	4								5	2	1			5				
Vitaceae	Tetrastigma nitens																	50		1				
Poaceae	Themeda australis	Kangaroo Grass																						
Poaceae	Themeda triandra					50																		
Commelinaceae	Tradescantia fluminensis	Wandering Jew						10								1								
Uvulariaceae	Tripladenia cunninghamii				100	0		20	1	20		20												
Myrtaceae	Tristaniopsis laurina	Kanooka																1	4	1				
Ericaceae	Trochocarpa laurina	Tree Heath			1	0				1					1									
Moraceae	Trophis scandens	Burny Vine					3			2					1	1	20							
Apocynaceae	Tylophora paniculata	Thin-leaved Tylophora								1														
Asteraceae	Vernonia cinerea									1														
Violaceae	Viola banksii																							
Violaceae	Viola hederacea	Ivy-leaved Violet																						

Flora species recorded

Family	Scientific Name	Common Name	EPBC Act	BC Act	PT_1	PT_2	PT_3	PT_4	PT_5	PT_6	PT_7	PT_8	PT_9	PT_10	PT_11	PT_12	PT_13	PT_14	PT_15	PT_16	PT_17	PT_18	PT_19	PT_20	PT_21	PT_22	PT_23
Thymelaeaceae	Wikstroemia indica																										
Monimiaceae	Wilkiea huegeliana	Veiny Wilkiea						2			15	5	20	8	2			5	1				1			5	6
Monimiaceae	Wilkiea sp	Smooth Wilkiea								5																	
Xanthorrhoeaceae	Xanthorrhoea macronema																					1					
Xanthorrhoeaceae	Xanthorrhoea sp																						2				
Rutaceae	Zieria smithii	Sandfly Zieria														1											

Flora species recorded

Family	Scientific Name	Common Name	EPBC Act	BC Act	PT_24	PT_25	PT_26	PT_27	PT_28	PT_29	PT_30	PT_31	PT_32	PT_33	PT_34	PT_35	PT_36	PT_37	PT_38	PT_39	PT_40	PT_41	PT_42	PT_43
Thymelaeaceae	Wikstroemia indica																				1			
Monimiaceae	Wilkiea huegeliana	Veiny Wilkiea						2	2	6			10		3	4	1			1				51
Monimiaceae	Wilkiea sp	Smooth Wilkiea			10																			
Xanthorrhoeaceae	Xanthorrhoea macronema																							
Xanthorrhoeaceae	Xanthorrhoea sp																							
Rutaceae	Zieria smithii	Sandfly Zieria																						

Fauna species recorded within the study area

Below is a list of fauna species recorded from the study area during the assessment.

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

Notes to table:

Conservation status – EPBC Act: CR – Critically Endangered EN – Endangered VU – Vulnerable Mi - Migratory	**Conservation status – TSC Act:** E1 – endangered species E2 – endangered population E4 – presumed extinct E4A – critically endangered V – vulnerable
Observation Codes E – Nest/roost F – tracks, scratchings FB - burrow O – Observed OW – Observed and heard call	**Observation Codes** P - Scats T – Trapped or netted U – Ultrasonic recording W – Heard call

Recorded fauna

Fauna group	Common Name	Scientific name	Status		Ecosystem credit species or species credit species?	Observation type
			BC Act	EPBC Act		
Amphibian	Tusked Frog	*Adelotus brevis*			n/a	W
Amphibian	Common Eastern Froglet	*Crinia signifera*			n/a	W, O
Amphibian	Brown-striped Frog	*Limnodynastes peronii*			n/a	W
Amphibian	Green-thighed Frog	*Litoria brevipalmata*	V		Species	W, O
Amphibian	Green Tree Frog	*Litoria caerulea*			n/a	W, O
Amphibian	Bleating Tree Frog	*Litoria dentata*			n/a	W
Amphibian	Eastern Dwarf Tree Frog	*Litoria fallax*			n/a	W, O
Amphibian	Dainty Green Tree Frog	*Litoria gracilenta*			n/a	W, O
Amphibian	Peron's Tree Frog	*Litoria peronii*			n/a	W
Amphibian	Revealed Frog	*Litoria revelata*			n/a	W
Amphibian	Desert Tree Frog	*Litoria rubella*			n/a	W
Amphibian	Tyler's Tree Frog	*Litoria tyleri*			n/a	W
Amphibian	Verreaux's Frog	*Litoria verreauxii*			n/a	W
Amphibian	Great Barred Frog	*Mixophyes fasciolatus*			n/a	W, O
Amphibian	Giant Barred Frog	*Mixophyes iteratus*	E1	EN	Species	W
Amphibian	Red-backed Toadlet	*Pseudophryne coriacea*			n/a	W
Amphibian	Large Toadlet	*Pseudophryne major*			n/a	W
Amphibian	Northern Toadlet	*Uperoleia borealis*			n/a	W
Amphibian	Smooth Toadlet	*Uperoleia laevigata*			n/a	W
Aves	Brown Thornbill	*Acanthiza pusilla*			n/a	
Aves	Brown Goshawk	*Accipiter fasciatus*			n/a	
Aves	Grey Goshawk	*Accipiter novaehollandiae*			n/a	
Aves	Australian Owlet-	*Aegotheles*			n/a	

Fauna group	Common Name	Scientific name	Status		Ecosystem credit species or species credit species?	Observation type
			BC Act	EPBC Act		
	nightjar	*cristatus*				
Aves	Green Catbird	*Ailuroedus crassirostris*			n/a	
Aves	Australian Brush-turkey	*Alectura lathami*			n/a	
Aves	Pale-vented Bush-hen	*Amaurornis moluccana*	V		Ecosystem	
Aves	Pacific Black Duck	*Anas superciliosa*			n/a	OW
Aves	Pacific Black Duck Mallard Hybrid	*Anas superciliosa x platyrhynchos*			n/a	O
Aves	Red Wattlebird	*Anthochaera carunculata*			n/a	O
Aves	Cattle Egret	*Ardea ibis*			n/a	O
Aves	Fan-tailed Cuckoo	*Cacomantis flabelliformis*			n/a	O, W
Aves	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*			n/a	O
Aves	Pheasant Coucal	*Centropus phasianinus*			n/a	O
Aves	Azure Kingfisher	*Ceyx azureus*			n/a	O
Aves	Horsfield's Bronze-Cuckoo	*Chalcites basalis*			n/a	O
Aves	Australian Wood Duck	*Chenonetta jubata*			n/a	O
Aves	White-headed Pigeon	*Columba leucomela*			n/a	O
Aves	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			n/a	O
Aves	White-throated Treecreeper	*Cormobates leucophaea*			n/a	O
Aves	Brown Quail	*Coturnix ypsilophora*			n/a	O
Aves	Australian Magpie	*Cracticus tibicen*			n/a	O
Aves	Laughing Kookaburra	*Dacelo novaeguineae*			n/a	OW
Aves	Wandering Whistling-Duck	*Dendrocygna arcuata*			n/a	O
Aves	Spangled Drongo	*Dicrurus bracteatus*			n/a	O
Aves	Black-shouldered Kite	*Elanus axillaris*			n/a	O
Aves	Blue-faced Honeyeater	*Entomyzon cyanotis*			n/a	O
Aves	Eastern Yellow Robin	*Eopsaltria australis*			n/a	O
Aves	Dollarbird	*Eurystomus orientalis*			n/a	O
Aves	Eurasian Coot	*Fulica atra*			n/a	O
Aves	Dusky Moorhen	*Gallinula tenebrosa*			n/a	O
Aves	Green-backed Gerygone	*Gerygone chloronota*			n/a	O
Aves	Magpie-lark	*Grallina cyanoleuca*			n/a	O
Aves	White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V		Ecosystem*	O
Aves	Welcome	*Hirundo neoxena*			n/a	O

Fauna group	Common Name	Scientific name	Status		Ecosystem credit species or species credit species?	Observation type
			BC Act	EPBC Act		
	Swallow					
Aves	Yellow-faced Honeyeater	*Lichenostomus chrysops*			n/a	OW
Aves	Brown Honeyeater	*Lichmera indistincta*			n/a	O
Aves	Chestnut-breasted Mannikin	*Lonchura castaneothorax*			n/a	O
Aves	Square-tailed Kite	*Lophoictinia isura*	V		Ecosystem*	O
Aves	Topknot Pigeon	*Lopholaimus antarcticus*			n/a	O
Aves	Brown Cuckoo-Dove	*Macropygia amboinensis*			n/a	OW
Aves	Superb Fairy-wren	*Malurus cyaneus*			n/a	O
Aves	Red-backed Fairy-wren	*Malurus melanocephalus*			n/a	O
Aves	Noisy Miner	*Manorina melanocephala*			n/a	OW
Aves	Lewin's Honeyeater	*Meliphaga lewinii*			n/a	OW
Aves	Little Pied Cormorant	*Microcarbo melanoleucos*			n/a	O
Aves	Black-faced Monarch	*Monarcha melanopsis*		Mi	n/a	O
Aves	Scarlet Honeyeater	*Myzomela sanguinolenta*			n/a	OW
Aves	Red-browed Finch	*Neochmia temporalis*			n/a	O
Aves	Southern Boobook	*Ninox novaeseelandiae*			n/a	W
Aves	Olive Whistler	*Pachycephala olivacea*	V		Ecosystem	OW
Aves	Golden Whistler	*Pachycephala pectoralis*			n/a	OW
Aves	Rufous Whistler	*Pachycephala rufiventris*			n/a	OW
Aves	Common Bronzewing	*Phaps chalcoptera*			n/a	OW
Aves	Noisy Friarbird	*Philemon corniculatus*			n/a	OW
Aves	Crimson Rosella	*Platycercus elegans*			n/a	OW
Aves	Eastern Rosella	*Platycercus eximius*			n/a	OW
Aves	Tawny Frogmouth	*Podargus strigoides*			n/a	O
Aves	Purple Swamphen	*Porphyrio porphyrio*			n/a	OW
Aves	Eastern Whipbird	*Psophodes olivaceus*			n/a	W
Aves	Satin Bowerbird	*Ptilonorhynchus violaceus*			n/a	O
Aves	Grey Fantail	*Rhipidura albiscapa*			n/a	OW
Aves	Willie Wagtail	*Rhipidura leucophrys*			n/a	OW

Fauna group	Common Name	Scientific name	Status		Ecosystem credit species or species credit species?	Observation type
			BC Act	EPBC Act		
Aves	Rufous Fantail	*Rhipidura rufifrons*		Mi	n/a	O
Aves	White-browed Scrubwren	*Sericornis frontalis*			n/a	OW
Aves	Regent Bowerbird	*Sericulus chrysocephalus*			n/a	
Aves	Australasian Figbird	*Sphecotheres vieilloti*			n/a	OW
Aves	Pied Currawong	*Strepera graculina*			n/a	OW
Aves	Grey Currawong	*Strepera versicolor*			n/a	O
Aves	Spotted Turtle-Dove	*Streptopelia chinensis*			n/a	OW
Aves	Spectacled Monarch	*Symposiachrus trivirgatus*		Mi	n/a	O
Aves	Australasian Grebe	*Tachybaptus novaehollandiae*			n/a	O
Aves	Australian White Ibis	*Threskiornis molucca*			n/a	O
Aves	Straw-necked Ibis	*Threskiornis spinicollis*			n/a	O
Aves	Sacred Kingfisher	*Todiramphus sanctus*			n/a	W, O
Aves	Rainbow Lorikeet	*Trichoglossus haematodus*			n/a	W, O
Aves	Masked Lapwing	*Vanellus miles*			n/a	W, O
Aves	Silvereye	*Zosterops lateralis*			n/a	O
FISH	Longfin Eel	*Anguilla reinhardtii*			n/a	O
INS	Monarch Butterfly	*Danaus plexippus*		Mi	n/a	O
INS	Common Grass Yellow	*Eurema hecabe hecabe*			n/a	O
INS	Coastal Petaltail	*Petalura litorea*	E1		Species	FB
Mammal	White-striped Freetail-bat	*Austronomous australis*				U
Mammal	White-striped Freetail-bat	*Austronomus australis*			n/a	T
Mammal	Chital Deer	*Axis axis*			n/a	W
Mammal	Dingo, domestic dog	*Canis lupus*			n/a	W, O
Mammal	Large-eared Pied Bat	*Chalinolobus dwyeri*	V	VU	Species/Ecosystem	U (low conf.)
Mammal	Gould's Wattled Bat	*Chalinolobus gouldii*				T, U
Mammal	Chocolate Wattled Bat	*Chalinolobus morio*				U
Mammal	Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V		Ecosystem	U
Mammal	Fawn-footed Melomys	*Melomys cervinipes*				T
Mammal	Little Bentwing-bat	*Miniopterus australis*	V		n/a	O, U
Mammal	Little Bentwing-bat	*Miniopterus australis*	V		Species/Ecosystem	T, U
Mammal	Eastern	*Miniopterus*	V		Species/Ecosystem	U

Fauna group	Common Name	Scientific name	Status		Ecosystem credit species or species credit species?	Observation type
			BC Act	EPBC Act		
	Bentwing-bat	*schreibersii oceanensis*				
Mammal	Eastern Freetail-bat	*Mormopterus norfolkensis*	V		Ecosystem	U
Mammal		*Mormopterus ridei*				U
Mammal	Southern Myotis	*Myotis macropus*	V		Species/Ecosystem	O, U, T
Mammal	Gould's long-eared Bat	*Nyctophilus gouldi*				T
Mammal	Long-eared bat	*Nyctophilus* sp				U
Mammal	Sugar Glider	*Petaurus breviceps*			Species	T
Mammal	glider	*Petaurus* sp.			n/a	O
Mammal	Koala	*Phascolarctos cinereus*	V	VU	n/a	O
Mammal	Long-nosed Bandicoot	*Potorous tridactylus*			Species/Ecosystem	O,W,F, P
Mammal	Common Ringtail Possum	*Pseudocheirus peregrinus*			n/a	O
Mammal	Black Flying-fox	*Pteropus alecto*			n/a	O
Mammal	Grey-headed Flying-fox	*Pteropus poliocephalus*	V	VU	n/a	O
Mammal	Little Red Flying-fox	*Pteropus scapulatus*			Ecosystem*	O
Mammal	Bush Rat	*Rattus fuscipes*			n/a	O
Mammal	Eastern Horseshoe-bat	*Rhinolophus megaphyllus*				U
Mammal	Yellow-bellied Sheathtail-bat	*Saccolaimus falviventris*	V		Ecosystem	U
Mammal	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Ecosystem	U
Mammal		*Scotorepens orion*				T
Mammal	Short-eared Possum	*Trichosurus caninus*			n/a	T
Mammal	Common Brushtail Possum	*Trichosurus vulpecula*			n/a	T
Mammal	Large Forest Bat	*Vespadelus darlingtoni*				U
Mammal	Eastern Forest Bat	*Vespadelus pumilis*				T, U
Mammal	Little Forest Bat	*Vespadelus vulturnus*				U
Mammal	Swamp Wallaby	*Wallabia bicolor*			n/a	O
Reptile	Land Mullet	*Bellatorias major*			n/a	O
Reptile	Long-Necked Turtle Species Unknown	*Chelodina sp.*			n/a	O
Reptile	Unidentified Emydura	*Emydura sp.*			n/a	O
Reptile	Eastern Water Dragon	*Intellagama lesueurii*			n/a	O
Reptile	Dark-flecked Garden Sunskink	*Lampropholis delicata*			n/a	O
Reptile	Red-bellied Black Snake	*Pseudechis porphyriacus*			n/a	O
Reptile	Eastern Brown Snake	*Pseudonaja textilis*			n/a	O

Fauna group	Common Name	Scientific name	Status		Ecosystem credit species or species credit species?	Observation type
			BC Act	EPBC Act		
Reptile	Common Scaly-foot	*Pygopus lepidopodus*			n/a	O
Reptile	Blackish Blind Snake	*Ramphotyphlops nigrescens*			n/a	O
Reptile	Weasel Skink	*Saproscincus mustelinus*			n/a	O
Reptile	Eastern Blue-tongue	*Tiliqua scincoides*			n/a	O

Appendix B – Habitat assessment table

Likelihood of occurrence criteria

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey
High	It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (ie. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10km) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration.
Moderate	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (ie. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10km). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (ie. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
Negligible	Suitable habitat is absent from the study area.

Flora habitat assessment

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Acacia chrysotricha	Newry Golden Wattle		E1	BioBanking	Species	An understorey species on rainforest edges and in wet or dry eucalypt forest in steep narrow gullies on quartzite soils. Newry Golden Wattle is relatively short-lived. The seeds which remain in the soil require heat from fire to induce germination.	Negligible	Present in the IBRA subregion. No records within 10km of the study area. The species is restricted to an area south of Bellingen on the NSW north coast. Study area outside known geographic range.
Acronychia littoralis	Scented Acronychia	EN	E1	OEH PMST	Species	Scented Acronychia occurs in transition zones between littoral rainforest and swamp sclerophyll forest; between littoral and coastal cypress pine communities; and margins of littoral forest. The species mainly occurs within 2km from the coast on sandy soil.	Low	Present in IBRA subregion and recorded within 10km of the study area. Found in transition zones between littoral rainforest and swamp sclerophyll forest. This particular habitat type is absent from the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Alexfloydia repens	Floyd's Grass		E1	BioBanking OEH	Species	Floyd's Grass occurs predominantly in swamp sclerophyll forest where Swamp Oak *Casuarina glauca* and/or Broad-leaved Paperbark *Melaleuca quinquenervia* are usually the dominant canopy species. The plant favours the moderate to high sunlight levels in this habitat. High salinity levels are not tolerated by Floyd's Grass. The majority of its distribution is between 1m and 2m above the mean tide level, i.e. immediately above the zone of king tide inundation. The most vigorous and extensive examples of Floyd's Grass are found on rich alluvial floodplain terraces. However, the grass will grow on a wide variety of substrates, e.g. it is found on two coastal headlands. The majority of Floyd's Grass is found in riparian zones within 5km of the coast. However, it reaches inland along Warrell Ck as far as Macksville (over 7km from the coast).	Medium	Present in IBRA subregion and has been recorded within 500m of the study area. Occurs in swamp sclerophyll forests with Swamp Oak or broad-leaved Paperbark. Areas of this habitat type were confirmed to be present in the study area.
Allocasuarina defungens	Dwarf Heath Casuarina	EN	E1	OEH PMST	Species	Dwarf Heath Casuarina grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. The species also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. Grows mainly in tall heath on sand. Habitat confirmed to be absent from the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Arthraxon hispidus	Hairy Jointgrass	VU	V	BioBanking OEH PMST	Species	Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. The species is found in or on the edges of rainforest and wet eucalypt forest, often near creeks or swamps. Areas of this habitat type were confirmed to be present in the study area.
Asperula asthenes	Trailing Woodruff	VU	V	BioBanking	Species	Occurs in damp sites, often along river banks.	Low	Present in the IBRA subregion, with two records in the far south-west. No records within 10km of the study area. The study area is outside known geographic distribution for the species.
Boronia umbellata	Orara Boronia	VU	V	OEH PMST	Species	This Boronia grows as an understorey shrub in and around gullies in wet open forest. It appears to regenerate well after disturbance, but it is not known whether prolonged or repeated disturbance affects long-term persistence.	Medium	Present in IBRA subregion and recorded within 10km of the study area. This species grows as an understorey shrub in and around gullies in wet open forest. Areas of this habitat type were confirmed to be present in the study area.
Chamaesyce psammogeton	Sand Spurge		E1	OEH	Species	Grows on fore-dunes, pebbly strandlines and exposed headlands, often with Spinifex *Spinifex sericeus* and Prickly Couch *Zoysia macrantha*. Flowering recorded in spring and summer. Sand Spurge seeds float, so some dispersal between beaches may occur.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. Species inhabits fore-dunes, pebbly strandlines and exposed headlands. Habitat confirmed to be absent from the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Corynocarpus rupestris* subsp. *rupestris	Glenugie Karaka	VU	V	OEH PMST	Species	Dry rainforest on steep basalt boulder slopes. Soil is scarce but relatively high in nutrients and very well-drained. Fire is generally excluded by the rocky terrain and absence of ground litter.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. Inhabits dry rainforest on steep basalt boulder slopes. Habitat confirmed to be absent from the study area.
Cryptocarya foetida	Stinking Cryptocarya	VU	V	PMST	Species	Found in littoral, warm temperate and subtropical rainforest, wet sclerophyll forest and Camphor Laurel forest usually on sandy soils, but mature trees are also known on basalt soils. The seeds are readily dispersed by fruit-eating birds, and seedlings and saplings have been recorded from other habitats where they are unlikely to develop to maturity. Though seedlings can be fairly numerous, few mature trees are known.	Negligible	Not present or predicted to occur in the in IBRA subregion. Study area is outside the known geographic range.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Cryptostylis hunteriana	Leafless Tongue Orchid	VU	V	PMST	Species	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum *Eucalyptus sclerophylla*, Silvertop Ash *Eucalyptus. sieberi*, Red Bloodwood *Corymbia gummifera* and Black Sheoak *Allocasuarina littoralis*; appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid *Cryptostylis subulata* and the Tartan Tongue Orchid *Cryptostylis erecta*. Little is known about the ecology of the species; being leafless it is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material.	Negligible	Not present or predicted to occur in the in IBRA subregion. Study area is outside the known geographic range.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Cynanchum elegans	White-flowered Wax Plant	EN	E1	BioBanking PMST	Species	The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree *Leptospermum laevigatum*, Coastal Banksia *Banksia integrifolia* subsp. *integrifolia coastal scrub*; Forest Red Gum *Eucalyptus tereticornis* aligned open forest and woodland; Spotted Gum *Corymbia maculata* aligned open forest and woodland; and Bracelet Honeymyrtle *Melaleuca armillaris* scrub to open scrub.. Plants are capable of suckering from rootstock in response to occasional slashing or grazing. The fire response of the species is unknown although it has been known to reshoot following fire.	Low	Present in IBRA subregion, with two records in the far south-west. No records within 10km of the study area. Usually occurs on the edge of dry rainforest vegetation, littoral rainforest, Forest Red Gum aligned open forest and woodland; Spotted Gum aligned open forest and woodland. Marginal areas of this habitat type were confirmed to be present in the study area, but no records within 10km.
Dendrobium melaleucaphilum	Spider orchid		E1	BioBanking	Species	Grows frequently on Prickly-leaved paperbark *Melaleuca styphelioides*, less commonly on rainforest trees or on rocks in coastal districts.	Low	Present in IBRA subregion. No records within 10km of the study area. Grows frequently on *Melaleuca styphelioides*, less commonly on rainforest trees or on rocks. Marginal habitat may be present in limited parts of the study area, but no records within 10km.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Diospyros mabacea	Red-fruited Ebony	EN	E1	OEH PMST	Species	Usually grows as an understorey tree in lowland subtropical rainforest, often close to rivers. Soils are generally basalt-derived or alluvial.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. Usually grows as an understorey tree in lowland subtropical rainforest, often close to rivers. Limited areas of subtropical rainforest habitat are available in the study area.
Diploglottis campbellii	Small-leaved Tamarind	EN	E1	OEH PMST	Species	Confined to the warm subtropical rainforests of the NSW-Queensland border lowlands and adjacent low ranges. The forest types in which the species occurs vary from lowland subtropical rainforest to drier subtropical rainforest with a Brush Box open overstorey. Occurs on basalt-derived soils and also on poorer soils such as those derived from quartz monzonite.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. Species is confined to the warm subtropical rainforests of the NSW-Queensland border lowlands and adjacent low ranges. The forest types in which the species occurs vary from lowland subtropical rainforest to drier subtropical rainforest with a Brush Box open over-storey. Limited areas of subtropical rainforest habitat are available in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Diuris praecox	Rough Double Tail	VU	V	OEH	Species	Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year.	Low	Present in IBRA subregion and has been recorded within 500m of the study area. Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Areas of this habitat type were confirmed to be present in the study area, but the most recent record in relation to the study area is more than 50 years old.
Diuris* sp. aff. *chrysantha	Byron Bay Diuris		E1	OEH	Species	Occurs in low-growing grassy heath on clay soil.	Negligible	Present in IBRA subregion, with a single record within 10km of the study area. Occurs in low-growing grassy heath on clay soil. Habitat confirmed to be absent from the study area.
Eidothea hardeniana	Nightcap Oak	CE	E1	OEH	Species	The species occurs in upland warm temperate rainforest, usually near creeks.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. The species occurs in upland warm temperate rainforest, usually near creeks. Limited areas of this habitat type were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Eleocharis tetraquetra	Square-stemmed Spike-rush		E1	BioBanking OEH	Species	Found in damp locations on stream edges and in and on the margins of freshwater swamps.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. The species is found in damp locations on stream edges and in and on the margins of freshwater swamps. Limited areas of this habitat type were confirmed to be present in the study area.
Endiandra floydii	Crystal Creek Walnut	EN	E1	OEH PMST	Species	Warm temperate, subtropical rainforest or wet sclerophyll forest with Brush Box overstorey, and in and Camphor Laurel forest. The species can occur in disturbed and regrowth sites. The species generally prefers sheltered locations however it has been recorded on ridgelines, slopes, gullies and creek flats. It occurs from sea level up to 430 m above sea level. From one recorded fire exposure event the species was found to resprout from the root stock following the fire, the main trunk was killed by the fire.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. The species occurs in warm temperate, subtropical rainforest or wet sclerophyll forest with Brush Box over-storey. The species can occur in disturbed and regrowth sites. Areas of this habitat type were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Endiandra hayesii	Rusty Rose Walnut	VU	V	OEH PMST	Species	Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils. The species occurs in regrowth and highly modified forms of these habitats.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. The species occurs in sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils. The species occurs in regrowth and highly modified forms of these habitats. Areas of this habitat type were confirmed to be present in the study area.
Hakea archaeoides	Big Nellie Hakea	VU	V	OEH	Species	Found on steep, rocky, sheltered slopes and in deep gullies in open eucalypt forest. Commonly occurs at the interface of dry eucalypt forest and gully communities.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. The species is found on steep, rocky, sheltered slopes and in deep gullies in open eucalypt forest. Areas of this habitat type were confirmed to be present in the study area.
Haloragis exalata subsp. velutina	Tall Velvet Sea-berry	VU	V	PMST	Species	Grows in damp places near watercourses. This subspecies also occurs in woodland on the steep rocky slopes of gorges.	Low	Present in IBRA subregion, with a single record in the far south-west. No records within 10km of the study area. The species grows in damp places near watercourses. Habitat in the study area is marginal and no records occur within 10km.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Hicksbeachia pinnatifolia	Red Boppel Nut	VU	V	BioBanking PMST	Species	Subtropical rainforest, moist eucalypt forest and Brush Box forest.	Low	Present in IBRA subregion. No records within 10km of the study area. The species habitat consists of subtropical rainforest, moist eucalypt forest and Brush Box forest. Limited habitat is present in the study area, but no records occur within 10km.
Kennedia retrorsa		VU	V	OEH	Species	Found in a variety of habitats from mountainsides to riparian zones, from sheltered forest to steep, exposed rocky ridgelines.	Medium	Present in IBRA subregion and has been recorded within 500m of the study area. The species is found in a variety of habitats from mountainsides to riparian zones, from sheltered forest to steep, exposed rocky ridgelines. Areas of this habitat type were confirmed to be present in the study area.
Lindsaea incisa	Slender Screw Fern		E1	BioBanking OEH	Species	Dry eucalypt forest on sandstone and moist shrubby eucalypt forest on metasediments. It is usually found in waterlogged or poorly drained sites along creeks, where ferns, sedges and shrubs grow thickly.	Medium	Present in IBRA subregion and has been recorded within 500m of the study area. Occurs in dry eucalypt forest on sandstone and moist shrubby eucalypt forest on metasediments, usually in waterlogged or poorly drained sites along creeks. Areas of these habitat types were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Macadamia integrifolia	Macadamia Nut	VU		OEH	Species	Not known to occur naturally in the wild in NSW.	Negligible	Present in IBRA subregion, with a single record within 500m of the study area. The species is not known to occur naturally in the wild in NSW. Outside known natural geographic distribution for the species. Only cultivated specimens are likely to occur.
Macadamia tetraphylla	Rough-shelled Bush Nut	VU	V	OEH	Species	Found in subtropical rainforest, usually near the coast.	Low	Present in IBRA subregion, with a single record within 10km of the study area. The species is found in subtropical rainforest, usually near the coast. Limited areas of subtropical rainforest habitat are available in the study area, but the most recent record in relation to the study area is more than 40 years old.
Marsdenia longiloba	Slender Marsdenia	VU	E1	BioBanking OEH PMST	Species	Subtropical and warm temperate rainforest, lowland moist or open eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops. Associated species include Narrow-leaved ironbark *Eucalyptus crebra,* Tallowwood *Eucalyptus microcorys,* White Mahogany *Eucalyptus acmenoides,* Sydney Blue Gum *Eucalyptus saligna,* Small fruited Grey Gum *Eucalyptus propinqua,* Pink Bloodwood *Corymbia intermedia* and Brushbox *Lophostemon confertus*.	Medium	Present in IBRA subregion and has been recorded within 500m of the study area. The species occurs in subtropical and warm temperate rainforest and adjoining moist or open eucalypt forest. Occasionally in areas with rocky outcrops. Limited areas of subtropical rainforest and adjoining moist eucalypt forest habitat are available in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Myrsine richmondensis	Ripple-leaf Muttonwood	E	E1	PMST	Species	Subtropical and dry rainforest and swamp forest on creek flats and slopes on basalt derived soil and alluvial deposits.	Negligible	Not present or predicted to occur in the in IBRA subregion. Study area is outside the known geographic range.
Niemeyera whitei	Rusty Plum, Plum Boxwood		V	BioBanking OEH	Species	Found in gully, warm temperate or littoral rainforests and the adjacent understorey of moist eucalypt forest. It occurs on poorer soils in areas below 600 metres above sea level.	Recorded	Present in IBRA subregion and the species has been recorded within the study area previously in 2007. Found in gully, warm temperate or littoral rainforests and the adjacent understorey of moist eucalypt forest. It occurs on poorer soils in areas below 600 metres above sea level. Species previously recorded within study area.
Oberonia complanata	Yellow-flowered King of the Fairies		E1	BioBanking OEH	Species	This species grows on trees and rocks in littoral rainforest, subtropical rainforest, dry rainforest, wet or dry eucalypt forests, dunes (including stabilised sands), stream-side areas, swampy forests and mangroves.	Low	Present in IBRA subregion, with two records within 10km of the study area. This species grows on trees and rocks in littoral rainforest, subtropical rainforest, dry rainforest, wet or dry eucalypt forests, dunes (including stabilised sands), stream-side areas, swampy forests and mangroves. Limited areas of these habitat types (except sand dunes and mangroves) are available in the study area, but the most recent record in relation to the study area is more than 50 years old.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Oberonia titania	Red-flowered King of the Fairies		V	BioBanking OEH	Species	Red-flowered King of the Fairies occurs in littoral and subtropical rainforest and paperbark swamps, but it can also occur in eucalypt-forested gorges and in mangroves.	Low	Present in IBRA subregion, with a single record within 10km of the study area. This species occurs in littoral and subtropical rainforest and paperbark swamps, but it can also occur in eucalypt-forested gorges and in mangroves. Limited areas of these habitat types (except mangroves) are available in the study area, but the most recent record in relation to the study area is more than 60 years old.
Parsonsia dorrigoensis	Milky Silkpod	EN	V	BioBanking OEH PMST	Species	Found in subtropical and warm-temperature rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils. Appears to be able to withstand, and maybe even favour, light to moderate physical disturbance.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. This species is found in subtropical and warm-temperature rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils. Areas of these habitat types were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Peristeranthus hillii	Brown Fairy-chain Orchid		V	BioBanking OEH	Species	Restricted to coastal and near-coastal environments, particularly Littoral Rainforest and the threatened ecological community Lowland Rainforest on Floodplain.	Medium	Present in IBRA subregion, with two records within 10km of the study area. This species is restricted to coastal and near-coastal environments, particularly littoral rainforest and the threatened ecological community Lowland Rainforest on Floodplain. Areas of these habitat types were confirmed to be present in the study area.
Persicaria elatior	Tall Knotweed	VU	V	OEH PMST	Species	This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	Low	Present in IBRA subregion, with two records within 10km of the study area. This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. Limited areas of these habitat types are available in the study area, but the most recent record in relation to the study area is more than 50 years old.
Phaius australis	Southern Swamp Orchid	EN	E1	BioBanking OEH PMST	Species	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.	Recorded	Present in IBRA subregion and recorded within 500m of the study area. Species has been recorded from swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas. Areas of these habitat types were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Polygala linariifolia	Native Milkwort		E1	BioBanking	Species	Sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of Drooping ironbark *Eucalyptus caleyi,* Tumbledown red gum *Eucalyptus dealbata* and Callitris species on yellow podsolic soil on granite in layered open forest. Other associated species include White Bloodwood *Eucalyptus trachyphloia,* Blackdown stringybark *Eucalyptus sphaerocarpa,* Rough-barked apple *Angophora floribunda, Angophora leiocarpa,* Swamp Mahogany *Lophostemon suaveolens,* Forest oak *Allocasuarina torulosa* and Wahlenbergia species in the understorey.	Low	Not previously recorded in the IBRA subregion, but predicted to occur. The species has been recorded in sandy soils in dry eucalypt forest and woodland with a sparse under-storey. Soils are generally not sandy and no records occur within 10km.
Pomaderris queenslandica	Scant Pomaderris		E1	BioBanking	Species	Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Medium	Not previously recorded in the in IBRA subregion, but predicted to occur. Found in moist eucalypt forest or sheltered woodlands with a shrubby under-storey, and occasionally along creeks. Areas of these habitat types were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Pultenaea maritima	Coast Headland Pea		V	OEH	Species	The species occurs in grasslands, shrublands and heath on exposed coastal headlands and adjoining low coastal heath. Found on clay or sandy loam or clay loam over sandstone at altitude 5–30 metres. Associated *with* Coast Banksia *Banksia integrifolia* and Kangaroo Grass *Themeda australis*.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. The species occurs in grasslands, shrublands and heath on exposed coastal headlands and adjoining low coastal heath. Habitat confirmed to be absent from the study area.
***Quassia* sp. Moonee Creek**	Moonee Quassia	EN	E1	BioBanking OEH	Species	Shrubby layer below tall moist eucalypt forest and tall dry eucalypt forest, including forest edges, mostly at lower altitudes.	Medium	Present in IBRA subregion and recorded within 10km of the study area. All records located north of the study area. The species occurs as an understorey shrub most commonly in moist shrubby open eucalypt forest on slopes or riparian rainforest gullies, and occasionally in dry open forest with a heathy understorey. Areas of these habitat types were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Sarcochilus fitzgeraldii	Ravine Orchid	VU	V	OEH PMST	Species	The Ravine Orchid grows mainly on rocks, amongst organic matter, in cool, moist, shady ravines, gorges and on cliff faces in dense subtropical rainforest at altitudes between 500 and 700 metres. Occasional clumps are found on the bases of fibrous-barked trees.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. This species grows mainly on rocks, amongst organic matter, in cool, moist, shady ravines, gorges and on cliff faces in dense subtropical rainforest at altitudes between 500 and 700m. Occasional clumps are found on the bases of fibrous-barked trees. Habitat confirmed to be absent from the study area.
Sarcochilus hartmannii	Hartman's Sarcochilus	VU	V	OEH PMST	Species	Favours cliff faces on steep narrow ridges supporting eucalypt forest and clefts in volcanic rock from 500 to 1,000 metres in altitude. Also found occasionally at the bases of fibrous trunks of trees, including cycads and grass-trees.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. This species grows in cliff faces on steep narrow ridges supporting eucalypt forest and clefts in volcanic rock from 500 to 1000m in altitude. Habitat confirmed to be absent from the study area.
Senna acclinis	Rainforest Cassia		E1	BioBanking OEH	Species	Grows on the margins of subtropical, littoral and dry rainforests. Often found as a gap phase shrub. Flowering occurs in spring and summer and the fruit is ripe in summer and autumn. Primarily pollinated by a variety of bees.	Medium	Present in IBRA subregion and recorded within 10km of the study area. This species grows on the margins of subtropical, littoral and dry rainforests. Areas of these habitat types were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Sophora tomentosa	Silverbush		E1	OEH	Species	Silverbush occurs on coastal dunes.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. This species occurs on coastal dunes. Habitat confirmed to be absent from the study area.
Syzygium paniculatum	Magenta Lilly Pilly	VU	E1	PMST	Species	On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	Negligible	Not present or predicted to occur in the in IBRA subregion. Study area is outside the known geographic range.
Thesium australe	Austral Toadflax	VU	V	OEH PMST	Species	Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass.	Medium	Present in IBRA subregion and has been recorded within 500m of the study area. This species occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Marginal areas of the latterhabitat type were confirmed to be present in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Tinospora smilacina	Tinospora Vine		E1	BioBanking	Species	Dry rainforest and along the boundaries of dry rainforest and dry eucalypt forest.	Low	Not present in the in IBRA subregion but predicted to occur. This species occurs in and along the margins of dry rainforest and along the boundaries of dry rainforest and dry eucalypt forest. Marginal areas of this habitat type were confirmed to be present in the study area, but no records within 10km
Tylophora woollsii	Cryptic Forest Twiner	EN	E1	BioBanking OEH PMST	Species	This species grows in moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins.	Medium	Present in IBRA subregion and recorded within 10km of the study area. This species grows in moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins. Areas of these habitat types were confirmed to be present in the study area.
Typhonium* sp. aff. *brownii	Stinky Lily		E1	OEH	Species	Occurs on reasonably fertile soils, in moist eucalypt forest and the moist eucalypt forest-subtropical rainforest interface. Its remaining habitat is now significantly disturbed. Some of the known populations comprise only a few plants.	Medium	Present in IBRA subregion, with a single record within 10km of the study area. Records appear to be restricted to the plateau areas. This species occurs on reasonably fertile soils, in moist eucalypt forest and at the interface between moist eucalypt forest-subtropical rainforest. Limited areas of these habitat types are available in the study area.

Scientific name	Common name	EPBC Act	BC Act	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Uromyrtus australis	Peach Myrtle	EN	E1	OEH	Species	Warm temperate rainforest on less fertile soils derived from rhyolite rock. Often associated with Coachwood *Ceratopetalum apetalum*.	Medium	Present in IBRA subregion, with two records within 10km of the study area. This species occurs in warm temperate rainforest on less fertile soils derived from rhyolite rock. Often associated with Coachwood *Ceratopetalum apetalum*. Limited areas of rainforest habitat are available in the study area.
Zieria prostrata	Headland Zieria	EN	E1	OEH PMST	Species	Low grassy heath on exposed sites and wind-pruned open to sparse shrubland on more sheltered aspects.	Negligible	Present in IBRA subregion and has been recorded within 500m of the study area. However, this record has an accuracy of 10,000 metres. This species is restricted to coastal headlands where it occurs in low grassy heath on exposed sites and wind-pruned open to sparse shrubland on more sheltered aspects. Habitat confirmed to be absent from the study area.

Fauna habitat assessment

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Mammals								
Aepyprymnus rufescens	Rufous Bettong		V	OEH BioBanking	Species	Rufous Bettongs inhabit a variety of forests from tall, moist eucalypt forest to open woodland, with a tussock grass understorey. A dense cover of tall native grasses is the preferred shelter. They sleep during the day in cone-shaped nests constructed of grass in a shallow depression at the base of a tussock or fallen log. At night they feed on grasses, herbs, seeds, flowers, roots, tubers, fungi and occasionally insects.	Low	Present in IBRA subregion and recorded within 10km of the study area. This species inhabits a variety of forests from tall, moist eucalypt forest to open woodland, with a tussock grass understorey. A dense cover of tall native grasses is the preferred shelter. Understorey is unsuitable in most areas and is often weedy. The forest patches are quite fragmented and disturbed.
Arctocephalus pusillus doriferus	Australian Fur-seal		V	OEH	n/a	Prefers rocky parts of islands with flat, open terrain. They occupy flatter areas than do New Zealand Fur-seals where they occur together.	Negligible	Marine or pelagic species
Balaenoptera musculus	Blue Whale	EN	E1	OEH PMST	n/a	Breeds in warm water at low latitudes, preferring open seas rather than coastal waters. Often feeds during spring and summer on krill close to the ice edge.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Cercartetus nanus	Eastern Pygmy-possum		V	OEH BioBanking	Species	Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum *Pseudocheirus peregrinus* dreys or thickets of vegetation.	Medium	Present in IBRA subregion and recorded within 10km of the study area. Inhabits rainforest through to sclerophyll forest and tree heath. In North-eastern NSW Eastern Pygmy-possum are most frequently encountered in rainforest. Banksias and myrtaceous shrubs and trees are a favoured food source. Soft fruits are eaten when flowers are unavailable and it also feeds on insects. There are only two small patches of rainforest in the study area, which are quite isolated. There is often a weedy understorey throughout the remnants in the study area, reducing the chance of this species occurring.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Chalinolobus dwyeri	Large-eared Pied Bat	VU	V	PMST BioBanking	Eco & Species	Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin *Petrochelidon ariel* frequenting low to mid-elevation dry open forest and woodland close to these features. |Found in well-timbered areas containing gullies.	Low	Not present in the in IBRA subregion but predicted to occur. Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands. Roosts in colonies of between three and 80, but usually less than 10 individuals in caves, Fairy Martin nests and mines, and beneath rock overhangs. No likely roost sites were located in the study area.
Chalinolobus nigrogriseus	Hoary Wattled Bat		V	OEH BioBanking	Ecosystem	In NSW the Hoary Wattled Bat occurs in dry open eucalypt forests, favouring forests dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common. Because it flies fast below the canopy level, forests with naturally sparse understorey layers may provide the best habitat. Roosts in hollows and rock crevices. Will occupy urban areas with suitable habitat.	Low	Present in the IBRA subregion. No records within 10km of the study area. In NSW the Hoary Wattled Bat occurs in dry open eucalypt forests, favouring forests dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common. Because it flies fast below the canopy level, forests with naturally sparse understorey layers may provide the best habitat. Roosts in hollows and rock crevices. Habitat is marginal

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Dasyurus maculatus	Spotted-tailed Quoll	EN	V	OEH PMST BioBanking	Ecosystem	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites. Use communal 'latrine sites', often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares. Are known to traverse their home ranges along densely vegetated creeklines.	High	Present in IBRA subregion and recorded within 10km of the study area. This species uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests. Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas. Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and a large area of intact vegetation in which to forage. Suitable habitat is present in some of the larger patches of remnant vegetation in the study area.
Dugong dugon	Dugong		E1	OEH		Major concentrations of Dugongs occur in wide shallow protected bays, wide shallow mangrove channels and in the lee of large inshore islands. Will also occupy deeper waters if their sea grass food is available. Shallow waters such as tidal sandbanks and estuaries have been reported as sites for calving.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Eubalaena australis	Southern Right Whale	EN	E1	OEH PMST		Migrate between summer feeding grounds in Antarctica and winter breeding grounds around the coasts of southern Australia, New Zealand, South Africa and South America.	Negligible	Marine or pelagic species
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	OEH BioBanking	Ecosystem	Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	Recorded	Present in IBRA subregion with a single record within 10km of the study area. Prefers wet high-altitude sclerophyll and coastal mallee habitat, preferring wet forests with a dense understorey but being found in open forests at lower altitudes. Apparently hibernates in winter. Roosts in tree hollows and sometimes in buildings in colonies of between 3 and 80 individuals. Often change roosts every night. Records show movements of up to 12 km between roosting and foraging sites. Habitat is present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Kerivoula papuensis	Golden-tipped Bat		V	OEH BioBanking	Ecosystem	Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. Also recorded in tall open forest, Casuarina dominated riparian forest and coastal Melaleuca forests. Bats will fly up to two kilometres from roosts to forage in rainforest and sclerophyll forest on mid and upper-slopes. Roost mainly in rainforest gullies on small first- and second-order streams in usually abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests modified with an access hole on the underside. Bats may also roost under thick moss on tree trunks, in tree hollows, dense foliage and epiphytes. Maternity roots may occur away from water sources with one maternity roost found 450m upslope of the nearest water course in a broken bough.	High	Present in IBRA subregion and recorded within 10km of the study area. All records within 10km on plateau to west of the study area. Occurs in moist, closed forest that receives high rainfall. Important habitat features includes forest ecotones, streams and an abundance of vines. Primarily feeds on web-building spiders. Most nightly movements occur within 2km of the roost. Roosts in the nests of Yellow-throated Scrubwren and Brown Gerygone, as well as in tree hollows, foliage and roofs of houses. Habitat is available in the riparian areas of the study area.
Megaptera novaeangliae	Humpback Whale	VU	V	OEH PMST		The population of Australia's east coast migrates from summer cold-water feeding grounds in Subantarctic waters to warm-water winter breeding grounds in the central Great Barrier Reef. They are regularly observed in NSW waters in June and July, on northward migration and October and November, on southward migration.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Miniopterus australis	Little Bentwing-bat		V	OEH	Eco & Species	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. Only five nursery sites /maternity colonies are known in Australia.	Recorded	Present in IBRA subregion recorded within 500m of the study area. Roost sites encompass a range of structures including caves, tunnels and stormwater drains. Young are raised by the females in large maternity colonies in caves in summer. Shows a preference for well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. There are culverts and bridges within the study area that may provide suitable roosting habitat for this species. Foraging may occur widely across the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat		V	OEH	Eco & Species	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Hunt in forested areas, catching moths and other flying insects above the tree tops.	Medium	Present in IBRA subregion and recorded within 10km of the study area. The species occurs in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. This species form large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites where they roost in caves, culverts, buildings and bridges. There are culverts and bridges within the study area that may provide suitable roosting habitat for this species. Foraging may occur widely across the study area.
Mirounga leonina	Southern Elephant Seal	VU		OEH			Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Mormopterus norfolkensis	Eastern Freetail-bat		V	OEH BioBanking	Ecosystem	Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in man-made structures.	Recorded	Present in IBRA subregion and recorded within 10km of the study area. The majority of records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging and roosting habitat is present within the study area, however is not considered preferred habitat.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Myotis macropus	Southern Myotis		V	OEH	Eco & Species	Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	Recorded	Present in IBRA subregion and recorded within 500m of the study area. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. There are culverts, bridges and tree hollows within the study area that may provide suitable roosting habitat for this species. Foraging may occur widely across the study area, over riparian areas and dams.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Petaurus australis	Yellow-bellied Glider		V	OEH BioBanking	Ecosystem	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. 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. Den, often in family groups, in hollows of large trees. Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources.	High	Present in IBRA subregion and recorded within 10km of the study area. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types. Preferred feed trees occur widely across the study area, with all areas of remnant native vegetation containing feed tree species (Pink Bloodwood, Blue Gum, Flooded Gum, Blackbutt, Grey Gum and Brush Box).
Petaurus norfolcensis	Squirrel Glider		V	OEH BioBanking	Species	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.	High	Present in IBRA subregion and recorded within the study area. Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow-bearing trees and a mix of eucalypts, banksias and acacias. Species previously recorded within study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Petrogale penicillata	Brush-tailed Rock-wallaby	VU	E1	PMST	Species	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15 ha.	Negligible	Present in the IBRA subregion. No records within 10km of the study area. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Habitat not present in the study area.
Phascogale tapoatafa	Brush-tailed Phascogale		V	OEH	Species	Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Agile climber foraging preferentially in rough barked trees of 25 cm DBH or greater. Females have exclusive territories of approximately 20 - 40 ha, while males have overlapping territories often greater than 100 ha. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span.	Medium	Present in IBRA subregion and recorded within 10km of the study area. This species prefers open forests with a sparse ground cover, but also inhabits mallee and rainforests. It feeds on insects and nectar, particularly in rough-barked trees. The Brush-tailed Phascogale will nest and shelter in tree hollows, tree stumps and occasionally birds' nests. Some areas of suitable habitat do occur in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Phascolarctos cinereus	Koala	VU	V	OEH PMST BioBanking	Species	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery.	Recorded	Present in IBRA subregion and has been previously recorded 67 times within the study area. Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally. Favoured tree species in the Coffs Harbour area include Tallowwood *Eucalyptus microcorys*, Swamp Mahogany *E. robusta*, Flooded Gum *E. grandis*, Forest Red Gum *E. tereticornis* and Small Fruited Grey Gum *E. propinqua*. Species previously recorded within study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Planigale maculata	Common Planigale		V	OEH BioBanking	Species	Common Planigales inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water. They are active at night and during the day shelter in saucer-shaped nests built in crevices, hollow logs, beneath bark or under rocks. They are fierce carnivorous hunters and agile climbers, preying on insects and small vertebrates, some nearly their own size.;3|They breed from October to January.;4|The female builds a nest lined with grass, eucalypt leaves or shredded bark.;5|	Medium	Present in IBRA subregion and recorded within 10km of the study area. The Common Planigale is known to occur in a variety of habitats from weed-infested urban reserves to cool mountain forests from sea level up to 400m. Habitat selection is considered to be dependent on an adequate surface cover of grasses, hollow logs, rocks and leaf litter. It feeds on insects, spiders and small lizards. This species shelters under rocks, timber, rubbish (e.g. sheet iron) and in termite mounds. Habitat is present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Potorous tridactylus	Long-nosed Potoroo	VU	V	OEH PMST BioBanking	Ecosystem	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. The fruit-bodies of hypogeous (underground-fruiting) fungi are a large component of the diet of the Long-nosed Potoroo. They also eat roots, tubers, insects and their larvae and other soft-bodied animals in the soil. Individuals are mainly solitary, non-territorial and have home range sizes ranging between 2-5 ha.	Medium	Present in IBRA subregion and recorded within 10km of the study area. Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy. Habitat may be suitable in a couple of the less disturbed, larger patches.
Pseudomys gracilicaudatus	Eastern Chestnut Mouse		V	OEH BioBanking	Species	In NSW the Eastern Chestnut Mouse is mostly found, in low numbers, in heathland and is most common in dense, wet heath and swamps. In the tropics it is more an animal of grassy woodlands. Optimal habitat appears to be in vigorously regenerating heathland burnt from 18 months to four years previously.	Low	Not present in the in IBRA subregion but predicted to occur. In NSW the Eastern Chestnut Mouse is mostly found, in low numbers, in heathland and is most common in dense, wet heath and swamps. Optimal habitat appears to be in vigorously regenerating heathland burnt from 18 months to four years previously. Habitat not present.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Pseudomys novaehollandiae	New Holland Mouse	VU		OEH PMST BioBanking	Ecosystem	Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes. Distribution is patchy in time and space, with peaks in abundance during early to mid stages of vegetation succession typically induced by fire	Low	Present in IBRA subregion and recorded within 10km of the study area. The New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland under-storey, and vegetated sand dunes. Habitat not present.
Pseudomys oralis	Hastings River Mouse	EN	E1	PMST	Species	A variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs. Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops and fallen logs. Nests may be in either gully areas or ridges and slopes. Home range is generally between 0.5ha and 4ha and there may be some overlap with other individuals.	Low	Present in the IBRA subregion. No records within 10km of the study area. The Hastings River Mouse occurs in upland forests (at altitudes between 300-1250 m) from Barrington Tops to Queensland. Inhabits open forests and woodlands with a grass, sedge, rush or heath under-storey. The Hastings River Mouse nests within cavities in root systems of trees, holes in the ground, rock piles, hollow logs and epiphytes near the ground. Habitat likely to be marginal in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Pteropus poliocephalus	Grey-headed Flying-fox	VU	V	OEH PMST	Eco & Species	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca, Banksia, and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops.	Recorded	Present in IBRA subregion and has been previously recorded within 500m of the study area. There are three known camps within 10km of the study area. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. No flying-fox camps were located during the habitat assessment, however suitable habitat does occur. Foraging habitat is widely available across the site, including planted figs and mango.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat		V	OEH BioBanking	Ecosystem		Medium	Present in IBRA subregion and recorded within 10km of the study area. Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert. They usually roost in tree hollows. Roosting and foraging habitat is present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Scoteanax rueppellii	Greater Broad-nosed Bat		V	OEH BioBanking	Ecosystem		Recorded	Present in IBRA subregion and has been previously recorded within 500m of the study area. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Roosts in hollow tree trunks and branches. Roosting and foraging habitat is present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Syconycteris australis	Common Blossom-bat		V	OEH	Ecosystem	Common Blossom-bats often roost in littoral rainforest and feed on nectar and pollen from flowers in adjacent heathland and paperbark swamps. They have also been recorded in a range of other vegetation communities, such as subtropical rainforest, wet sclerophyll forest and other coastal forests. They generally roost individually in dense foliage and vine thickets of the sub-canopy, staying in the same general area for a season. They require a year round supply of nectar and pollen which is gathered from a mosaic of coastal complex vegetation types. When these vegetation types are in short supply of nectar and pollen (Nov/Dec in northern NSW) Common Blossom-bats have been known to utilise riverine areas containing Black Bean, Silky Oak and Weeping Bottlebrush.	High	Present in IBRA subregion and has been previously recorded within the study area. This species requires a combination of heathland and coastal rainforest.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Thylogale stigmatica	Red-legged Pademelon		V	BioBanking	Ecosystem	Inhabits forest with a dense understorey and ground cover, including rainforest, moist eucalypt forest and vine scrub. Wet gullies with dense, shrubby ground cover provide shelter from predators. In NSW, rarely found outside forested habitat. They disperse from dense shelter areas to feed from late afternoon to early morning, favouring native grasses and herbs on the edge of the forest.	Low	Present in the IBRA subregion. No records within 10km of the study area. Inhabits forest with a dense understorey and ground cover, including rainforest, moist eucalypt forest and vine scrub. Wet gullies with dense, shrubby ground cover provide shelter from predators. Habitat is marginal due to fragmentation and disturbed understorey in many areas.
Birds								

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Anthochaera phrygia	Regent Honeyeater	CE	E4A	OEH PMST BioBanking	Species	The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important.	High	Present in IBRA subregion and recorded within 10km of the study area. A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: *E. microcarpa, E. punctata, E. polyanthemos, E. mollucana, Corymbia robusta, E. crebra, E. caleyi, C. maculata, E. mckieana, E. macrorhyncha, E. laevopinea* and *Angophora floribunda*. Nectar and fruit from the mistletoes *A. miquelii, A. pendula, A. cambagei* are also eaten during the breeding season. Swamp Mahogany are present at several location s in the study area, providing foraging habitat when flowering.
Ardenna carneipes	Flesh-footed Shearwater		V	OEH	Species	Nest on Lord Howe Island in forests on sandy soils from Ned's Beach to Clear Place, with smaller colonies below Transit Hill and at Old Settlement Beach.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Botaurus poiciloptilus	Australasian Bittern	EN	E1	OEH PMST BioBanking	Species	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	Low	Present in the IBRA subregion. No records within 10km of the study area. Often found in terrestrial and estuarine wetlands, generally where there is permanent water with tall, dense vegetation including *Typha* spp. and *Eleoacharis* spp. Nests are built amongst dense vegetation on a flattened platform of reeds. Although dams are present, most are not suitably vegetated or very exposed.
Burhinus grallarius	Bush Stone-curlew		E1	OEH BioBanking	Ecosystem	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feed on insects and small vertebrates, such as frogs, lizards and snakes. Nest on the ground in a scrape or small bare patch.	Low	Present in IBRA subregion, with a single record within 10km of the study area. Occurs in lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present. Marginal habitat.
Calidris alba	Sanderling		V	OEH	Ecosystem	Often found in coastal areas on low beaches of firm sand, near reefs and inlets, along tidal mudflats and bare open coastal lagoons; individuals are rarely recorded in near-coastal wetlands.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Calidris ferruginea	Curlew Sandpiper	CE	E1	OEH	Ecosystem	It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts.;1|It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland.	Negligible	Marine or pelagic species
Calidris tenuirostris	Great Knot		V	OEH BioBanking	Ecosystem	Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms.	Negligible	Marine or pelagic species
Callocephalon fimbriatum	Gang-gang Cockatoo		V	OEH	Ecosystem	In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. Favours old growth forest and woodland attributes for nesting and roosting.	Negligible	Only a single record within the IBRA subregion. In NSW the species is distributed north to the Hunter region. Study area outside known geographic range.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Calyptorhynchus lathami	Glossy Black-Cockatoo		V	OEH BioBanking	Ecosystem	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak and Forest Sheoak are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, *Allocasuarina diminuta*, and *Allocasuarina gymnathera.* Belah is also utilised and may be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah *Casuarina cristata*. Dependent on large hollow-bearing eucalypts for nest sites.	Low	Present in IBRA subregion and recorded within 10km of the study area. Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types. Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead. Marginal habitat. She-oak species were rare in the study area. No suitable nest hollows were observed during the initial habitat assessment.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Carterornis leucotis	White-eared Monarch		V	BioBanking	Species	In NSW, White-eared Monarchs occurs in rainforest, especially drier types, such as littoral rainforest, as well as wet and dry sclerophyll forests, swamp forest and regrowth forest. They appear to prefer the ecotone between rainforest and other open vegetation types or the edges of rainforest, such as along roads. They are highly active when foraging, characteristically sallying, hovering and fluttering around the outer foliage of rainforest trees.	Negligible	Not present in the in IBRA subregion but predicted to occur. In NSW the White-eared Monarch is distributed from the Queensland border, south to Iluka, with only occasional records south to Woolgoolga. It occurs in rainforest, especially drier types, such as littoral rainforest, as well as wet and dry sclerophyll forests, swamp forest and regrowth forest. They appear to prefer the ecotone between rainforest and other open vegetation types or the edges of rainforest, such as along roads. Study area outside known geographic range.
Charadrius mongolus	Lesser Sand-plover		V	OEH	Species	Almost entirely coastal in NSW, favouring the beaches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats; occasionally occurs on sandy beaches, coral reefs and rock platforms.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Circus assimilis	Spotted Harrier		V	OEH BioBanking	Ecosystem	Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland, and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	Medium	Present in IBRA subregion with a single record within 10km of the study area. Preferred habitat consists of open and wooded country with grassland nearby for hunting. Habitat types include open grasslands, acacia and mallee remnants, spinifex, open shrublands, saltbush, very open woodlands, crops and similar low vegetation. Occasionally also found in densely forested and wooded habitat of the escarpment and coast. Habitat may be suitable for the Spotted Harrier.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)		V	OEH BioBanking	Ecosystem	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	Low	Present in IBRA subregion and recorded within 10km of the study area. Lives in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present. Habitat not suitable.
Coracina lineata	Barred Cuckoo-shrike		V	OEH BioBanking	Ecosystem	Rainforest, eucalypt forests and woodlands, clearings in secondary growth, swamp woodlands and timber along watercourses.	High	Present in IBRA subregion and recorded within 10km of the study area. Found in rainforests, vine thickets and their margins. Also found in eucalypt forests and clearing in secondary growth forests. Habitat present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Cyclopsitta diopthalma coxeni	Coxen's Fig-Parrot	EN	E4A	OEH	Species	Usually recorded from drier rainforests and adjacent wetter eucalypt forest but rarely seen due to its small size and cryptic habits. Also found in the wetter lowland rainforests that are now largely cleared in NSW. The bird shows a decided preference for fig trees, but also feeds on other fruiting rainforest species, lichen, nectar and grubs.	Low	Present in IBRA subregion and recorded within 10km of the study area. Coxen's fig parrot is limited to about five populations scattered between Bundaberg in Queensland and the Hastings River in NSW. They are usually recorded from drier rainforests and adjacent wetter eucalypt forest but rarely seen due to its small size and cryptic habits. They are also found in the wetter lowland rainforests that are now largely cleared in NSW. The bird shows a decided preference for fig trees, but also feeds on other fruiting rainforest species. Minimal rainforest in the study area, in very small patches. All records are older than 20 years.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Daphoenositta chrysoptera	Varied Sittella		V	OEH BioBanking	Ecosystem	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	Medium	Present in IBRA subregion and recorded within 10km of the study area. The Varied Sittella is a sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in mallee and acacia woodlands, paperbarks or mature Eucalypts. Habitat is present in the study area, however not considered preferred habitat.
Dasyornis brachypterus	Eastern Bristlebird	EN	E1	PMST	Species	Habitat for central and southern populations is characterised by dense, low vegetation including heath and open woodland with a heathy understorey. In northern NSW the habitat occurs in open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone; all of these vegetation types are fire prone. |	Negligible	Present in the IBRA subregion. No records within 10km of the study area. The species occurs as three distinct populations. Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands. Study area outside known geographic range.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Diomedea epomophora epomophora	Southern Royal Albatross	VU		PMST		During the non-breeding season, it has a wide and possibly circumpolar distribution, ranging north to about 35°S. The Royal Albatross is moderately common throughout the year in offshore waters of southern Australia, mostly off southeastern NSW, Victoria and Tasmania. Off South Australia, they are mostly seen May to September.	Negligible	Marine or pelagic species
Diomedea epomophora sanfordi	Northern Royal Albatross	EN		PMST		The Northern Royal Albatross ranges widely over the Southern Ocean, with individuals seen in Australian waters off south-eastern Australia. The Northern Royal Albatross feeds regularly in Tasmanian and South Australian waters, and less frequently in NSW waters.	Negligible	Marine or pelagic species
Diomedea exulans	Wandering Albatross	VU	E1	OEH		A marine, pelagic and aerial species. Versatile feeders in pelagic and shelf waters. Breed on subantarctic and antarctic islands.	Negligible	Marine or pelagic species
Diomedea exulans (sensu lato)	Wandering Albatross	VU	E1	PMST		A marine, pelagic and aerial species. Versatile feeders in pelagic and shelf waters. Breed on subantarctic and antarctic islands.	Negligible	Marine or pelagic species
Diomedea exulans antipodensis	Antipodean Albatross	VU	V	PMST		A marine pelagic species rarely visiting Australia	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Diomedea exulans exulans	Tristan albatross	EN		PMST		*Diomedea exulans exulans* is a newly defined species and its 'at sea' range is yet to be defined. Currently, only one definitive record of this species exists; on Gough Island and was recaptured 4 years later off Wollongong.	Negligible	Marine or pelagic species
Diomedea exulans gibsoni	Gibson's Albatross	VU	V	PMST		A marine pelagic species which breeds on the Auckland islands, New Zealand.	Negligible	Marine or pelagic species
Dromaius novaehollandiae	Emu		E2	OEH	Species	On the NSW north coast, Emus occur in a range of predominantly open lowland habitats, including grasslands, heathland, shrubland, open and shrubby woodlands, forest, and swamp and sedgeland communities, as well as the ecotones between these habitats. They also occur in plantations of tea-tree and open farmland, and occasionally in littoral rainforest.	Medium	Present in IBRA subregion and recorded within 10km of the study area. This threatened population occurs in a range of predominantly open lowland habitats, including grasslands, heathland, shrubland, open and shrubby woodlands, forest, and swamp and sedgeland communities, as well as the ecotones between these habitats. They also occur in plantations of tea-tree and open farmland, and occasionally in littoral rainforest. Habitat is likely to be present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Ephippiorhynchus asiaticus	Black-necked Stork		E1	OEH BioBanking	Species	Floodplain wetlands (swamps, billabongs, watercourses and dams) of the major coastal rivers are the key habitat in NSW for the Black-necked Stork. Secondary habitat includes minor floodplains, coastal sandplain wetlands and estuaries. Storks usually forage in water 5-30cm deep for vertebrate and invertebrate prey. Eels regularly contribute the greatest biomass to their diet, but they feed on a wide variety of animals, including other fish, frogs and invertebrates (such as beetles, grasshoppers, crickets and crayfish).	High	Present in IBRA subregion with three records within 500m of the study area. The species is found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water. Foraging /temporary habitat is present in the form of dams, however the species is unlikely to nest in the site.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Erythrotriorchis radiatus	Red Goshawk	VU	E4A	PMST BioBanking	Species	Red Goshawks inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers.	Low	Present in the IBRA subregion, with a single record in the west. No records within 10km of the study area. The Red Goshawk is sparsely distributed through NSW and inhabits open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers. Some small areas of habitat is present, however no records for the area.
Esacus magnirostris	Beach Stone-curlew		E4A	OEH	Species	Beach Stone-curlews are found exclusively along the coast, on a wide range of beaches, islands, reefs and in estuaries, and may often be seen at the edges of or near mangroves. They forage in the intertidal zone of beaches and estuaries, on islands, flats, banks and spits of sand, mud, gravel or rock, and among mangroves.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. This species breeds above the littoral zone, at the backs of beaches, among low vegetation of grass, scattered shrubs or low trees. Habitat not present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Fregetta grallaria grallaria	White-bellied Storm-Petrel	VU	V	PMST	EEC/Marine	The White-bellied Storm-Petrel (Tasman Sea) breeds on small offshore islets and rocks in the Lord Howe Island group, including Roach Island and Balls Pyramid. Its pelagic distribution is poorly understood, but it has been recorded north and east of its breeding islands to the tropics, in the Tasman Sea, Coral Sea, and north of New Zealand, and it is thought that some birds also reach the central Pacific Ocean. It has also been recorded over near-shore waters off the coasts of Queensland, NSW and Tasmania, and a single dead bird has been collected from the southeastern coast of Tasmania.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Glossopsitta pusilla	Little Lorikeet		V	OEH BioBanking	Ecosystem	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards.	Medium	Present in IBRA subregion and recorded within 10km of the study area. Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes. Suitable habitat may occur in the study area, however it is not considered preferred habitat.
Grantiella picta	Painted Honeyeater	VU	V	OEH	Ecosystem	Inhabits Boree/ Weeping Myall *Acacia pendula*, Brigalow *Acacia harpophylla* and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	Low	Present in IBRA subregion with a single record within 10km of the study area. Record older than 20 years. Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe. Often found on plains with scattered eucalypts and remnant trees on farmlands. Habitat marginal.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Grus rubicunda	Brolga		V	OEH BioBanking	Ecosystem	Though Brolgas often feed in dry grassland or ploughed paddocks or even desert claypans, they are dependent on wetlands too, especially shallow swamps, where they will forage with their head entirely submerged.	Low	Present in IBRA subregion with two records within 10km of the study area. Brolgas often feed in dry grassland, ploughed paddocks and claypans. They are dependent on wetlands. Habitat marginal in the study area.
Haematopus fuliginosus	Sooty Oystercatcher		V	OEH BioBanking	Species	The Sooty Oystercatcher is found on undisturbed tidal rocks on ocean shores and islands. Occasionally it is observed on sandspits and mudflats. It forages on exposed rock or coral at low tide for limpets and mussels. The Sooty Oystercatcher breeds in spring and summer almost exclusively offshore or on isolated promontories	Negligible	Present in IBRA subregion, with one record from within 500m of the study area. The Sooty Oystercatcher is found on undisturbed tidal rocks on ocean shores and islands. Occasionally it is observed on sandspits and mudflats. It forages on exposed rock or coral at low tide for limpets and mussels. The Sooty Oystercatcher breeds in spring and summer almost exclusively offshore or on isolated promontories. Habitat not present in study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Haematopus longirostris	Pied Oystercatcher		E1	OEH	Species	An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Its food supply (beach macroinvertebrates) have been negatively affected by human impacts. The Pied Oystercatcher is restricted to the littoral zone of beaches and estuaries, nesting on the ground above the tideline. A pair will re-nest in the same spot each year, rarely shifting their territory. Occasionally the Pied Oystercatcher is found in paddocks near the coast.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. The Pied Oystercatcher is restricted to the littoral zone of beaches and estuaries, nesting on the ground above the tideline. Occasionally the Pied Oystercatcher is found in paddocks near the coast. Habitat not present in study area.
Hieraaetus morphnoides	Little Eagle		V	OEH	Ecosystem	The Little Eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species. It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests.	Medium	Present in IBRA subregion and recorded within 10km of the study area. The Little Eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species. It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests. Habitat resent in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Irediparra gallinacea	Comb-crested Jacana		V	OEH BioBanking	Species	Occurs in freshwater wetlands, lagoons, Billabongs, swamps, lakes, rivers and reservoirs, generally with abundant floating aquatic vegetation.	Medium	Present in IBRA subregion and recorded within 10km of the study area. The Comb-crested Jacana inhabits permanent freshwater wetlands, either still or slow-flowing, with a good surface cover of floating vegetation, especially water-lilies, or fringing and aquatic vegetation. Some possible habitat is present at two water bodies in the study area.
Ixobrychus flavicollis	Black Bittern		V	OEH BioBanking	Species	The Black Bittern is found along the coastal plains within NSW, although individuals have rarely being recorded south of Sydney or inland. It inhabits terrestrial and estuarine wetlands such as flooded grasslands, forests, woodlands, rainforests and mangroves with permanent water and dense waterside vegetation. The Black Bittern typically roosts on the ground or in trees during the day and forages at night on frogs, reptiles, fish and invertebrates. The breeding season extends from December to March. Nests are constructed of reeds and sticks in branches overhanging the water	Medium	Present in IBRA subregion and within 500m of the study area. The Black Bittern inhabits terrestrial and estuarine wetlands such as flooded grasslands, forests, woodlands, rainforests and mangroves with permanent water and dense waterside vegetation. The Black Bittern typically roosts on the ground or in trees during the day and forages at night on frogs, reptiles, fish and invertebrates. Some possible habitat is present at two water bodies in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Lathamus discolor	Swift Parrot	EN	E1	OEH PMST BioBanking	Ecosystem	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. Favoured feed trees include winter flowering species such as Swamp Mahogany Eucalyptus robusta, Spotted Gum Corymbia maculata, Red Bloodwood C. gummifera, Mugga Ironbark E. sideroxylon, and White Box E. albens. Commonly used lerp infested trees include Grey Box E. microcarpa, Grey Box E. moluccana and Blackbutt E. pilularis. This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability.	Medium	Present in IBRA subregion and recorded within 500m of the study area. The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis.* May visit the study area to forage on Swamp Mahogany.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Lophoictinia isura	Square-tailed Kite		V	OEH BioBanking	Ecosystem	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by Eucalyptus longifolia, Corymbia maculata, E. elata, or E. smithii. Individuals appear to occupy large hunting ranges of more than 100 km2. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs.	High	Present in IBRA subregion and recorded within 500m of the study area. Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by *Eucalyptus longifolia*, *Corymbia maculata*, *E. elata*, or *E. smithii*. Individuals appear to occupy large hunting ranges of more than 100 km2. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs. Habitat is present in the study area.
Macronectes giganteus	Southern Giant Petrel	EN	E1	OEH PMST	EEC/ Marine	The Southern Giant-Petrel is a marine species found throughout the Antarctic to subtropical waters occasionally venturing to inshore waters.	Negligible	Marine or pelagic species
Macronectes halli	Northern Giant-Petrel	VU	V	OEH PMST	EEC/ Marine	Marine, pelagic species found mainly in subantarctic waters	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Ninox connivens	Barking Owl		V	OEH BioBanking	Ecosystem	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country. Territories are typically 2000 ha in NSW habitats.	Medium	Present in IBRA subregion and recorded within 10km of the study area. Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country. Territories are typically 2000 ha in NSW habitats. Habitat present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Ninox strenua	Powerful Owl		V	OEH BioBanking	Ecosystem	The Powerful Owl occupies wet and dry eucalypt forests and rainforests. It may inhabit both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm. It has a large home range of between 450 and 1450 ha.	Medium	Present in IBRA subregion and recorded within 10km of the study area. The Powerful Owl occupies wet and dry eucalypt forests and rainforests. It may inhabit both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm. It has a large home range of between 450 and 1450 ha. Habitat present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Numenius madagascariensis	Eastern Curlew	CE		OEH PMST	Ecosystem	Occurs in sheltered coasts, especially estuaries, embayments, harbours, inlets and coastal lagoons with large intertidal mudflats or sandflats often with beds of seagrass.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. Occurs in sheltered coasts, especially estuaries, embayments, harbours, inlets and coastal lagoons with large intertidal mudflats or sandflats often with beds of seagrass. Habitat not present.
Onychoprion fuscata	Sooty Tern		V	OEH	Species	The Sooty Tern is a pelagic species found over tropical waters were it feeds offshore far away from land. It breeds off the coast of WA and QLD rarely venturing to the south-east of Australia.	Negligible	Marine or pelagic species
Oxyura australis	Blue-billed Duck		V	BioBanking	Ecosystem	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached. Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland.	Low	Present in the IBRA subregion, with a single record in the west. No records within 10km of the study area. This duck spends most of its time on the water. They breed amongst dense vegetation over water. Form large groups on large, deep open freshwater dams and lakes outside breeding time. It is unlikely that the waterbodies in the study area are suitable.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Pachyptila turtur subantarctica	Fairy Prion (southern)	VU		PMST		Fairy Prions (including other subspecies) are often beachcast on the south-eastern coast of Australia, and are commonly seen offshore over the continental shelf and over pelagic waters. Observations are less common off Western Australia and Queensland than in south-eastern Australia. Beachcast birds are found along the whole coast of NSW, and the species is common offshore along the entire Victorian coast, where thousands are sometimes seen. In Tasmania, the Fairy Prion is an abundant visitor to all offshore waters. In South Australia, this species is regularly seen and often beachcast.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Pandion cristatus	Osprey		V	OEH BioBanking	Species	Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 km inland along larger rivers. It is water-dependent, hunting for fish in clear, open water. The Osprey occurs in terrestrial wetlands, coastal lands and offshore islands. It is a predominantly coastal species, generally using marine cliffs as nesting and roosting sites. Nests can also be made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	High	Present in IBRA subregion and recorded within the study area. Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 km inland along larger rivers and wetlands. It is water-dependent, hunting for fish in clear, open water. It is a predominantly coastal species, generally using marine cliffs as nesting and roosting sites. Nests can also be made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea. Species known from the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Petroica boodang	Scarlet Robin		V	OEH	Ecosystem	During the breeding season the Scarlet Robin is found in eucalypt forests and temperate woodlands, often on ridges and slopes. During autumn and winter it moves to more open and cleared areas. It has dispersive or locally migratory seasonal movements. The Scarlet Robin forages amongst logs and woody debris for insects which make up the majority of its diet. The nest is an open cup of plant fibres and cobwebs, sited in the fork of a tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 m above the ground. It is conspicuous in open and suburban habitats.	Medium	Present in IBRA subregion with two records within 10km of the study area. During the breeding season the Scarlet Robin is found in eucalypt forests and temperate woodlands, often on ridges and slopes. During autumn and winter it moves to more open and cleared areas. It has dispersive or locally migratory seasonal movements. The Scarlet Robin forages amongst logs and woody debris for insects which make up the majority of its diet. Habitat is present in the study area.
Phaethon rubricauda	Red-tailed Tropicbird		V	OEH	Species	The Red-tailed Tropicbird is a pelagic species found flying over tropical and subtropical waters. It prefers waters between 24 and 30°C although it has occasionally been recorded in cooler waters following warm currents. In NSW, it is observed as a vagrant to coastal waters often because it has been forced in during storm events.	Negligible	Marine or pelagic species
Phoebetria fusca	Sooty Albatross	VU	V	PMST	EEC/Marine	A pelagic species that inhabits subantarctic and subtropical marine waters.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)		V	OEH BioBanking	Ecosystem	The Grey-crowned Babbler is found in dry, open forests, scrubby woodlands, trees bordering roads and farmland with isolated trees	Low	Present in IBRA subregion and recorded within 10km of the study area. The Grey-crowned Babbler is found in dry, open forests, scrubby woodlands, trees bordering roads and farmland with isolated trees. Habitat is unlikely to be suitable in the study area.
Pterodroma leucoptera leucoptera	Gould's Petrel	EN	V	OEH PMST	Species	The Gould's Petrel is a marine species which only comes to shore to breed. It breeds exclusively on Cabbage Tree Island, 1.4 km offshore from Port Stephens and on nearby Boondelbah Island. The first arrival of Gould's petrel on cabbage tree Island occurs from mid to late September. Fledglings depart the island from late March to early May.	Negligible	Marine or pelagic species
Pterodroma neglecta neglecta	Kermadec Petrel (west Pacific subspecies)	VU	V	PMST	Species	Marine pelagic, in subtropical and tropical waters. They breed on islands, atolls and rock cliff where they nest on the ground or in rock crevices under ferns, shrubs or trees. Forage far away from breed sites (Marchant & Higgins 1990).	Negligible	Marine or pelagic species
Pterodroma nigripennis	Black-winged Petrel		V	OEH	Species	The Black-winged Petrel is a pelagic marine species rarely coming closer to shore than the continental shelf. It breeds on Lord Howe and Norfolk islands.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Pterodroma solandri	Providence Petrel		V	OEH	Species	The Providence Petrel is a pelagic marine species which rarely comes closer to the Australian mainland than the continental shelf. It breeds exclusively on Lord Howe and Phillip Islands since suffering extinction in 1800 on the larger Norfolk Island.	Negligible	Marine or pelagic species
Ptilinopus magnificus	Wompoo Fruit-Dove		V	OEH BioBanking	Ecosystem	Mainly occurs in large undisturbed patches of tall tropical or subtropical rainforest. Occasionally occurs in patches of monsoon forest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland, or vine thickets near rainforest.	High	Present in IBRA subregion, with one record within 500m of the study area. Mainly occurs in large undisturbed patches of tall tropical or subtropical rainforest. Occasionally occurs in patches of monsoon forest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland, or vine thickets near rainforest. May visit areas of habitat in the study area, including large fig trees.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Ptilinopus regina	Rose-crowned Fruit-Dove		V	OEH BioBanking	Ecosystem	Occurs in tall tropical and subtropical, evergreen or semi-deciduous rainforest, especially with dense growth of vines. Prefers large patches of rainforest, but sometimes occurs in remnant patches surrounded by suboptimal habitat including farmlands.	Low	Present in IBRA subregion and recorded within 10km of the study area. Occurs in tall tropical and subtropical, evergreen or semi-deciduous rainforest, especially with dense growth of vines. Prefers large patches of rainforest, but sometimes occurs in remnant patches surrounded by suboptimal habitat including farmlands. Only two small patches of rainforest occur in the study area – unlikely to be suitable, however there is a small chance of visitation with a high number of records within 10km of the study area.
Ptilinopus superbus	Superb Fruit-Dove		V	OEH BioBanking	Ecosystem	The Superb Fruit Dove's NSW distribution ranges from northern NSW to as far south as Moruya. It is found in rainforests, closed forests (including mesophyll vine forests) and sometimes in eucalypt and acacia woodlands where there are fruit-bearing trees. It forages in the canopy of fruiting trees such as figs and palms. Nests are constructed high in the canopy throughout September to January.	Medium	Present in IBRA subregion and recorded within 10km of the study area. The Superb Fruit Dove's NSW distribution ranges from northern NSW to as far south as Moruya. It is found in rainforests, closed forests (including mesophyll vine forests) and sometimes in eucalypt and acacia woodlands where there are fruit-bearing trees. It forages in the canopy of fruiting trees such as figs and palms. Habitat is present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Puffinus assimilis	Little Shearwater		V	OEH	Species	The Little Shearwater is pelagic marine species found in subantarctic and subtropical (occasionally tropical) waters and often seen in continental shelf waters. It breeds on subtropical and subantarctic islands.	Negligible	Marine or pelagic species
Rostratula australis	Australian Painted Snipe	EN	E1	PMST BioBanking	Ecosystem	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters.	Low	Not present in the in IBRA subregion but predicted to occur. Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters. Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. Marginal habitat may be present in the form of farm dams.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Stagonopleura guttata	Diamond Firetail		V	OEH BioBanking	Ecosystem	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.	Low	Present in the IBRA subregion, with a single record in the south. No records within 10km of the study area. Commonly use grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands, but will also use open forest, mallee, grasslands. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Habitat not present in the study area.
Sternula albifrons	Little Tern		E1	OEH	Species	The Little Tern favours sheltered coasts, harbours, bays, lakes, inlets, estuaries, coastal lagoons and ocean beaches especially with sand-spits and sand islets. It forages over shallow waters close inshore or over sandbars and reefs.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Stictonetta naevosa	Freckled Duck		V	OEH BioBanking	Ecosystem	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.	Low	Present in the IBRA subregion, with a single record in the north. No records within 10km of the study area. This duck prefers densely vegetated permanent fresh water swamps and creeks. Will also use lakes, dams and sewerage ponds. Marginal habitat may be available in the form of farm dams.
Sula dactylatra	Masked Booby		V	OEH	Species	This species breeds on Lord Howe Island, where it remains year around but can range widely for food and some juveniles wander before returning to breed.	Negligible	Marine or pelagic species
Thalassarche bulleri	Buller's Albatross	VU		PMST		A marine pelagic species rarely visiting Australia.	Negligible	Marine or pelagic species
Thalassarche cauta	Shy Albatross	VU	V	OEH	EEC/Marine	The Shy Albatross is a marine pelagic species inhabiting sub-antarctic and subtropical waters, spending the majority of their time at sea. Occasionally it is observed in continental shelf waters in bays and harbours.	Negligible	Marine or pelagic species
Thalassarche cauta salvini	Salvin's Albatross	VU		PMST		Salvin's Albatross is a non-breeding visitor to Australian waters.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Thalassarche cauta steadi	White-capped Albatross	VU		PMST		The White-capped Albatross is probably common off the coast of south-east Australia throughout the year. It has been observed that juveniles are rare in New Zealand waters, being more common off south-east Australia and South Africa. Breeding colonies occur on islands south of New Zealand.	Negligible	Marine or pelagic species
Thalassarche chlororhynchos	Yellow-nosed Albatross	VU		OEH		A marine pelagic species which visits the south-east coast of Australia.	Negligible	Marine or pelagic species
Thalassarche eremita	Chatham Albatross	EN		PMST		The Chatham Albatross is a medium sized albatross, with a wing-span less than 2.1 m. The bright yellow bill has a distinctive black spot near the tip of the lower mandible, allowing discrimination from the similar Shy Albatross. Breeding for the Chatham Albatross is restricted to Pyramid Rock, Chatham Islands, off the coast of New Zealand. The principal foraging range for this species is in coastal waters off eastern and southern New Zealand, and Tasmania.	Negligible	Marine or pelagic species
Thalassarche melanophris	Black-browed Albatross	VU	V	PMST	EEC/Marine	Inhabits Antarctic, subantarctic and subtropical waters. Although generally pelagic the species also occurs on the continental shelf and can be seen from land.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Thalassarche melanophris impavida	Campbell Albatross	VU		PMST		Inhabits Antarctic, subantarctic and subtropical waters.	Negligible	Marine or pelagic species
Todiramphus chloris	Collared Kingfisher		V	OEH	Species	Occurs in mangroves and coastal areas.	Negligible	Present in IBRA subregion and recorded within 10km of the study area. This species is restricted to mangrove associations of estuaries, inlets, sheltered bays and islands, and the tidal flats and littoral zone bordering mangroves. Habitat not present.
Turnix melanogaster	Black-breasted Button-quail	VU	E4A	PMST	Species	Within NSW, the species inhabits areas with an elevation of 200 to 700m, in dry or subtropical rainforests which contain brigalow, belah, bottletrees, hoop pine, lantana, ironbark, wattle, spotted gum, wallaby grass or rhodes grass.	Negligible	Not present or predicted to occur in the IBRA subregion. Preferred habitat includes drier low closed forests, including dry rainforests, vine forest and vine thickets with a deep, moist leaf litter. Habitat unlikely to be suitable.
Tyto longimembris	Eastern Grass Owl		V	OEH	Ecosystem	Occurs mainly in open tussock grassland, usually in treeless areas. Can also occur in marshy areas with tall dense tussocks of grass. Occasionally occurs in densely vegetated agricultural lands such as sugarcane fields.	High	Present in IBRA subregion and recorded within 500m of the study area. Occurs mainly in open tussock grassland, usually in treeless areas. Can also occur in marshy areas with tall dense tussocks of grass. Occasionally occurs in densely vegetated agricultural lands such as sugarcane fields. Habitat is present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Tyto novaehollandiae	Masked Owl		V	OEH BioBanking	Ecosystem	The Masked Owl may be found across a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. It has mostly been recorded in open forests and woodlands adjacent to cleared lands. They nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. The nest hollows are usually located within dense forests or woodlands. Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet. It has a large home range of between 500 to 1000 ha.	High	Present in IBRA subregion and recorded within the study area. The Masked Owl may be found across a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. It has mostly been recorded in open forests and woodlands adjacent to cleared lands. They nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. Species recorded from the study area.
Tyto tenebricosa	Sooty Owl		V	OEH BioBanking	Ecosystem	The Sooty Owl is often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW it is mostly found on escarpments with a mean altitude <500 m. The Sooty Owl nests and roosts in hollows of tall emergent trees, mainly eucalypts often located in gullies. Nests have been located in trees 125 to 161 cm in diameter.	Medium	Present in IBRA subregion and recorded within 10km of the study area. The Sooty Owl is often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW it is mostly found on escarpments with a mean altitude <500 m. The Sooty Owl nests and roosts in hollows of tall emergent trees, mainly eucalypts often located in gullies. Habitat may be suitable in some of the larger vegetation patches.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Reptiles								
Cacophis harriettae	White-crowned Snake		V	BioBanking	Species	Favours low to mid-elevation dry eucalypt forest and woodland, particularly areas with a varied and well-developed litter layer, where their prey of small lizards may be more abundant. Also occasionally found in moist eucalypt forest and coastal heathland.	Low	Not present in the IBRA subregion, but predicted to occur. Prefers dry eucalypt forest and woodland. Also occasionally found in moist eucalypt forest and coastal heathland. Habitat marginal
Caretta caretta	Loggerhead Turtle	EN	E1	OEH	EEC/ Marine	In Australia, the Loggerhead Turtle occurs in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia. While nesting is concentrated in southern Queensland and from Shark Bay to the North West Cape in Western Australia, foraging areas are more widely distributed. Small Loggerhead Turtles live at or near the surface of the ocean and move with the ocean currents. In eastern Australia, there is evidence that they spend around 15 years or more in the open ocean, with much of their feeding in the top 5 m of water, before recruiting to their chosen inshore or neritic feeding area. Loggerhead Turtles choose a wide variety of tidal and sub-tidal habitat as feeding areas and show fidelity to both their foraging and breeding areas.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Chelonia mydas	Green Turtle	VU	V	OEH	EEC/ Marine	Marine species with a pan-tropical distribution throughout the world. More abundant along the tropical coasts of Australia and the Great Barrier Reef. Green Turtles spend their first five to ten years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with driftlines and rafts of Sargassum (a floating marine plant that is also carried by currents). Once Green Turtles reach 30 to 40 cm curved carapace length, they settle in shallow benthic foraging habitats such as tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds. The shallow foraging habitat of adults contains seagrass beds or algae mats on which Green Turtles mainly feed.	Negligible	Marine or pelagic species

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Eretmochelys imbricata	Hawksbill Turtle	VU		OEH		Hawksbill Turtles spend their first five to ten years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with rafts of Sargassum (a floating marine plant that is also carried by currents). Once Hawksbill Turtles reach 30 to 40 cm curved carapace length, they settle and forage in tropical tidal and sub-tidal coral and rocky reef habitat. They primarily feed on sponges and algae. They have also been found, though less frequently, within seagrass habitats of coastal waters, as well as the deeper habitats of trawl fisheries. Major nesting of Hawksbill Turtles in Australia occurs at Varanus Island and Rosemary Island in Western Australia, and in the northern Great Barrier Reef and Torres Strait.	Negligible	Marine or pelagic species
Hoplocephalus bitorquatus	Pale-headed Snake		V	OEH BioBanking	Species	Found in a variety of habitats from wet sclerophyll forest to dry eucalypt forest on the western slopes of NSW. Feeds largely on frogs and lizards.	Low	Present in IBRA subregion with a single record within 10km of the study area. This species is found mainly in dry eucalypt forests and woodlands and occasionally in moist eucalypt forest. In drier environments, it appears to favour habitats close to riparian areas. Marginal habitat

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Hoplocephalus stephensii	Stephens' Banded Snake		V	OEH BioBanking	Species	This nocturnal species is partly arboreal and is usually found in wet sclerophyll forest or rainforest. It feeds on lizards, birds and small mammals.	High	Present in IBRA subregion and recorded within 10km of the study area. This nocturnal species is partly arboreal and is usually found in wet sclerophyll forest or rainforest. It feeds on lizards, birds and small mammals. Habitat is likely to be present in the study area. Habitat is present in the study area.
Frogs								
Crinia tinnula	Wallum Froglet		V	OEH BioBanking	Species	The Wallum Froglet is a coastal species, confined to acid, paperbark swamps and sedge swamps of the "wallum" country. The species occurs from near Noosa in southern Queensland south to the central coast of NSW, with a disjunct population on Kurnell Peninsula. The species is a late winter breeder and males call in choruses from within sedge tussocks or at the water edge.	High	Present in IBRA subregion and recorded within 10km of the study area. The Wallum Froglet is a coastal species, confined to acid, paperbark swamps and sedge swamps of the "wallum" country. The species is a late winter breeder and males call in choruses from within sedge tussocks or at the water edge. Habitat is available for this species in several areas of swamp forest.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Litoria aurea	Green and Golden Bell Frog	VU	E1	OEH PMST BioBanking	Species	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC. The species is found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks. Although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land.	Medium	Present in IBRA subregion with a single record within 10km of the study area. This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Several dams and creeklines within the study area may contain suitable habitat.
Litoria booroolongensis	Booroolong Frog	EN	E1	PMST	Species	The species is restricted to NSW and north-eastern VIC, predominantly along the western-flowing streams of the Great Dividing Range. The most recent records occur on the south-west slopes of NSW. The species is found in upland rivers, montane creeks and lowland rivers and creeks, particularly in permanent rocky western-flowing streams and rivers on the slopes and tablelands of NSW, with some fringing vegetation cover such as ferns, sedges or grasses.	Low	Present in the IBRA subregion, with a single record in the north. No records within 10km of the study area. This species lives along western-flowing permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults occur on or near cobble banks and other rock structures within stream margins. Habitat marginal.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Litoria brevipalmata	Green-thighed Frog		V	OEH BioBanking	Species	The majority of records for the species are in the NSW North Coast. There are disjunct records near Bulahdelah and in the ranges behind the Central Coast. Populations in NSW have declined over the last century. The Green Thighed Frog occurs within wet forests (swamp forests, wet sclerophyll forest and rainforest), although records from dry sclerophyll forest have been reported within the northern part of its range. Habitat of the species is poorly known however, the species is thought to forage and shelter in areas of deep leaf litter, dense low vegetation, or both, during non-breeding times.	Recorded	Present in IBRA subregion and recorded within 10km of the study area. This species occurs in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. It prefers wetter forests in the south of its range, but extends into drier forests in northern NSW and southern Queensland. Habitat present in the study area.
Litoria olongburensis	Olongburra Frog	VU	V	PMST	Species	The Olongburra Frog is only known from well vegetated acid swamps and streams on coastal sand masses.	Negligible	Not present or predicted to occur in the in IBRA subregion. Study area is outside the known geographic range.
Mixophyes balbus	Stuttering Frog	VU	E1	OEH PMST	Species	This species is usually associated with mountain streams, wet mountain forests and rainforests. It rarely moves very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains.	Medium	Present in IBRA subregion and with a single record within 10km of the study area. This species is found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Habitat is present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Mixophyes iteratus	Giant Barred Frog	EN	E1	OEH PMST BioBanking	Species	Occurs along coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW. Found in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m, often hiding in leaf litter near permanent fast-flowing streams.	Recorded	Present in IBRA subregion and recorded within 500m of the study area. Found in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000m, often hiding in leaf litter near permanent fast-flowing streams. Habitat is present in the study area.
Philoria sphagnicolus	Sphagnum Frog		V	OEH BioBanking	Species	Occur in North-eastern NSW along the eastern escarpment of the Great Dividing Range from the Gibraltar Ranges to Barrington Tops. Found in rainforests, including Antarctic Beech forest, moist eucalypt forest and sphagnum moss beds, usually at higher elevations. Burrow in loose, moist soil or moss, under leaf litter often in soaks or seepages, or may use cracks and cavities behind and beside large or small waterfalls where the environment remains saturated with moisture.	Low	Present in IBRA subregion and recorded within 10km of the study area. This species habitat is characterised by high moisture levels. Habitat often occurs in rainforest and wet sclerophyll forest. They can also occur at lower elevation (to about 250 m) in wet coastal foothills. Habitat marginal.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Fish								
Epinephelus daemelii	Black cod	VU	V (FM Act)	PMST	n/a	Black Cod has been recorded from the temperate and subtropical waters of the southwestern Pacific: Australia, Norfolk Island, Kermadec Islands and New Zealand (North Island and Poor Knights Island). The Australian range extends from southern Queensland to Kangaroo Island off South Australia	Negligible	Not present or predicted to occur in the in IBRA subregion. Study area is outside the known geographic range.
Maccullochella ikei	Eastern freshwater cod	EN	E1 (FM Act)	PMST	n/a		Low	Present in IBRA subregion, with the most recent record within 10km from 1966. This species prefers clear rocky streams and rivers with low flow velocity and abundant instream cover of rocks, timber or tussocks. The habitat requirements of the various life history stages are largely unknown. Habitat marginal. Record within 10km more than 20 years old.
Nannoperca oxleyana	Oxleyan Pygmy Perch	EN	E1 (FM Act)	PMST	n/a		Medium	Suitable habitat has potential to occur within the study area and the study area occurs within the potential distribution of the species.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Invertebrates								
Argyreus hyperbius	Australian Fritillary		E1	BioBanking	Species		Medium	Not recorded in IBRA subregion, but predicted to occur. Occurs in open swampy coastal areas where Arrowhead Violet *Viola betonicifolia*, the larval food plant is abundant. Swamp Forest habitat present in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Ocybadistes knightorum	Black Grass-dart Butterfly		E1	OEH BioBanking	Species	"The Black Grass-dart Butterfly is considered to be monophageous, with Floyd's Grass *Alexfloydia repens* being the only larval food plant known. The butterfly is generally restricted to within about 50m of suitable patches of Floyd's Grass. Habitat is predominantly located in swamp sclerophyll forest where Swamp Oak and/or Broad-leaved Paperbark are usually the dominant canopy species. The larval food plant Floyd's Grass favours the moderate to high sunlight levels in this habitat. High salinity levels are not tolerated by Floyd's Grass. The majority of its distribution is between 1m and 2m above the mean tide level, i.e. immediately above the zone of king tide inundation. The Black Grass-dart Butterfly is generally found in riparian zones within 5km of the coast. However, it reaches inland along Warrell Ck as far as Macksville (over 7km from the coast).	Medium	Present in IBRA subregion and recorded within 500m of the study area. The species is generally located in swamp sclerophyll forest where Swamp Oak *Casuarina glauca* and/or Broad-leaved Paperbark *Melaleuca quinquenervia* are the dominant canopy species. Generally found within 50m of the larval food plant Floyds Grass *Alexfloydia repens*. Floyds grass mainly occurs within 1-2m of the mean tide mark. Floyd's grass may occur in the swamp forest in the study area.

Scientific name	Common name	EPBC	BC / FM	Source	Credit type	Habitat and Ecology	Likely occurrence in study area	Rationale for likelihood ranking
Petalura litorea	Coastal Petaltail		E1	OEH BioBanking	Species	In NSW known populations are restricted to coastal and near coastal lowlands between Coffs Harbour and Ballina. The Coastal Petaltail lives in permanent swamps and bogs with some free water and open vegetation. Adults emerge from late October and are short-lived, surviving for one summer after emergence. Adults spend most of their time settled on low vegetation on or adjacent to the swamp. They hunt for flying insects over the swamp and along its margins. Females lay eggs into moss, under other soft ground layer vegetation, and into moist litter and humic soils, often associated with groundwater seepage areas within appropriate swamp and bog habitats. The species does not utilise areas of standing water wetland, although it may utilise suitable boggy areas adjacent to open water wetlands. Larvae dig long branching burrows under the swamp. Larvae are slow growing and the larval stage may last 10 years or more. It is thought that larvae leave their burrows at night and feed on insects and other invertebrates on the surface and also use underwater entrances to hunt for food in the aquatic vegetation.	Recorded	Present in IBRA subregion and recorded within 10km of the study area. In NSW known populations are restricted to coastal and near coastal lowlands between Coffs Harbour and Ballina. The Coastal Petaltail lives in permanent to semi-permanent swamps and bogs with some free water and open vegetation. Suitable habitat may be suitable in two areas of swamp forest in the study area.

Appendix C – Biodiversity credit reports

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 24/05/2019 Time: 5:40:44PM Calculator version: v4.0

Major Project details

Proposal ID:	0173/2019/4983MP
Proposal name:	Coffs Harbour Bypass EIS updated footprint 1/2
Proposal address:	Pacific Highway Coffs Harbour NSW
Proponent name:	NSW Roads and Maritime Services
Proponent address:	Unit 14, 17-27 Power Avenue Alexandria NSW 2015
Proponent phone:	0407 341 764
Assessor name:	Callan Wharfe
Assessor address:	Unit 14 17 - 27 Power Avenue Alexandria NSW 2015
Assessor phone:	02 9101 8713
Assessor accreditation:	0173

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	15.40	926.00
Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	6.26	438.00
Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	2.48	149.00
Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	2.04	141.78
Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast	0.94	64.00
White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion	0.51	35.00
Total	27.63	1,754

Credit profiles

1. White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion, (NR280)

Number of ecosystem credits created	35
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion, (NR280) Pepperberry - Giant Stinging Tree - Fig lowland rainforest in the NSW North Coast Bioregion, (NR299)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion, (NR120)

Number of ecosystem credits created	926
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions

Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion, (NR120) Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the NSW North Coast Bioregion, (NR117) Blackbutt - Tallowwood tall moist forest of the far north east of the NSW North Coast Bioregion, (NR121) Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion, (NR122) Blackbutt tall moist forest of the coastal ranges of the central and southern NSW North Coast Bioregion, (NR126) Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion, (NR138) Brush Box - Tallowwood shrubby moist forest of the escarpment ranges of central NSW North Coast Bioregion, (NR139) Brush Box - Turpentine shrubby open forest of the coastal ranges of the NSW North Coast Bioregion, (NR143) Dunn's White Gum tall open forest of the ranges of the northern NSW North Coast Bioregion, (NR156) Flooded Gum - Brush Box moist forest of the coastal ranges of the North Coast, (NR159) Flooded Gum - Tallowwood - Brush Box moist open forest of the coastal ranges of the North Coast, (NR160) Pink Bloodwood - Tallowwood moist open forest of the far northern ranges of the NSW North Coast Bioregion, (NR219) Spotted Gum - Brush Box moist forest of ranges of the southern Clarence Valley of the NSW North Coast Bioregion, (NR243) Spotted Gum - Grey Ironbark shrubby open forest of the Richmond Range of the NSW North Coast, (NR248) Steel Box shrubby open forest of the ranges of the northern NSW North Coast, (NR251) Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast, (NR258) Tallowwood - Brush Box - Sydney Blue Gum moist shrubby forest of the southern NSW North Coast Bioregion, (NR259) Tallowwood - Brush Box moist open forest of the coastal ranges of the central NSW North Coast, (NR260) Tallowwood - Narrow-leaved White Mahogany - Spotted Gum moist open forest in the Washpool area of the NSW North Coast, (NR261) Tallowwood - Narrow-leaved White Mahogany open forest of the hinterland ranges of the North Coast, (NR262) Tallowwood - Sydney Blue Gum moist open forest of the northern ranges of the NSW North Coast Bioregion, (NR265) Tallowwood - Turpentine moist open forest of the ranges of the Nymboida area of the NSW North Coast Bioregion, (NR266) Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion, (NR274)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion, (NR122)

Number of ecosystem credits created	438
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions

Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion, (NR122) Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the NSW North Coast Bioregion, (NR117) Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion, (NR120) Blackbutt - Tallowwood tall moist forest of the far north east of the NSW North Coast Bioregion, (NR121) Blackbutt tall moist forest of the coastal ranges of the central and southern NSW North Coast Bioregion, (NR126) Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion, (NR138) Brush Box - Tallowwood shrubby moist forest of the escarpment ranges of central NSW North Coast Bioregion, (NR139) Brush Box - Turpentine shrubby open forest of the coastal ranges of the NSW North Coast Bioregion, (NR143) Dunn's White Gum tall open forest of the ranges of the northern NSW North Coast Bioregion, (NR156) Flooded Gum - Brush Box moist forest of the coastal ranges of the North Coast, (NR159) Flooded Gum - Tallowwood - Brush Box moist open forest of the coastal ranges of the North Coast, (NR160) Pink Bloodwood - Tallowwood moist open forest of the far northern ranges of the NSW North Coast Bioregion, (NR219) Spotted Gum - Brush Box moist forest of ranges of the southern Clarence Valley of the NSW North Coast Bioregion, (NR243) Spotted Gum - Grey Ironbark shrubby open forest of the Richmond Range of the NSW North Coast, (NR248) Steel Box shrubby open forest of the ranges of the northern NSW North Coast, (NR251) Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast, (NR258) Tallowwood - Brush Box - Sydney Blue Gum moist shrubby forest of the southern NSW North Coast Bioregion, (NR259) Tallowwood - Brush Box moist open forest of the coastal ranges of the central NSW North Coast, (NR260) Tallowwood - Narrow-leaved White Mahogany - Spotted Gum moist open forest in the Washpool area of the NSW North Coast, (NR261) Tallowwood - Narrow-leaved White Mahogany open forest of the hinterland ranges of the North Coast, (NR262) Tallowwood - Sydney Blue Gum moist open forest of the northern ranges of the NSW North Coast Bioregion, (NR265) Tallowwood - Turpentine moist open forest of the ranges of the Nymboida area of the NSW North Coast Bioregion, (NR266) Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion, (NR274)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion, (NR138)

Number of ecosystem credits created	149
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion, (NR138) Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the NSW North Coast Bioregion, (NR117) Brush Box - Turpentine shrubby open forest of the coastal ranges of the NSW North Coast Bioregion, (NR143) Dunn's White Gum tall open forest of the ranges of the northern NSW North Coast Bioregion, (NR156) Flooded Gum - Brush Box moist forest of the coastal ranges of the North Coast, (NR159) Flooded Gum - Tallowwood - Brush Box moist open forest of the coastal ranges of the North Coast, (NR160) Pink Bloodwood - Tallowwood moist open forest of the far northern ranges of the NSW North Coast Bioregion, (NR219) Spotted Gum - Brush Box moist forest of ranges of the southern Clarence Valley of the NSW North Coast Bioregion, (NR243) Spotted Gum - Grey Ironbark shrubby open forest of the Richmond Range of the NSW North Coast, (NR248) Steel Box shrubby open forest of the ranges of the northern NSW North Coast, (NR251) Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast, (NR258) Tallowwood - Brush Box - Sydney Blue Gum moist shrubby forest of the southern NSW North Coast Bioregion, (NR259) Tallowwood - Brush Box moist open forest of the coastal ranges of the central NSW North Coast, (NR260) Tallowwood - Narrow-leaved White Mahogany - Spotted Gum moist open forest in the Washpool area of the NSW North Coast, (NR261) Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion, (NR274)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast, (NR258)

Number of ecosystem credits created	64
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast, (NR258) Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the NSW North Coast Bioregion, (NR117) Flooded Gum - Tallowwood - Brush Box moist open forest of the coastal ranges of the North Coast, (NR160) Spotted Gum - Grey Ironbark shrubby open forest of the Richmond Range of the NSW North Coast, (NR248) Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion, (NR274)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

6. Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion, (NR217)

Number of ecosystem credits created	142
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion, (NR217) Swamp Mahogany swamp forest on coastal lowlands of the NSW North Coast Bioregion and northern Sydney Basin Bioregion, (NR254)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Coastal Petaltail	Petalura litorea	2.50	192
Giant Barred Frog	Mixophyes iteratus	3.28	253
Green-thighed Frog	Litoria brevipalmata	1.79	23
Koala	Phascolarctos cinereus	36.70	954
Pale-vented Bush-hen	Amaurornis moluccana	4.95	64
Rusty Plum, Plum Boxwood	Niemeyera whitei	57.00	855
Southern Myotis	Myotis macropus	15.10	332
Southern Swamp Orchid	Phaius australis	1.00	13

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 24/05/2019 Time: 5:41:44PM Calculator version: v4.0

Major Project details

Proposal ID:	0173/2019/4984MP
Proposal name:	Coffs Harbour Bypass EIS updated footprint 2/2
Proposal address:	Pacific Highway Coffs Harbour NSW
Proponent name:	NSW Roads and Maritime Services
Proponent address:	Unit 14, 17-27 Power Avenue Alexandria NSW 2015
Proponent phone:	0407 341 764
Assessor name:	Callan Wharfe
Assessor address:	Unit 14 17 - 27 Power Avenue Alexandria NSW 2015
Assessor phone:	02 9101 8713
Assessor accreditation:	0173

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	4.22	178.00
Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	3.35	216.00
Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	1.61	106.41
Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	1.62	100.00
Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	3.03	184.00
White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion	1.91	109.00
Total	15.74	893

Credit profiles

1. White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion, (NR280)

Number of ecosystem credits created	109
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion, (NR280) Pepperberry - Giant Stinging Tree - Fig lowland rainforest in the NSW North Coast Bioregion, (NR299)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast, (NR263)

Number of ecosystem credits created	100
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast, (NR263) Blackbutt - Tallowwood dry grassy open forest of the central parts NSW North Coast Bioregion, (NR119) Blackbutt - Turpentine open forest of the foothills of the NSW North Coast Bioregion, (NR124) Blackbutt grassy open forest of the lower Clarence Valley of the NSW North Coast Bioregion, (NR125) Brush Box tall moist forest of the northern ranges of the NSW North Coast Bioregion, (NR144) Red Mahogany open forest of the coastal lowlands of the NSW North Coast Bioregion and northern Sydney Basin Bioregion, (NR222) Tallowwood dry grassy forest of the far northern ranges of the NSW North Coast Bioregion, (NR267)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion, (NR122)

Number of ecosystem credits created	178
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions

Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion, (NR122) Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the NSW North Coast Bioregion, (NR117) Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion, (NR120) Blackbutt - Tallowwood tall moist forest of the far north east of the NSW North Coast Bioregion, (NR121) Blackbutt tall moist forest of the coastal ranges of the central and southern NSW North Coast Bioregion, (NR126) Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion, (NR138) Brush Box - Tallowwood shrubby moist forest of the escarpment ranges of central NSW North Coast Bioregion, (NR139) Brush Box - Turpentine shrubby open forest of the coastal ranges of the NSW North Coast Bioregion, (NR143) Dunn's White Gum tall open forest of the ranges of the northern NSW North Coast Bioregion, (NR156) Flooded Gum - Brush Box moist forest of the coastal ranges of the North Coast, (NR159) Flooded Gum - Tallowwood - Brush Box moist open forest of the coastal ranges of the North Coast, (NR160) Pink Bloodwood - Tallowwood moist open forest of the far northern ranges of the NSW North Coast Bioregion, (NR219) Spotted Gum - Brush Box moist forest of ranges of the southern Clarence Valley of the NSW North Coast Bioregion, (NR243) Spotted Gum - Grey Ironbark shrubby open forest of the Richmond Range of the NSW North Coast, (NR248) Steel Box shrubby open forest of the ranges of the northern NSW North Coast, (NR251) Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast, (NR258) Tallowwood - Brush Box - Sydney Blue Gum moist shrubby forest of the southern NSW North Coast Bioregion, (NR259) Tallowwood - Brush Box moist open forest of the coastal ranges of the central NSW North Coast, (NR260) Tallowwood - Narrow-leaved White Mahogany - Spotted Gum moist open forest in the Washpool area of the NSW North Coast, (NR261) Tallowwood - Narrow-leaved White Mahogany open forest of the hinterland ranges of the North Coast, (NR262) Tallowwood - Sydney Blue Gum moist open forest of the northern ranges of the NSW North Coast Bioregion, (NR265) Tallowwood - Turpentine moist open forest of the ranges of the Nymboida area of the NSW North Coast Bioregion, (NR266) Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion, (NR274)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion, (NR138)

Number of ecosystem credits created	216
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion, (NR138) Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the NSW North Coast Bioregion, (NR117) Brush Box - Turpentine shrubby open forest of the coastal ranges of the NSW North Coast Bioregion, (NR143) Dunn's White Gum tall open forest of the ranges of the northern NSW North Coast Bioregion, (NR156) Flooded Gum - Brush Box moist forest of the coastal ranges of the North Coast, (NR159) Flooded Gum - Tallowwood - Brush Box moist open forest of the coastal ranges of the North Coast, (NR160) Pink Bloodwood - Tallowwood moist open forest of the far northern ranges of the NSW North Coast Bioregion, (NR219) Spotted Gum - Brush Box moist forest of ranges of the southern Clarence Valley of the NSW North Coast Bioregion, (NR243) Spotted Gum - Grey Ironbark shrubby open forest of the Richmond Range of the NSW North Coast, (NR248) Steel Box shrubby open forest of the ranges of the northern NSW North Coast, (NR251) Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast, (NR258) Tallowwood - Brush Box - Sydney Blue Gum moist shrubby forest of the southern NSW North Coast Bioregion, (NR259) Tallowwood - Brush Box moist open forest of the coastal ranges of the central NSW North Coast, (NR260) Tallowwood - Narrow-leaved White Mahogany - Spotted Gum moist open forest in the Washpool area of the NSW North Coast, (NR261) Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion, (NR274)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion, (NR274)

Number of ecosystem credits created	184
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion, (NR274) Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the NSW North Coast Bioregion, (NR117) Flooded Gum - Tallowwood - Brush Box moist open forest of the coastal ranges of the North Coast, (NR160) Spotted Gum - Grey Ironbark shrubby open forest of the Richmond Range of the NSW North Coast, (NR248) Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast, (NR258)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

6. Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion, (NR217)

Number of ecosystem credits created	106
IBRA sub-region	Coffs Coast & Escarpment

Offset options - Plant Community types	Offset options - IBRA sub-regions
Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion, (NR217) Swamp Mahogany swamp forest on coastal lowlands of the NSW North Coast Bioregion and northern Sydney Basin Bioregion, (NR254)	Coffs Coast & Escarpment and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Ecosystem credits summary

Veg Zone	PC type code	Plant community type name	Management zone area (ha)	Loss in Landscape Value	Loss in site value score	EEC Offset Multiplier	Credits req for TS	TS with highest credit req	TS offset multiplier	Ecosystem credits required
1	NR280	White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion	0.51	23.75	82.67	3	35	Sooty Owl	3	35
2	NR120	Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	11.27	23.75	81.33	1	754	Sooty Owl	3	754
3	NR120	Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	3.39	23.75	45.56	1	136	Sooty Owl	3	136
5	NR122	Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	6.26	23.75	85.33	1	438	Sooty Owl	3	438
6	NR120	Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	0.74	23.75	57.33	1	36	Sooty Owl	3	36
8	NR258	Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast	0.94	23.75	82.67	1	64	Sooty Owl	3	64
9	NR138	Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	2.48	23.75	72	1	149	Sooty Owl	3	149
10	NR217	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	0.89	23.75	84	3	61	Barking Owl	3	61
11	NR217	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	1.15	23.75	85.33	3	80	Barking Owl	3	80
12	NR217	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	1.23	23.75	78	3	79	Barking Owl	3	79

Veg Zone	PC type code	Plant community type name	Management zone area (ha)	Loss in Landscape Value	Loss in site value score	EEC Offset Multiplier	Credits req for TS	TS with highest credit req	TS offset multiplier	Ecosystem credits required
13	NR122	Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	0.15	23.75	89.33	1	11	Sooty Owl	3	11
14	NR122	Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	4.07	23.75	46.67	1	167	Sooty Owl	3	167
15	NR263	Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	0.73	23.75	71.33	1	43	Masked Owl	3	43
16	NR217	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	0.38	23.75	87.33	3	27	Barking Owl	3	27
17	NR280	White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion	1.91	23.75	68	3	109	Sooty Owl	3	109
100	NR263	Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	0.89	23.75	77.33	1	57	Masked Owl	3	57
101	NR274	Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	1.42	23.75	74	1	87	Sooty Owl	3	87
102	NR138	Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	3.35	23.75	78	1	216	Sooty Owl	3	216
103	NR274	Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	1.61	23.75	72.67	1	97	Sooty Owl	3	97

Appendix D – Secretary's Environmental Assessment Requirements

Secretary's Environmental Assessment Requirements

Section 115Y of the *Environmental Planning and Assessment Act 1979*

Application Number	SSI 7666
Proposal	New four lane divided motorway standard road from south of Englands Road to Korora Hill, distance of approximately 14 kilometres bypassing the Pacific Highway through Coffs Harbour
Location	Land generally located from south of the Englands Road intersection to Korora Hill at the southern end of the Sapphire to Woolgoolga upgrade in the Coffs Harbour local government area
Proponent	Roads and Maritime Services
Date of Issue	30 October 2017

General SEARs

Desired Performance Outcome	Requirement	Current Guidelines[1]
1. Environmental Impact Assessment Process The process for assessment of the proposal is transparent, balanced, well focussed and legal.	1. The Environmental Impact Statement (EIS) must be prepared in accordance with Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (the Regulation). 2. The project will impact on matters of national environmental significance (MNES) protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and will be assessed in accordance with the NSW Bilateral Agreement (2015). The Proponent must assess impacts to MNES protected under the EPBC Act. The assessment must be in accordance with the requirements listed in Attachment A 3. The onus is on the Proponent to ensure legislative requirements relevant to the project are met.	EPBC Act Environment Assessment Process (SEWPAC, 2010)
2. Environmental Impact Statement The project is described in sufficient detail to enable clear understanding that the project has been developed through an iterative process of impact identification and assessment and project refinement to avoid, minimise or offset impacts so that the project, on balance, has the least adverse biophysical, social and economic impact, including its cumulative impacts.	1. The EIS must include, but not necessarily be limited to, the following: (a) an executive summary; (b) a description of the project and all components and activities (including ancillary components and activities) required to construct and operate it, including: – the proposed route; – design of the motorway and its components, including interchanges, tunnels and bridges, and road user, pedestrian and cyclist facilities, and lighting; – local road upgrade works, including road widening, intersection treatment and grade separation works, property access, parking, pedestrian and cyclist and public transport facilities;	

[1] Guidelines listed are the current list of guidelines that may be applicable to a CSSI project. It is the Proponents responsibility to identify, and justify, which guidelines have been applied to a specific project.

Desired Performance Outcome	Requirement	Current Guidelines[1]
	– ancillary infrastructure and operational facilities, such as operational and maintenance facilities, ventilation systems, fire and emergency systems and services, and infrastructure, for the project; – location and operational requirements of construction ancillary facilities and access; and – the relationship and/or integration of the project with existing public and freight transport services; (c) a statement of the objective(s) of the project, including how it meets the objectives of the overall Pacific Highway Upgrade program; (d) a summary of the strategic need for the project with regard to its State significance and relevant State Government policy; (e) an analysis of any feasible alternatives to the project[2]; (f) a description of feasible options within the project[3], including: – alternative methods considered for the construction of the project, including the tunnels; and – staging of the project; (g) a description of how alternatives to and options within the project were analysed to inform the selection of the preferred alternative / option. The description must contain sufficient detail to enable an understanding of why the preferred alternative to, and options(s) within, the project were selected, including: – details of the highway corridors and route options from the development of the Coffs Harbour Highway Planning Strategy, and the criteria that was considered in the selection of the preferred route; and – a justification for the preferred proposal taking into consideration the objects of the *Environmental Planning and Assessment Act 1979* (h) a concise description of the general biophysical and socio-economic environment that is likely to be impacted by the project (including indirect impacts). Elements of the environment that are not likely to be affected by the project do not need to be described; (i) a demonstration of how the project design has been developed to avoid or minimise likely adverse impacts; (j) the identification and assessment of key issues as provided in the 'Assessment of Key Issues' performance outcome; (k) a statement of the outcome(s) the proponent will achieve for each key issue; (l) measures to avoid, minimise or offset impacts must be linked to the impact(s) they treat, so it is clear which measures will be applied to each impact;	

[2] Alternatives to a project are different projects which would achieve the same project objective(s) including the consequences of not carrying out the project. For example, alternatives to a road project may be a rail project in the same area and alternate routes for the road, or a combination of these alternatives.

[3] Options within the project are variations of the same project. For example, options within a road project could be design of an intersection; the location or design of a bridge; locations for a ventilation outlet.

Desired Performance Outcome	Requirement	Current Guidelines[1]
	(m) consideration of the interactions between mitigation measures, between impacts and between measures and impacts;[4] (n) an assessment of the cumulative impacts of the project taking into account other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed; (o) statutory context of the project as a whole, including: – how the project meets the provisions of the EP&A Act and EP&A Regulation; – a list of any approvals that must be obtained under any other Act or law before the project may lawfully be carried out; (p) a chapter that synthesises the environmental impact assessment and provides: – a succinct but full description of the project for which approval is sought; – a description of any uncertainties that still exist around design, construction methodologies and/or operational methodologies and how these will be resolved in the next stages of the project; – a compilation of the impacts of the project that have not been avoided; – a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or offset these impacts; – a compilation of the outcome(s) the proponent will achieve; and – the reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts; and (q) relevant project plans, drawings, diagrams in an electronic format that enables integration with mapping and other technical software. 2. The EIS must only include data and analysis that is reasonably needed to make a decision on the proposal. Relevant information must be succinctly summarised in the EIS and included in full in appendices. Irrelevant, conflicting or duplicated information must be avoided.	
3. Assessment of Key Issues* Key issue impacts are assessed objectively and thoroughly to provide confidence that the project will be constructed and operated within acceptable levels of impact.	1. The level of assessment of likely impacts must be proportionate to the significance of, or degree of impact on, the issue, within the context of the proposal location and the surrounding environment. The level of assessment must be commensurate to the degree of impact and sufficient to ensure that the Department and other government agencies are able to understand and assess impacts. 2. For each key issue the Proponent must: (a) describe the biophysical and socio-economic environment, as far as it is relevant to that issue, including adequate baseline data, in terms of temporal, spatial and parameters monitored;	

[4] Measures proposed to avoid or minimise one impact may cause an unintended impact on another issue. Therefore these impacts and their interactions need to be analysed and resolved where possible.

Desired Performance Outcome	Requirement	Current Guidelines[1]
* Key issues are nominated by the Proponent in the CSSI project application and by the Department in the SEARs. Key issues need to be reviewed throughout the preparation of the EIS to ensure any new key issues that emerge are captured. The key issues identified in this document are not exhaustive but are key issues common to most CSSI projects.	(b) describe the legislative and policy context, as far as it is relevant to the issue; (c) identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts; (d) demonstrate how potential impacts have been avoided (through design, or construction or operation methodologies); (e) detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant); and (f) detail how any residual impacts will be managed or offset, and the approach and effectiveness of these measures. 3. Where multiple reasonable and feasible options to avoid or minimise impacts of the preferred route/project are available, they must be identified and considered and the proposed measure justified taking into account the public interest.	
4. Consultation The project is developed with meaningful and effective engagement during project design and preparation of the EIS.	1. The project must be informed by consultation, including with relevant local, State and Commonwealth government agencies, infrastructure and service providers, special interest groups (including Local Aboriginal Land Councils, Aboriginal stakeholders, and pedestrian and bicycle user groups), affected landowners, businesses and the community. The consultation process must be undertaken in accordance with the current guidelines. 2. The Proponent must document the consultation process, and demonstrate how the project has responded to the inputs received.	NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013)

Key Issue SEARs

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
1. Transport and Traffic Network connectivity, safety and efficiency of the transport system in the vicinity of the project are managed to minimise impacts. The safety of transport system customers is maintained. Impacts on network capacity and the level of	1. The Proponent must assess construction transport and traffic (vehicle, pedestrian and cyclists) impacts, including, but not necessarily limited to: (a) a considered approach to the identification of transport routes and movements, particularly outside standard construction hours; (b) the indicative number, frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements); (c) indicative construction worker parking requirements; (d) the nature of existing traffic (types and number of movements) on	Guide to Traffic Management – Part 3 Traffic Studies and Analysis (Austroads, 2007) Guide to Traffic Generating Developments Version 2.2 (RTA, 2002) Cycling Aspects of Austroads Guides (Austroads, 2014) NSW Bicycle Guidelines v 1.2 (RTA, 2005)

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
service are effectively managed. Works are compatible with existing infrastructure and future transport corridors.	construction access routes (including consideration of peak traffic times, land uses, in particular sensitive receivers, and parking arrangements); (e) access constraints and impacts on public transport, pedestrians and cyclists; (f) impacts to the operation of the North Coast railway line; (g) the need to close, divert or otherwise reconfigure elements of the road and cycle network associated with construction of the project; and (h) the cumulative traffic impacts of other major development projects preparing for or commencing construction in the vicinity of the proposal. 2. The Proponent must assess (and model) the operational transport impacts of the project including, but not necessarily limited to: (a) forecast travel demand and traffic volumes for the project and the surrounding road, cycle and public transport network; (b) travel time analysis; (c) performance of key interchanges and intersections by undertaking a level of service analysis at key locations; (d) wider transport interactions and modifications (local and regional roads, cycling, public and freight transport, and the North Coast railway line); (e) access to identified and future urban release areas, such as North Boambee Valley; (f) impacts on cyclists and pedestrian access and safety; and (g) opportunities to integrate cycling and pedestrian elements with surrounding networks (existing and proposed) and within the project.	Planning Guidelines for Walking and Cycling (DIPNR, 2004) NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013)
2. Noise and Vibration - Amenity Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions affecting nearby	1. The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration. 2. An assessment of construction noise and vibration impacts which must address:	Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZECC, 1990) Assessing Vibration: a technical guideline (DEC, 2006) Australian Standard AS 2187.2-2006 Explosives – Storage and use – Part 2 use of explosives

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community.	(a) the nature of construction activities (including transport, tonal or impulsive noise-generating works and the removal of operational noise barriers, as relevant); (b) the intensity and duration of noise and vibration impacts (both air and ground borne); (c) the nature, sensitivity and impact to receivers (including Bishop Druitt College and Korora Public School); (d) the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management); (e) the potential for extended standard construction hours and/or works outside standard construction hours, including predicted levels, exceedances and number of potentially affected receivers and justification for the activity in terms of the Interim Construction Noise Guideline (DECCW, 2009); and (f) a cumulative noise and vibration assessment inclusive of impacts from other major development projects preparing for or commencing construction in the vicinity of the proposal. 3. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Interim Construction Noise Guideline (DECCW, 2009) NSW Industrial Noise Policy (EPA, 2000) Construction Noise Strategy (TfNSW, 2012) NSW Road Noise Policy (DECCW, 2011) Environmental Noise Management Manual (RMS 2001) Noise Mitigation Guideline (RMS, 2015) Noise Criteria Guideline (RMS, 2015)
3. Noise and Vibration - Structural Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage. Increases in noise emissions and vibration affecting environmental heritage as defined in the *Heritage Act 1977* during operation of the project are effectively managed.	1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage). 2. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	German Standard DIN 4150-3: 1999-02 - Structural Vibration - effects of vibration on structures Australian Standard AS 2187.2-2006 Explosives – Storage and use – Part 2 use of explosives
4. Biodiversity	1. The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment	NSW Biodiversity Offsets Policy for Major Projects (OEH,

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. The delivery of offsets and/or supplementary measures required for the project is assured and which are equivalent to any remaining impacts from its construction and operation.	(FBA) and be carried out by a person accredited in accordance with section 142B(1)(c) of the *Threatened Species Conservation Act, 1995*. 2. The Proponent must survey and assess any impacts on biodiversity values not covered by the FBA, as specified in section 2.3[5], including but not limited to aquatic species, riparian vegetation, instream macrophytes and habitat condition. 3. The Proponent must assess impacts on EECs, threatened species and/or populations[6] and provide the information specified in section 9.2 of the FBA. 4. The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the *Threatened Species Conservation Act 1995* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environmental Protection and Biodiversity Conservation Act 2000* (EPBC Act).	2014) Framework for Biodiversity Assessment (OEH, 2014) Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013 (DPI, 2013) Threatened Species Survey and Assessment Guidelines Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003) NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013) Aquatic Ecology in Environmental Impact Assessment – EIA Guideline (Marcus Lincoln Smith 2003)
5. Urban Design The project design complements the visual amenity, character and quality of the surrounding environment. The project contributes to the accessibility and connectivity of communities.	1. The Proponent must: (a) identify the urban design and landscaping aspects of the project and its components, including interchanges, tunnel portals, bridges, noise walls, landscaped mounds, ancillary buildings, and infrastructure services; (b) assess the impact of the project on the urban, rural and natural fabric, including residual land treatment, and demonstration of how the proposed hard and soft urban design elements of the project would be consistent with the existing and desired future character of the area traversed or affected by the project; (c) explore the use of Crime Prevention Through Environmental Design (CPTED) principles during the design development process, including natural surveillance, lighting, walkways, signage and landscaping; (d) identify urban design strategies to enhance healthy, cohesive and inclusive communities directly impacted by the project; and	AS4282-1997 Control of the obtrusive effects of outdoor lighting Beyond the Pavement: RTA urban design policy, procedures and design principles (RMS, 2014) Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW (RMS, 2012) NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013) Crime prevention and the assessment of development applications (DUAC, 2001) Crime Prevention through Environmental Design (CPTED) (Queensland Government, 2007) Technical guideline for Urban Green Cover in NSW

[5] OEH will provide specific assessment requirements for any such impacts during agency consultation on the SEARs.
[6] OEH will provide this list of species during agency consultation on the SEARs.

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
	(e) describe urban design and landscape mitigation measures, having regard to the urban design and landscape objectives for the project and the overall Pacific Highway Upgrade program.	Healthy Urban Development *Checklist* (NSW Health, 2009) Pacific Highway Urban Design Framework 2013 (RMS, 2013)
6. Visual Amenity The project minimises adverse impacts on the visual amenity of the built and natural environment (including public open space) and capitalises on opportunities to improve visual amenity.	1. The Proponent must assess the visual impact of the project and any ancillary infrastructure (including noise walls) on: (a) views and vistas; (b) streetscapes, key sites and buildings; (c) heritage items including Aboriginal places and environmental heritage; and (d) the local community (including view loss and overshadowing). 2. The Proponent must provide artist impressions and perspective drawings of the project from a variety of locations along and adjacent to the route to illustrate how the project has responded to the visual impact through urban design and landscaping.	AS4282-1997 Control of the obtrusive effects of outdoor lighting Beyond the Pavement: urban design policy, procedures and design principles (RMS, 2014) Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW (RMS, 2012) NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013) Technical guideline for Urban Green Cover in NSW (OEH, 2015)
7. Socio-economic, Land Use and Property The project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities. The project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure. Effective engagement is undertaken with stakeholders during project design and delivery.	1. The Proponent must assess social and economic impacts in accordance with the current guidelines (including cumulative ongoing impacts of the project). 2. The Proponent must assess impacts from construction and operation on potentially affected properties, businesses, Council assets and services, recreational users and land and water users, including property acquisitions/adjustments, access amenity and relevant statutory rights. 3. The design, construction and operation of the project should address and minimise (existing and future) land use conflicts and operations (including existing and ongoing horticultural activities). Siting of project elements should be located in such a way that functional, contiguous areas of residual land and land uses are maximised. 4. The Proponent must assess potential impacts on utilities (including communications, electricity, gas, and water and sewerage) and the relocation of these utilities. 5. A draft Community Consultation Framework must be prepared identifying relevant stakeholders, procedures for distributing information and	Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment (RMS, 2013) Guidelines for developments adjoining land and water managed by DECCW (DECCW 2010) Revocation, Re-categorisation and Road Adjustment Policy (OEH, 2012)

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
	receiving/responding to feedback and procedures for resolving stakeholder and community complaints during the design, construction and operation of the project. Key issues that must be addressed in the draft Framework include, but are not limited to: (a) traffic management (including property access, pedestrian access), (b) landscaping/urban design matters, (c) construction activities including out of hours work, and (d) noise and vibration mitigation and management, (e) soil erosion and water quality management, and (f) interaction with existing land uses.	
8. Heritage The design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places. The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.	1. The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: (a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines; (b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan; (c) environmental heritage, as defined under the *Heritage Act 1977*; and (d) items listed on the National and World Heritage lists. 2. Where impacts to State or locally significant heritage items are identified, the assessment must: (a) include a significance assessment and statement of heritage impact for all heritage items (including any unlisted places that are assessed as having heritage value); (b) provide a discussion of alternative locations and design options that have been considered to reduce heritage impacts; (c) in areas identified as having potential archaeological significance, undertake a comprehensive archaeological assessment in line with Heritage Council guidelines which includes a methodology and research design to assess the impact of the works on the potential archaeological resource and to guide physical archaeological test excavations and include the results of these excavations; (d) consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered	Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW (OEH, 2011) Aboriginal Cultural Heritage Consultation requirements for proponents (DECCW, 2010) Code of practice for archaeological investigation of Aboriginal objects in NSW (DECCW, 2010) NSW Skeletal Remains: Guidelines for Management of Human Remains (Heritage Office, 1998) Aboriginal site recording form Aboriginal site impact recording form Aboriginal Heritage Information Management System site registration form Care agreement application form Criteria for the assessment of excavation directors (NSW Heritage Council, 2011) NSW Heritage Manual (Heritage Office and Department of Urban Affairs and Planning, 1994) Assessing Heritage Significance (NSW Heritage Office, 2001) The Australia ICOMOS Burra Charter

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
	historical arrangements and access, increased traffic, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant); (e) outline measures to avoid and minimise those impacts in accordance with the current guidelines; and (f) be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria). 3. Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010). 4. Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines.	
9. Soils The environmental values of land, including soils, subsoils and landforms, are protected. Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination.	1. The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines. 2. The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the project area. 3. The Proponent must assess the impacts of the project on soil salinity and how it may affect groundwater resources and hydrology. 4. The Proponent must assess the impacts on soil and land resources (including bank stability, erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Managing Land Contamination: Planning Guidelines SEPP 55 –Remediation of Land, (DUAP & EPA, 1998) Guidelines for Consultants Reporting on Contaminated Sites (OEH, reprinted 2011) Guidelines for the NSW Site Auditor Scheme (DEC, 2006) Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 (EPA, 2015) Urban and regional salinity – guidance given in the Local Government Salinity Initiative booklets (http://www.environment.nsw.gov.au/salinity/solutions/urban.htm) which includes *Site Investigations for Urban* Salinity (DLWC, 2002) Landslide risk management guidelines presented in Australian Geomechanics Society (2007)

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
		Soil and Landscape Issues in Environmental Impact Assessment (DLWC 2000) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008) Other guidelines made or approved under section 105 of the *Contaminated Land Management Act 1997*
10. Water - Quality The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable).	1. The Proponent must: (a) state the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values; (b) identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment; (c) identify the rainfall event that the water quality protection measures will be designed to cope with; (d) assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes; (e) demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: – where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and – where the NSW WQOs are not currently being met, activities will work toward their achievement over time; (f) justify, if required, why the WQOs cannot be maintained or achieved over time; (g) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented; (h) identify sensitive receiving environments (which may include	NSW Water Quality and River Flow Objectives at http://www.environment.nsw.gov.au/ieo/ Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ ARMCANZ, 2000) Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECC, 2008) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008)

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
	estuarine and marine waters downstream such as the Solitary Islands Marine Park) and develop a strategy to avoid or minimise impacts on these environments; and (i) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	
11. Water - Hydrology Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised. The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved). Sustainable use of water resources.	1. The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the FBA. 2. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including: (a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge; (b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement; (c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources; (d) direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses; (e) minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the conveyance capacity of existing stormwater systems where discharges are proposed through such systems; and (f) water take (direct or passive) from all surface and groundwater	Framework for Biodiversity Assessment – Appendix 2 (OEH, 2014) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008) NSW Aquifer Interference Policy (DPI, 2012) NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013) Risk assessment Guidelines for Groundwater Dependent Ecosystems (Office of Water, 2012)

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
	sources with estimates of annual volumes during construction and operation. 3. The Proponent must identify any requirements for baseline monitoring of hydrological attributes. 4. The assessment must include details of proposed surface and groundwater monitoring.	
12. Flooding The project minimises adverse impacts on existing flooding characteristics. Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure.	1. The Proponent must assess and (model where required) the impacts from the project on flood behaviour, in particular Coffs Creek, during construction and operation for a full range of flood events up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including: (a) any detrimental increases in the potential flood affectation of the project infrastructure and other properties, assets and infrastructure; (b) consistency (or inconsistency) with applicable Council floodplain risk management plans; (c) compatibility with the flood hazard of the land; (d) compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land; (e) whether there will be adverse effect to beneficial inundation of the floodplain environment, on, or adjacent to or downstream of the site; (f) downstream velocity and scour potential; (g) impacts the project may have upon existing community emergency management arrangements for flooding, including Council's upper catchment detention basins. These matters must be discussed with the State Emergency Services and Coffs Harbour City Council; (h) any impacts the project may have on the social and economic costs to the community as consequence of flooding; (i) whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses; and (j) any mitigation measures required to offset potential flood risks attributable to the project.	NSW Government's Floodplain Development Manual (Department of Natural Resources, 2005) Practical Consideration of Climate Change - Flood risk management guideline (DECC, 2007) Coffs Creek Floodplain Risk Management Study draft Report October 2005 (CHCC)

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
13. Air Quality The project is designed, constructed and operated in a manner that minimises air quality impacts (including nuisance dust and odour) to minimise risks to human health and the environment to the greatest extent practicable.	1. The Proponent must undertake an air quality impact assessment (AQIA) for construction and operation of the project in accordance with the current guidelines. 2. The Proponent must ensure the AQIA also includes the following: (a) demonstrated ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulation 2010*; (b) an assessment of the impacts of the construction and operation of the project on sensitive receivers and the local community, including risks to human health; (c) details of the proposed mitigation measures to minimise the generation and emission of dust (particulate matter and TSP) and air pollutants (including odours) during the construction of the project, particularly in relation to the operation of ancillary facilities (such as concrete and asphalt batching), the use of mobile plant and machinery, stockpiles and the processing and movement of spoil, and construction vehicle movement along the alignment; and (d) a cumulative assessment of the local and regional air quality.	Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC, 2005) Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2005) Technical Framework - Assessment and Management of Odour from Stationary Sources in NSW (DEC, 2006)
14. Waste All wastes generated during the construction and operation of the project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects environmental values.	1. The Proponent must assess predicted waste generated from the project during construction and operation, including: (a) classification of the waste in accordance with the current guidelines; (b) estimates / details of the quantity of each classification of waste to be generated during the construction of the project, including bulk earthworks and spoil balance; (c) handling of waste including measures to facilitate segregation and prevent cross contamination; (d) management of waste including estimated location and volume of stockpiles; (e) waste minimisation (particularly of unsuitable material) and reuse; (f) lawful disposal or recycling locations for each type of waste; and (g) contingencies for the above, including managing unexpected waste volumes.	EPA's Waste Classification Guidelines (as in force from time to time) NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008)

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
	2. The Proponent must assess potential environmental impacts from the excavation, handling, storage on site, and transport and disposal of the waste particularly with relation to sediment/leachate control, noise and dust, and traffic and transport.	
15. Sustainability The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources. Conservation of natural resources is maximised.	1. The Proponent must assess the sustainability of the project in accordance with the Infrastructure Sustainability Council of Australia (ISCA) *Infrastructure Sustainability Rating Tool* and recommend an appropriate target rating for the project. 2. The Proponent must assess the project against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	Infrastructure Sustainability Rating Tool Scorecard relating to energy and carbon for large infrastructure projects, ISCA
16. Safety and Risk The project avoids, to the greatest extent possible, risk to public safety. The project is designed, constructed and operated to be resilient to the future impacts of climate change.	1. The Proponent must assess the likely risks of the project to public safety, paying particular attention to pedestrian safety, subsidence risks, bushfire risks and the storage, handling and use of dangerous goods. 2. The Proponent must assess the risk and vulnerability of the project to climate change in accordance with the current guidelines. 3. The Proponent must assess the biosecurity risk of the project to minimise the inadvertent spread of disease and pathogens affecting horticultural activities, vegetation and threatened fauna.	State Environmental Planning Policy No. 33 - Hazardous and Offensive Development Australian Government's Climate Change Impacts and Risk Management – A Guide for Business and Government (2006) AS/NZS 3100:2009 Risk Management – Principles and Guidelines Technical Guide for Climate Change Adaptation for the State Road Network (RMS, in draft)

ATTACHMENT A

Guideline for preparing Assessment Documentation relevant to the *Environment Protection and Biodiversity Conservation Act 1999*

Guidelines for preparing Assessment Documentation relevant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

Pacific Highway Upgrade Coffs Harbour Bypass (EPBC 2017/8005)

1. On 22 September 2017 it was determined that the Pacific Highway Upgrade Coffs Harbour Bypass will impact upon the following matters of national environmental significance (MNES) protected under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*:

   - **threatened species and communities (section 18 and section 18A)**

   The project will be assessed in accordance with the NSW Assessment Bilateral Agreement 2015 (the Agreement) and as such is required to be assessed in the manner specified in Schedule 1 to that Agreement. These requirements are a supplement to the Secretary's Environmental Assessment Requirements issued on 16 June 2016 and should be addressed in conjunction with those requirements.

2. Assessment documentation prepared for the purposes of approval under the EPBC Act must, in addition to providing sufficient information for a decision in accordance with the Agreement, address the matters outlined in Schedule 4 of the *Environment Protection and Biodiversity Conservation Regulations 2000 (*Cth). Proponents are advised to check that requirements in Schedule 4 of the EPBC Regulations have been appropriately addressed. http://www.austlii.edu.au/au/legis/cth/consol_reg/epabcr2000697/.

3. The requirements are intended such that there is sufficient information in the assessment report relevant to MNES such that the Commonwealth decision-maker may make a determination on whether or not to approve the action. The proponent must undertake an assessment of all the protected matters that may be impacted by the development under the controlling provision identified in paragraph 1. A list of protected matters that are considered likely to be significantly impacted is provided at Annexure 1 to these Guidelines. Note that this may not be a complete list and it is the responsibility of the proponent to ensure any protected matters under this controlling provision, likely to be significantly impacted, are assessed for the Commonwealth decision-maker's consideration.

General Requirements

Project Description

4. The title of the action, background to the development and current status.

5. The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on matters of national environmental significance (MNES).

6. How the action relates to any other actions that have been, or are being taken, in the region affected by the action.

7. How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.

Impacts

8. The EIS must include an assessment of the relevant impacts[7] of the action on threatened species and communities; including

   - a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts;
   - a statement whether any relevant impacts are likely to be known, unpredictable or irreversible; analysis of the significance of the relevant impacts;
   - any technical data and other information used or needed to make a detailed assessment of the relevant impacts; and
   - a comparative description of the impacts of alternatives, if any, on the threatened species and communities.

Avoidance, mitigation and offsetting

9. For each of the relevant matters protected that are likely to be significantly impacted by the development, the EIS must provide information on proposed avoidance and mitigation measures to deal with the relevant impacts of the action, including:

   - a description and an assessment of the expected or predicted effectiveness of the mitigation measures;
   - any statutory policy basis for the mitigation measures;
   - the cost of the mitigation measures;
   - a description of the outcomes that the avoidance and mitigation measures will achieve;
   - an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action;
   - the name of any agency responsible for endorsing or approving a mitigation measure or monitoring program; and
   - a description of the offsets proposed to address the residual adverse significant impacts and how these offsets will be established.

10. Where a significant residual adverse impact to a threatened species or community is considered likely, the EIS must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy. Paragraphs 13 and 14 provide further requirements in relation to offsets.

Key Issues – Biodiversity

11. The EIS must address the following issues in relation to Biodiversity including separate:

    - identification of each EPBC Act listed threatened species and community likely to be impacted by the development. Provide evidence why other EPBC Act listed threatened species and communities likely to be located in the project area or in the vicinity will not be impacted.

[7] Relevant impacts are those impacts likely to significantly impact any matter protected under the EPBC Act

12. For each of the relevant EPBC Act listed threatened species and communities likely to be impacted by the development the EIS must provide a separate:

    - description of the habitat and habits (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans, threat abatement plans and wildlife conservation plans.
    - details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements.
    - description of the impacts of the action having regard to the full national extent of the species or community's range.

[Note: the relevant guidelines and policy statements for each species and community are available from the Department of the Environment Species Profiles and Threats Database.http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl]

13. For each of the relevant EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide a separate:

    - identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account.
    - details of how the current published NSW Framework for Biodiversity Assessment (FBA) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts.
    - details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the development in accordance with the FBA and/or mapping and descriptions of the extent and condition of the relevant habitat and/or threatened communities occurring on proposed offset sites.

    [Note: For the purposes of approval under the EPBC Act, it is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. In applying the FBA, residual impacts on EPBC Act listed threatened ecological communities must be offset with Plant Community Type(s) (PCT) that are ascribed to the specific EPBC listed ecological community. PCTs from a different vegetation class will not generally be acceptable as offsets for EPBC listed communities.]

14. Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offset Policy. http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy. [Note if the EPBC Act Environmental Offset Policy is used to calculate proposed offsets for a threatened species or community you may wish to seek further advice from the Department of Planning and Environment.]

15. For each threatened species and community likely to be significantly impacted by the development, the EIS must provide reference to, and consideration of, relevant approved conservation advice or recovery plan for the species or community.

[Note: the relevant guidelines and policy statements for each species and community are available from the Department of the Environment Species Profiles and Threats Database. http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl]

Environmental Record of person proposing to take the action

16. Information in relation to the environmental record of a person proposing to take action must include details as prescribed in Schedule 4 Clause 6 of the EPBC Regulations 2000.

Information Sources

For information given in the EIS, the EIS must state the source of the information, how recent the information is, how the reliability of the information was tested; and what uncertainties (if any) are in the information.

REFERENCES

1. *Environment Protect and Biodiversity Conservation Act 1999* - section 51-55, section 96A(3)(a)(b), 101A(3)(a)(b), section 136, section 527E
2. NSW Assessment Bilateral Agreement (2015) - Item 18.1, Item 18.5, Schedule 1
3. *Matters of National Environmental Significance - Significant impact guidelines 1.1* (2013) EPBC Act
4. *Environment Protect and Biodiversity Conservation Act 1999* Environmental Offsets Policy October 2012

Annexure 1

The Department of the Environment's Environment Reporting Tool (ERT) identifies threatened species and communities that may occur within 2 km of the proposed action. Based on the information in the referral documentation, the location of the action, species records and likely habitat present in the area, there are likely to be significant impacts to:

- Koala (*Phascolarctos cinereus*) (*combined populations of Queensland, NSW and ACT*) – vulnerable
- Giant Barred Frog (*Mixophyes iterates)* – endangered
- Spotted-tail Quoll (*Dasyurus maculatus maculatus)* (*SE mainland population*) – endangered

In addition, there is some risk that there may be significant impacts on the following matters and levels of impact should be further investigated.

- Regent Honeyeater (*Anthochaera Phrygia*) – critically endangered
- Swift Parrot (*Lathamus discolor*) – critically endangered
- Grey-headed Flying-fox (*Pteropus poliocephalus)* - vulnerable
- Long-nosed Potoroo (*Potorous tridactylus tridactylus)* – vulnerable
- Hairy-joint Grass (*Arthraxon hispidus*)- vulnerable
- Orara Boronia (*Boronia umbellata)* – vulnerable
- Clear Milkvine (*Marsdenia longiloba)* - vulnerable
- Lesser Swamp-orchid (*Phaius australis)* – endangered
- *Samadera* sp. Moonee Creek (J.King s.n. Nov. 1949) – endangered
- *Tylophora woollsii* – endangered
- Lowland Rainforest of Subtropical Australia – critically endangered

An assessment in accordance with clauses 11-15 of these guidelines for all of these matters above must be presented in the EIS.

Appendix E – Biodiversity offset strategy

Transport Roads & Maritime Services

NSW GOVERNMENT

Coffs Harbour Bypass

Biodiversity Offset Strategy (BOS)

July 2019

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Roads and Maritime Services

Coffs Harbour Bypass
Biodiversity Offset Strategy

July 2019

Prepared by Biosis/Arup (Section 1) and Northern Project Office (Roads and Maritime Services)

Document history and status

Revision	Date	Description	By	Review	Approved
V1	14/9/2018	Working draft	Biosis/K Wells	R Mitchell	
V2	24/9/2018	Draft	Biosis/K Wells	R Mitchell	
V3	4/07/2019	Draft	Arup/K Wells	R Mitchell J Ravallion	

Executive summary

Roads and Maritime Services (Roads and Maritime) is seeking approval for the Coffs Harbour Bypass (the project) located to the west of the Coffs Harbour urban area in northern NSW. The project is located in the Coffs Harbour local government area (LGA). Approval is being sought under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as Critical State Significant Infrastructure (CSSI).

The project includes a 12 kilometre bypass of Coffs Harbour from south of Englands Road to Korora Hill in the north and a two kilometre upgrade of the existing highway between Korora Hill and Sapphire. The project would provide a four-lane divided highway that bypasses Coffs Harbour, passing through the North Boambee Valley, Roberts Hill ridgeline and then traversing the foothills of the Coffs Harbour basin to the west and north to Korora Hill.

The Project has been determined to be State Significant Infrastructure (SSI) and approval for the Project is being sought under Part 5.2 of the EP&A Act. An EIS is a requirement of the approval process. SEARs were issued by the NSW Department of Planning and Environment (DPE) in June 2016, and were updated in October 2017, and state that biodiversity impacts must be assessed and documented in accordance with the Framework for Biodiversity Assessment (OEH 2014a) and the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014b).

The project has also been referred under the EPBC Act (2017/8005) and deemed a controlled action to be assessed under the Bilateral agreement made under section 45 of the EPBC Act relating to environmental assessment between the Commonwealth of Australia and the State of New South Wales. The bilateral agreement endorses the FBA and the NSW Biodiversity Offsets Policy as accredited processes. Guidelines for preparing the EIS under the Bilateral agreement have been provided by the Australian Government Department of the Environment and Energy (DoEE)

This Biodiversity Offset Strategy (the Strategy) outlines the offsets required for the biodiversity impacts associated with the project. The impacts from the project that require offsets (ecosystem and species credits) under the FBA are as follows:

- PCT692 Blackbutt-Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion – 926 credits
- PCT695 Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion – 616 credits
- PCT 747 Brush Box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion – 365 credits
- PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion – 248 credits
- PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast – 64 credits
- PCT 1262 Tallowwood-Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast – 100 credits
- PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW north Coast Bioregion – 184 credits
- PCT 1302 White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion – 144 credits
- Rusty plum (*Niemeyera whitei*) – 855 credits
- Southern swamp orchid (*Phaius australis*) – 13 credits
- Coastal petaltail (*Petalura litorea*) – 192 credits
- Giant barred frog (*Mixophyes iteratus*) – 253 credits
- Green-thighed frog (*Litoria brevipalmata*) – 23 credits
- Koala (*Phascolarctos cinereus*) – 954 credits
- Pale-vented bush-hen (*Amaurornis moluccana*) – 64 credits

- Southern myotis (*Myotis macropus*) – 332 credits

This Strategy is based on the impacts associated with the 80% concept design for the project. During the detailed design phase the project footprint may change from that assessed here which would result in a different offset requirement for the project than what is presented in this Strategy. Any increases in clearing as a result of detailed design (which is unlikely as a "worse case" clearing footprint has been assessed) will be subject to environmental assessment in accordance with the modification provisions of the EP&A Act and any offset recalculations will be done in accordance with the FBA and the requirements of the EPBC Act bilateral Agreement.

In terms of offset availability, a review of available credits on the OEH public credit register indicates that all of the required offsets are not available. However, Roads and Maritime has made significant progress in sponsoring landholders to participate in the former BioBanking scheme and the current Biodiversity Offset Scheme. In addition, Roads and Maritime has utilised its own residual land portfolio as a source of credits and has purchased a property for this project for use as an offset. This offset strategy will be retiring credits on a like for like basis from these sources for the majority of its offset obligation (and all MNES matters) under this strategy. From assessments already undertaken, Roads and Maritime have secured 44% of the giant barred frog credits, 89% of the coastal petaltail credits and 100% of the green-thighed frog credits.

If Roads and Maritime is unable to purchase like-for-like credits after taking reasonable steps, payment to the Biodiversity Conservation Trust Biodiversity Offset Fund will be considered in accordance with the provisions of the EPBC Act bilateral agreement or we would seek to purchase credits in accordance with the variation rules for non MNES.

This Strategy will be updated when detailed assessments of each of the candidate sites are available.

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Glossary of terms for this template

Definitions

Ecosystem credit	Ecosystem or species credits (OEH 2014).
Ecosystem credit species	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site. (OEH 2014a)
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (OEH 2014).
Matters for further consideration	Impacts that are considered to be complicated or severe that will require further consideration by the consent authority (OEH 2014a). The assessment is based on thresholds detailed in Section 9 of the FBA. These can also be included as part of the project SEARs.
Matters of NES	A matter of national environmental significance (MNES) protected by a provision of Part 3 of the EPBC Act
Project area/ Proposal site	The area of land that is directly impacted on by a proposed Major Project that is under the EP&A Act, including access roads, and areas used to store construction materials (OEH 2014b).
Species credit species	Threatened species and populations that are assessed according to Section 6.4 of the FBA (OEH 2014a).
Study area	The area directly affected by the development and any additional areas likely to be affected by the development, either directly or indirectly (OEH 2014a).

Abbreviations

BAR	Biodiversity Assessment Report
BBCC	BioBanking Credit Calculator
BVT	Biometric Vegetation Type
CEMP	Construction Environmental Management Plan
DP&E	Department of Planning and Environment
DPI	Department of Primary Industries
EEC	Endangered ecological community
EIS	Environmental Impact Statement
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Federal).
FBA	Framework for Biodiversity Assessment
FM Act	Fisheries Management Act 1994 (NSW)
GDE	Groundwater dependent ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia
MNES	Matters of National Environmental Significance
OEH	Office of Environment and Heritage
PCT	Plant Community Type
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSI	State Significant Infrastructure
TECs	Threatened Ecological Communities
TSPD	Threatened Species Profile Database
TSC Act	Threatened Species Conservation Act 1995 (NSW).
VIS	Vegetation information system

1 Introduction

1.1 Project background

Roads and Maritime Services (Roads and Maritime) is seeking approval for the Coffs Harbour Bypass (the project) located to the west of the Coffs Harbour urban area in northern NSW. The project is located in the Coffs Harbour local government area (LGA) (Figure 1). Approval is being sought under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as Critical State Significant Infrastructure (CSSI).

The project includes a 12 km bypass of Coffs Harbour from south of Englands Road to Korora Hill in the north and a two kilometre upgrade of the existing highway between Korora Hill and Sapphire. The project would provide a four-lane divided highway that bypasses Coffs Harbour, passing through the North Boambee Valley, Roberts Hill ridge and then traversing the foothills of the Coffs Harbour basin to the west and north to Korora Hill.

The Project has been determined to be State Significant Infrastructure (SSI) and approval for the Project is being sought under Part 5.2 of the EP&A Act. An EIS is a requirement of the approval process. SEARs were issued by the NSW Department of Planning and Environment (DPE) (now DPIE) in June 2016, and were updated in October 2017, and state that biodiversity impacts must be assessed and documented in accordance with the Framework for Biodiversity Assessment (OEH 2014a) and the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014b).

The Project has also been referred under the EPBC Act referral (2017/8005) and deemed a controlled action to be assessed under the Bilateral agreement made under section 45 of the EPBC Act relating to environmental assessment between the Commonwealth of Australia and the State of New South Wales. The bilateral agreement endorses the FBA and the NSW Biodiversity Offsets Policy as accredited processes. Guidelines for preparing the EIS under the Bilateral agreement have been provided by the Australian Government Department of the Environment and Energy (DoEE).

There have been recent changes to environmental and biodiversity assessment regulations in NSW. The *Threatened Species Conservation Act 1995* (TSC Act) was repealed and replaced by the *Biodiversity Conservation Act 2016* (BC Act) on 25 August 2017; however, the NSW Government established transitional arrangements related to biodiversity assessment for the various categories of development consent or approval that are underway or have already been made. These transitional arrangements are defined in the Biodiversity Conservation (Savings and Transitional) Regulation 2017. In October 2017 and March 2019, DP&E (now DPIE) confirmed the project is considered a “pending or interim planning application” and the TSC Act would still apply to the project under the transitional arrangements in accordance with clause 27(1) (a) of the Biodiversity Conservation (Savings and Transitional) Regulation 2017.



Figure 1: Coffs Harbour Bypass project area

1.2 Offset requirements

Biodiversity offsets have been calculated using the FBA which is has been endorsed by the Commonwealth as part of the EPBC Act assessment bilateral agreement.

Biodiversity offsets will be secured by a combination of credits generated under the former NSW BioBanking Scheme and its replacement the NSW Biodiversity Offsets Scheme (BOS). Roads and Maritime will apply to OEH for a 'Statement of Reasonable Equivalence' where credits generated under the BOS are being used to meet an obligation under the FBA.

No offsetting is required for impacts to aquatic biodiversity under the FM Act.

Table 1.1 provides the list of values recorded and the credits required to offset impacts to those values.

Table 1.1 Biodiversity credits required

Biodiversity value	Credits required
Ecosystem credits	
PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	926
PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	616
PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	365
PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	248
PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast	64
PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	100
PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	184
PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion	144
Total	**2,647**
Species credits	
Rusty plum *Niemeyera whitei*	855
Southern swamp orchid *Phaius australis*	13
Coastal petaltail *Petalura litorea*	192
Giant barred frog *Mixophyes iterates*	253
Green-thighed frog *Litoria brevipalmata*	23

Biodiversity value	Credits required
Koala *Phascolarctos cinereus*	954
Pale-vented bush-hen *Amaurornis moluccana*	64
Southern myotis *Myotis macropus*	332
Total	**2,686**

2 Biodiversity offset strategy

2.1 Offset identification

Roads and Maritime's first preference is to purchase available biodiversity credits. A review of the OEH Biodiversity credits and expressions of interest (EOI) registers was undertaken to identify whether there are suitable existing credits or sites on the market. Roads and Maritime also reviewed whether any suitable credits were being held from other Pacific Highway Upgrade Projects.

The next preference is to facilitate or create credits by progressing biodiversity stewardship agreements on candidate properties. An initial desktop assessment of potential sites for offsetting was undertaken by:

- Listing required credits on the OEH credits wanted register
- Re-examining sites submitted during the Woolgoolga to Ballina Pacific Highway upgrade Expressions of Interest process
- Reviewing land acquired by Roads and Maritime for the project
- Liaising with local real estate agents
- Informal discussions with land owners affected by the project.

2.2 Available credits

2.2.1 Credit searches

OEH maintains a public register of existing biodiversity stewardship sites as well as a list of EOIs for the development of biodiversity stewardship sites on the Biodiversity credits public register. An initial search of the Biodiversity credits register was conducted on 20 April 2018 and has been undertaken periodically since then. The latest search (5 June 2019) showed there are the following credits available that are consistent with the offset options detailed in the credit report. Any credits already owned by Roads and Maritime that are committed for other projects have not been included in the following table.

Table 2.1: Summary of available ecosystem credits for the Coffs Harbour bypass project

ID/name	IBRA sub-region	Credits available
PCT 692 Blackbutt-Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion		
BioBank site 1 BA229	Coffs Coast and & Escarpment	Tallowwood-Turpentine moist open forest of the northern ranges of the NSW North Coast Bioregion – 221 credits
PCT695 Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion.		
BioBank site 1 BA229	Coffs Coast and & Escarpment	Tallowwood-Turpentine moist open forest of the northern ranges of the NSW North Coast Bioregion – 221 credits
PCT 747 Brush Box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion		
No offset options available		
PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion		
BioBank site 2 BA351	Coffs Coast and & Escarpment	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion – 29 credits.

BA396	Coffs Coast & Escarpment	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin bioregion – 178 credits.
BioBank site 3 BA 167	Macleay Hastings	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion – 92 credits
BioBank site 3 BA 167	Macleay Hastings	Swamp Mahogany swamp forest of the coastal lowlands of the NSW North Coast Bioregion and northern Sydney Basin Bioregion – 83 credits
BioBank site 4 BA 212	Macleay Hastings	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion – 681 credits.
BioBank site 4 BA 212	Macleay Hastings	Swamp Mahogany swamp forest of the coastal lowlands of the NSW North Coast Bioregion and northern Sydney Basin Bioregion – 380 credits
BA 275	Macleay Hastings	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion – 998 credits.
BA275	Macleay Hastings	Swamp Mahogany swamp forest of the coastal lowlands of the NSW North Coast Bioregion and northern Sydney Basin Bioregion – 244 credits.
PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast		
No offset options available		
PCT 1262 Tallowwood-Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast		
BioBank site 1 BA 229	Coffs Coast and & Escarpment	Blackbutt-Tallowwood dry grassy open forest of the central parts NSW North Coast Bioregion – 9 credits
BioBank site 2 BA 351	Coffs Coast and & Escarpment	Blackbutt-Tallowwood dry grassy open forest of the central parts NSW North Coast Bioregion – 36 credits
BioBank site 4 BA 212	Macleay Hastings	Blackbutt-Tallowwood dry grassy open forest of the central parts NSW North Coast Bioregion – 229 credits
PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion		
No offset options available		
PCT 1302 White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion		
No offset options available		

Species credits

Table 2.2: Summary of available species credits for the Coffs Harbour bypass project

Species credit	Available on credit register	IBRA sub-region	Priority for purchase?
Giant barred frog	9	Coffs Coast & Escarpment	No, 111 species credits have already been purchased from existing BioBanking

			Agreements. This species has also been recorded on two of the priority offset sites.
Koala	18,000+ 63 1760	Statewide Coffs Coast & Escarpment Macleay Hastings	No, koalas have been recorded on two of the priority offset properties and are highly likely on a third priority offset property.
Southern myotis	309	Upper Hunter	No, this species is likely to occur on several of the priority offset sites.
Green-thighed frog	265	Coffs Coast & Escarpment	No, required credits for this species are currently being created from a RMS BSA.
Pale-vented bush-hen	204	Murwillumbah	Yes, no further credits for this species can be created from new BSAs.
Coastal petaltail	0	-	-
Rusty plum	0	-	-
Southern swamp orchid	0	-	-

There are no or an insufficient number of ecosystem or species credits available for the majority of PCTs and species required to be offset by the project.

Roads and Maritime submitted a request on the OEH Biodiversity credits wanted register on 19 July 2018. As a result, three enquiries were received, all from credit brokers.

Properties that had previously expressed interest in becoming a biodiversity stewardship site through the Woolgoolga to Ballina Pacific Highway upgrade Expressions of Interest process were also reviewed. Attempts to contact one potentially suitable property have been unsuccessful.

2.2.2 Purchase and creation of credits

Roads and Maritime has purchased 111 species credits for the giant barred frog from two existing BioBanking Agreements within the Coffs Coast and Escarpment IBRA sub-region.

Roads and Maritime is currently preparing a Biodiversity Stewardship Agreement application for a property at Glenugie which will provide credits for the green-thighed frog. The application should be submitted to OEH in late 2019, with the credits available by mid-2020. The site is in the Clarence Lowland IBRA sub-region and is 50 km north of the project.

Roads and Maritime is currently preparing a variation to an existing BioBank Agreement to create 170 coastal petaltail species credits. The site is in the Clarence Lowland IBRA sub-region and is approximately 50 km north of the project.

Roads and Maritime offered to purchase 64 of the available pale-vented bush-hen credits, however the owner advised that they are not currently available for purchase.

For the remaining ecosystem and species credits available for sale, Roads and Maritime is expecting to create credits from the offset sites that will be secured for this project so is not progressing negotiations with the owners of the available credits at this stage. This will be reviewed after the detailed assessments have been completed on the priority properties.

Table 2.2 Credits to be to purchased or under creation

Biodiversity credit	Number to be purchased/created	Credits still required
Giant barred frog	111 (purchased)	142
Green-thighed frog	210 (created)	0

Biodiversity credit	Number to be purchased/created	Credits still required
Coastal petaltail	170 (created)	22
Pale-vented bush-hen	64 (available on register)	64 (unable to purchase)

2.3 Potential offset sites

BioBanking EOI register

- There are currently four EOIs in the Coffs Coast and Escarpment IBRA sub-region. Emails were sent to all four EOIs on 25 May 2018. Two responses have been received and one is being progressed. An initial site visit on this property was undertaken on 7 June 2018 and confirmed the property is likely to contain a number of the PCTs and species credits required for the project.
- There is one EOI in the adjoining Chaelundi IBRA sub-region. An email was sent on 25 May 2018, however the owner could not be contacted by the Office of Environment and Heritage.

Consultation

Roads and Maritime has identified one property through a direct approach from the landowner who is in close proximity to the proposed alignment. An initial site visit of this property was undertaken on 21 June 2018. The site is likely to contain a number of the PCTs and species credits required for the project.

Roads and Maritime Services is monitoring properties for sale in the region and has identified several suitable properties. Initial site visits were undertaken over July and August 2018 to confirm their suitability for rapid assessment. One site was purchased in March 2019.

Summary

Table 2.3 includes a summary of the properties identified as potential offset sites and the identified vegetation types and areas based on desktop work. As detailed site work has not been completed, an average of 9.3 credits per hectares has been used to determine the likely credits generated.

Table 2.3 Potential sites

Site ID[1]	Biodiversity values			Comments
	PCTs / Threatened species	Area (ha)	Likely credits generated	
CHB 1	Koala, GBF, wet sclerophyll PCTs	33	307	EOI property, rapid assessment
CHB 2	Koala, GBF, rusty plum, wet sclerophyll PCTs	34	307	Direct approach by landowner, rapid assessment
CHB 3	Koala, wet sclerophyll PCTs	80	744	For sale, desktop assessment.
CHB 4	Koala, GBF, rusty plum, lowland rainforest, wet sclerophyll PCTs	459	4,269	Purchased by RMS. BSA assessment July 2019.
CHB 5	Paperbark swamp, coastal petaltail dragonfly, southern swamp orchid	580	5,394	Joint RMS/NPWS acquisition. BSA assessment August 2019.

2.4 Priority sites

2.4.1 Prioritisation process

Following the desktop assessment four properties were short-listed for further consideration. Site 3 was excluded as it has been sold to another party. The suitability of the four remaining potential

sites identified in Table 2.2 was ranked through further desktop assessment based on the following criteria:

- Presence of vegetation communities requiring offsets
- Connectivity with other areas of habitat
- Located within 50km of the project
- Suitability of the land use zoning
- Records of threatened species and suitability of mapped vegetation as potential habitat
- Current condition and potential for improvement.
- Size and shape of remnants.
- Site area greater than 40 hectares.

Rapid ground-truthing surveys were conducted on all short-listed sites to confirm the desktop assessment and suitability as an offset.

2.4.2 Priority sites

Four priority sites have been selected after the rapid assessment process. Sites 1, 2 and 4 all occur in the Coffs Coast and Escarpment IBRA sub-region. Site 5 occurs in the adjoining Yuraygir IBRA sub-region (refer to overview map in Appendix B).

As the current credit calculator is not consistent with the calculator used for the project impacts and a credit conversion hasn't yet been applied for, an average of 9.3 credits per hectares has been assumed to determine the likely credits generated. Table 2.4 includes offset options for each PCT as identified in the credit report for the project's impact that occur on each priority site.

For species credits, known or likely habitat has been indicated on each of the priority sites for the outstanding species credit requirements.

Table 2.4 Summary of priority sites

PCTs / Threatened species	Credits available for Coffs Harbour bypass				Total credits
	Site CHB1	Site CHB2	Site CHB4	Site CHB5	
White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion (PCT1302) Permitted variation: Soft Corkwood-Yellow Carabeen-Cryptocarya spp. Subtropical rainforest of the NSW North Coast (PCT1201)	66	28	148		242
Blackbutt-Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (PCT692) <u>Offset options:</u> Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (PCT695) Blackbutt tall moist forest of the coastal ranges of the central and southern NSW		34	807 373		1214

PCTs / Threatened species	Credits available for Coffs Harbour bypass				Total credits
North Coast Bioregion (PCT699)					
Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (PCT695)	29	77	697		803
Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast (PCT1244)			74		74
Brush box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion (PCT747)	206	89	390		685
Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT1064)				250	250
Tallowwood-Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast (PCT1262) <u>Offset options:</u> Blackbutt-Turpentine open forest of the foothills of the NSW North Coast Bioregion (PCT697)			55 55		110
Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion <u>Offset options:</u> Flooded Gum-Tallowwood-Brush Box moist open forest of the coastal ranges of the North Coast (PCT827) Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast (PCT1244)	9	85	37 102		233
Rusty plum	Likely	Known	Likely		
Giant barred frog	Known	Known	Known		
Pale-vented bush hen	Suitable habitat	Suitable habitat	Suitable habitat		
Koala	Known	Known	Likely		
Southern swamp orchid				Likely	
Coastal petaltail				Likely	
Southern myotis			Suitable habitat	Likely	

CHB1 and 2 are proposed to be Biodiversity Stewardship Agreements and will remain under private ownership. The on-ground assessments have commenced on both properties.

CHB4 has been acquired by Roads and Maritime and will be placed under a Biodiversity Stewardship Agreement before being on-sold.

CHB5 is a joint acquisition with the NPWS, with Roads and Maritime also contributing the full Total Fund Deposit required for the on-going management of the site in-perpetuity. The site was acquired in early 2019, with final agreement with NPWS on the on-going management costs expected later in 2019.

2.5 Offset security and expected timeframes

A Biodiversity Stewardship Agreement under the NSW *Biodiversity Conservation Act 2016* will be entered into for Sites 1, 2 and 4 in perpetuity. The Biodiversity Stewardship Agreement will be registered on the property title and is binding on successors in title. Ongoing annual management funding will be provided through the Total Fund Deposit for each site and the BCT will manage annual reporting and compliance.

Site 5 will become part of the Yuraygir National Park. Funding will be provided to NPWS for on-going management of the site.

Roads and Maritime is aiming to have the credits required for the project created and purchased by late 2019-mid 2020, prior to the commencement of construction. Roads and Maritime intends to hold the required credits until the mainline clearing is completed (estimated 2022), at which point the required credits to offset the area cleared will be retired. Any surplus credits will be maintained until post-construction to cover any additional or unforeseen impacts.

2.6 Variation rules and supplementary measures

If Roads and Maritime is unable to locate a like-for-like offset after taking reasonable steps, the variation rules can be applied to locate an appropriate offset for non-EPBC Act listed matters. The variation rules allow vegetation to be offset with a broader suite of similar vegetation types in the locality that have undergone a similar of greater amount of past clearing. They also allow species to be offset with similar species in the locality that use the same habitat and are under a similar or greater level of threat. Before variation rules can be used, Roads and Maritime will:

- Continue to check the public credit register; and
- Liaise with OEH and local councils to identify potential sites that meet the requirements for offsetting.

If appropriate offset sites cannot be found, Roads and Maritime can then provide funds for supplementary measures.

Based on this Strategy, Roads and Maritime Services is only planning to use the variation rules for one PCT (PCT1302 White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion) if required. No variation rules or supplementary measures will be required to meet the other offset requirements. However, this will be reviewed upon the final credit assessment for each of the priority sites and the final credit requirements for the project.

2.7 Other biodiversity impacts requiring offsets

No offsets are required under the FM Act or for migratory species or GDEs.

2.8 Summary of offset measures

Based on the current requirements and pending detailed survey, the four priority offset sites and the proposed credit purchases will meet both the ecosystem and species credits required for this project.

Table 2.5 Summary of offset measures for the Coffs Harbour bypass project

PCTs/Threatened species	Credit requirement	Credits available/expected (includes offset options)	Shortfall/surplus
White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion	144	242	+98
Blackbutt-Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion	926	1214	+288
Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion	616	803	+187
Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast	64	74	+10
Brush box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	365	685	+320
Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	248	250	+2
Tallowwood-Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	100	110	+10
Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion	184	233	+49
Rusty plum	855	855*	0
Giant barred frog	253	111 (purchased) 142*	0
Pale-vented bush hen	64	0	64 (credits cannot be created under new BSAs)
Green-thighed frog	23	23 (to be created from RMS BSA)	0
Koala	954	954*	0
Southern swamp orchid	13	13#	0
Coastal petaltail	192	170 (to be created from RMS BA 435)	0

		22#	
Southern myotis	332	332#	0

* Koala, Giant Barred Frog and Rusty Plum have been confirmed on the candidate offset sites.
# suitable habitat for these species occurs on the candidate offset sites. Presence will be confirmed during detailed surveys.

2.9 Matters of National Environmental Significance

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The EIS indicates that two MNES will be significantly impacted by the project, koala and giant barred frog. The candidate offset sites have occupied habitat for both species that is equal to or in better condition than that being impacted by the project.

Giant barred frogs have been observed at Sites 2 and 4. Koalas have been observed on Sites 1 and 2 and are highly likely to occur on Site 4. This will be confirmed in the full assessment.

The offsets being provided also provide offsets for a number of MNES not significantly impacted by the project. Table 2.6 shows the MNES offsets provided by each PCT that occurs on the offset sites.

Table 2.6 Offsets provided for MNES potentially impacted by the project. MNES found to be significantly impacted are in bold.

MNES	EPBC Act status	Habitat impacted	Credit type	Total habitat present on offset sites (ha)	Habitat present on offset sites (ha and credits for each PCT) (habitat references from Table 5.1 of the BAR)
Giant barred frog (*Mixophyes iteratus*)	Endangered	4.79 ha of known and potential habitat	Species	280.5 ha	Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (PCT695) – 173.1 ha, est. 1610 credits. Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast (PCT1244) – 8 ha, est. 74 credits. Tallowwood-Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast (PCT 1262), 6 ha, est. 55 credits. Blackbutt-Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (PCT692), 3.7 ha, est. 34 credits. Brush box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion (PCT747), 73.7 ha, est. 685 credits. White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion (PCT1302), 16 ha, est. 148 credits.
Koala (*Phascolarctos cinereus*)	Vulnerable	43.37 ha of known and potential habitat	Species	318 ha	Blackbutt-Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (PCT692), 3.7 ha, est. 34 credits. Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (PCT695) – 173.1 ha, est. 1610 credits. Brush box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion (PCT747), 73.7 ha, est. 685 credits. Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT1064) – 37.5 ha, est. 349 credits. Sydney Blue Gum open forest on coastal foothills and

					escarpment of the North Coast (PCT1244) – 8 ha, est. 74 credits. Tallowwood-Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast (PCT 1262), 6 ha, est. 55 credits. White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion (PCT1302), 16 ha, est. 148 credits.
Southern swamp orchid (*Phaius australis*)	Endangered	1 individual, 5.77 ha of known and potential habitat	Species	215 ha	Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (PCT695) – 173.1 ha, est. 1610 credits. Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT1064) – 37.5 ha, est. 349 ha.
Grey-headed flying fox (*Pteropus poliocephalus*)	Vulnerable	43.37 ha of known and potential foraging habitat	Ecosystem	243 ha	Blackbutt-Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (PCT692), 3.7 ha, est. 34 credits. Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (PCT695) – 173.1 ha, est.1610 credits. Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT1064) – 37.5 ha, est. 349 ha. Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast (PCT1244) – 8 ha, est. 74 credits. White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion (PCT1302), 16 ha, est. 148 credits.
Regent honeyeater (*Anthochaera phrygia*)	Critically Endangered	3.65 ha of potential foraging habitat	Ecosystem	37.5 ha	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT1064) – 37.5 ha, est. 349 ha.
Spotted-tail quoll	Endangered	43.37 ha of potential	Ecosystem	249 ha	Blackbutt-Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion (PCT692), 3.7 ha,

(*Dasyurus maculatus maculatus*)		habitat			est. 34 credits. Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion (PCT695) – 173.1 ha, est. 1610 credits. Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT1064) – 37.5 ha, est. 349 ha. Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast (PCT1244) – 8 ha, est. 74 credits. Tallowwood-Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast (PCT 1262), 6 ha, est. 55 credits. White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion (PCT1302), 16 ha, est. 148 credits.

3 Conclusion

This strategy outlines the offsets required for the biodiversity impacts associated with the project and demonstrates that appropriate offsets are likely to be available and can be delivered for the project.

While the preferred approach was the purchase of credits available on the BioBanking Credit Register, insufficient credits are available from the North Coast IBRA sub-regions to meet the project's full requirements. This strategy identifies the following credit purchases:

- 111 credits of giant barred frog, purchased in 2019;
- 170 credits of coastal petaltail, currently being created from a Roads and Maritime BioBanking Agreement (BA 435); and
- 23 credits for green-thighed frog, which are surplus from a site owned by Roads and Maritime that will be created under a Biodiversity Stewardship Agreement in 2019-20.

To ensure a direct 'like for like' offset for the remaining offsets, Roads and Maritime has identified four candidate offsets sites that will meet the projects offset requirements, subject to detailed surveys being carried out on all properties. The sites meet the requirements of the credit report in that three are in the Coffs Coast and Escarpment IBRA sub-region with the fourth in the adjoining Yuraygir IBRA sub-region.

A direct like-for-like offset is available for all of the ecosystem credits required for the project. The variation rules may be used to meet some of the offset requirement for the White Booyong-Fig Subtropical Rainforest PCT pending the results of detailed vegetation assessment.

Direct like-for-like offsets will be available for the following species, which have been confirmed on the candidate offset sites.

- Rusty plum
- Giant barred frog
- Koala

Direct like-for-like offsets are likely to be available for the following species, based on suitable habitat contained on the candidate offset sites and records in close proximity to the candidate offset sites:

- Pale-vented bush hen
- Southern swamp orchid
- Coastal petaltail
- Southern myotis

The FBA has been endorsed by the Commonwealth so this strategy, as required under the FBA, will be sufficient to compensate for residual significant impacts to the EPBC Act listed koala and giant barred frog. The offsets required by the FBA will also account for residual impacts to MNES that have not been considered likely to be significant.

This strategy will be updated when detailed assessments of each of the candidate sites are available. The final offset requirement for the project will be determined during development of the offset package. During the detailed design phase the project footprint may change from that assessed here which would result in a different offset requirement for the project than what is presented in this strategy.

4 References

Office of Environment and Heritage (OEH) 2014a. *Framework for Biodiversity Assessment: NSW Biodiversity Offsets for Major Projects*, http://www.environment.nsw.gov.au/resources/biodiversity/140675fba.pdf

Office of Environment and Heritage (OEH) 2014b, *NSW Biodiversity Offset Policy for Major Projects*, http://www.environment.nsw.gov.au/resources/biodiversity/140672biopolicy.pdf

Appendix A – Priority offset site assessments

PCTs occurring on each offset site from Biodiversity Stewardship vegetation assessments (CHB1 and CHB2) and rapid assessments (CHB4 and CHB5). Shaded rows indicate that the PCT is an offset option for the project's offset requirements. Credit estimates have been provided for shaded rows only.

Site CHB1

PCT ref	PCT name	Total area on CHB1 (ha)	Area available for Coffs Bypass (ha)	Credit estimate* for Coffs Bypass
PCT695	Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central North Coast	3.14	3.14	29
PCT827	Flooded Gum-Tallowwood-Brush Box moist open forest of the coastal ranges of the North Coast	1.01	1.01	9
PCT1201	Soft Corkwood-Yellow Carabeen-Cryptocarya spp. Subtropical rainforest of the NSW North Coast Bioregion**	7.07	7.07	66
PCT747	Brush box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	22.15	22.15	206
	TOTAL	**33.36**	**33.36**	

*Based on 9.3 credits/ha.

** Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (EEC under the BC Act; CEEC under the EPBC Act). While not identified as an offset option for PCT1302, this PCT will meet the variation trading rules.

Site CHB2

PCT ref	PCT name	Total area on CHB2 (ha)	Area available for Coffs Bypass (ha)	Credit estimate* for Coffs Bypass
PCT695	Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central North Coast	8.26	8.26	77
PCT692	Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the North Coast	3.63	3.63	34
PCT827	Flooded Gum-Tallowwood-Brush Box moist open forest of the coastal ranges of the North Coast	9.18	9.18	85
PCT1201	Soft Corkwood-Yellow Carabeen-Cryptocarya spp. Subtropical rainforest of the NSW North Coast Bioregion**	3.06	3.06	28
PCT747	Brush box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	9.61	9.61	89
	TOTAL	**33.75**	**33.75**	

*Based on 9.3 credits/ha.

** Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (EEC under the BC Act; CEEC under the EPBC Act). While not identified as an offset option for PCT1302, this PCT will meet the variation trading rules.

Site CHB4

PCT ref	PCT name	Total area on CHB4 (ha)	Area available for Coffs Bypass (ha)	Credit estimate* for Coffs Bypass
PCT695	Blackbutt-Turpentine-Tallowwood shrubby open forest of the coastal foothills of the central North Coast	161.8	161.8	1505
PCT697	Blackbutt-Turpentine open forest of the foothills of the NSW North Coast Bioregion	29.5	6	55
PCT699	Blackbutt tall moist forest of the coastal ranges of the central and southern NSW North Coast Bioregion	40.2	40.2	373
PCT748	Brush Box-Tallowwood shrubby moist forest of the escarpment ranges of central NSW North Coast Bioregion	4.3	-	
PCT827	Flooded Gum-Tallowwood-Brush Box moist open forest of the coastal ranges of the North Coast	9.4	4	37
PCT1302	White Booyong-Fig subtropical rainforest of the NSW North Coast Bioregion	139.8	16	148
-	Warm Temperate Rainforest	2.8		
PCT747	Brush box-Tallowwood-Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion	46.3	42	390
PCT1244	Sydney Blue Gum open forest of the ranges of the northern NSW North Coast	18.9	18.9	175
PCT1262	Tallowwood-Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast	6	6	55
	TOTAL	**459**	**294.9**	

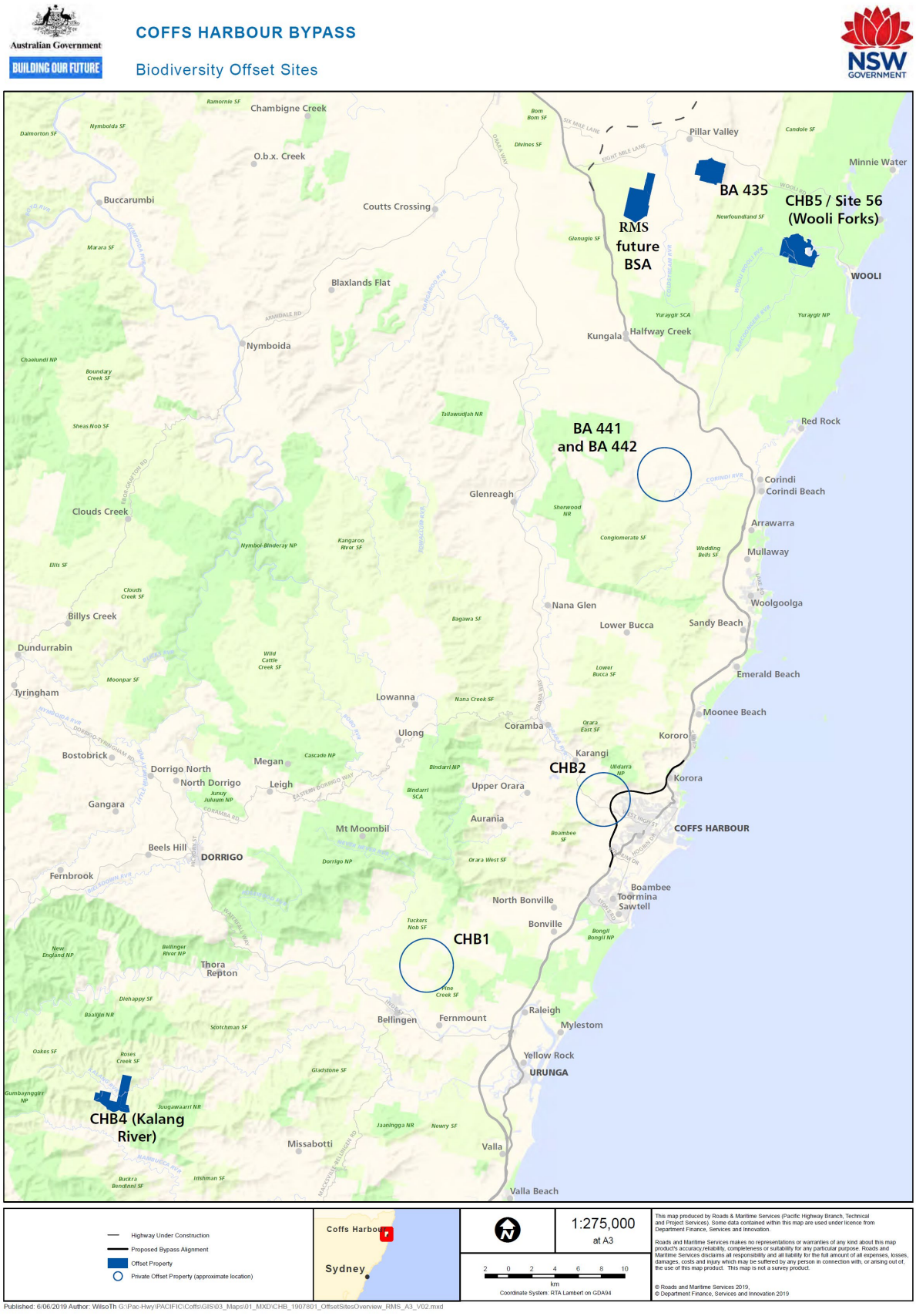
*Based on 9.3 credits/ha.

Site CHB5

PCT ref	PCT name	Total area on CHB5 (ha)	Area available for Coffs Bypass (ha)	Credit estimate* for Coffs Bypass
PCT1064	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	310.3	26.9	250
-	Mangrove	30.8		
-	Heath	74.3		
PCT683	Blackbutt-Bloodwood dry heathy open forest on sandstones of the northern North Coast	163.3		
	TOTAL	**578.7**	**26.9**	

*Based on 9.3 credits/ha.

Appendix B – Biodiversity offset sites



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Appendix F – EPBC Act Significant Impact Criteria assessments

Threatened ecological communities

Lowland Rainforest of Subtropical Australia – Critically Endangered EPBC Act

The *Lowland Rainforest of Subtropical Australia* critically endangered ecological community (Lowland Rainforest CEEC) occurs from Maryborough in Queensland to the Clarence River in New South Wales as well as isolated areas between the Clarence River and Hunter River and Hastings Valleys (TSSC 2011). The CEEC is typically found at low altitudes (below 300 metres above sea level), high rainfall areas on basalt and alluvial soils. Lowland Rainforest CEEC is most often present as a multilayered, moderately tall closed forest characterised by a highly diverse tree flora. Understorey vegetation is typically sparse consisting of low trees and shrubs, a variety of vines and seedlings of canopy tree species. (TSSC 2011, OEH 2018a)

In NSW, this CEEC has been extensively cleared to make way for agricultural land uses and only approximately 5% of the pre-European extent of this community is thought to remain.

Four separate patches of rainforest vegetation occur within the study area comprising two PCTs (PCT670 and PCT1302), however none of the patches are considered to conform to the EPBC Act listing criteria for *Lowland Rainforest of Subtropical Australia.* None of the patches support the required species richness for 'woody' characteristic species as listed in Appendix A of the EPBC Act Listing advice for the community, and as such do not meet the requirement for Key Diagnostic Features and Condition Thresholds (refer to Section 3.2). Therefore, Lowland Rainforest of Subtropical Australia has been assessed as not occurring within the study area, and will not be impacted by the Project.

Is the action likely to reduce the extent of an ecological community

Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area and therefore the Project will not reduce the extent of the CEEC.

Is the action likely to fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area and therefore the Project will not fragment or increase fragmentation of the CEEC.

Is the action likely to adversely affect habitat critical to the survival of an ecological community

Commonwealth of Australia (2013) defines critical habitat for an endangered ecological community as habitat which is necessary:

- For the long-term maintenance of the ecological community (including the maintenance of species essential to the survival of the ecological community, such as pollinators).
- To maintain genetic diversity and long term evolutionary development.
- For the recovery of the ecological community.

Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area, and the occurrences of PCTs that support potential habitat for the community occur as small fragmented patches. Larger, higher quality patches of potential habitat are considered to be more abundant in the wider locality and as such, it is not considered likely that the Project will impact upon habitats that meet any of the criteria listed above for habitat critical to the survival of an CEEC

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

Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area. The community is considered to have the potential to occur within a 10 kilometre buffer based on PCTs mapped by the Coffs Harbour LGA mapping project (OEH 2012) as likely to conform to the NSW TSC Act listed communities *Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion* or *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions*.

The majority of the vegetation mapped as potentially conforming to the EPBC Act listed community occurs to the west of the study area, at higher elevation on the escarpment and is considered unlikely to be impacted by potential alterations to groundwater flows or surface drainage patterns. At the northern end of the study area vegetation with the potential to conform to the EPBC Act listed community occurs along the coast to the east of the study area. However, this vegetation is separated from the study area by existing residential development and the current alignment of the Pacific Highway and as such, alterations to ground or surface water that may result from the Project are not considered likely to result in substantial impacts to the adjacent occurrences of mapped rainforest vegetation.

The removal of 43.37 hectares of native vegetation from a landscape largely cleared of naturally occurring vegetation is not considered likely to result in substantial changes to nutrient levels in the soil, increase erosion potential, or other alterations to abiotic factors necessary to maintain the existence of the community in the locality.

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

Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area and therefore the Project will not cause a substantial change in the species composition of an occurrence of the ecological community, including causing a decline or loss of functionally important species.

Is the action likely to cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

> assisting invasive species, that are harmful to the listed ecological community, to become established, or
>
> causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community

Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area and therefore the Project will not cause a substantial reduction in the quality or integrity of an occurrence of the CEEC.

Is the action likely to interfere with the recovery of an ecological community

Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area, and the occurrence of PCTs that support potential habitat for the community occur as small fragmented patches. Larger, higher quality patches of potential habitat are considered to be more abundant in the wider locality and as such, the Project is considered unlikely to interfere with the recovery of the CEEC.

Conclusion

Lowland Rainforest of Subtropical Australia was assessed as not occurring within the study area. Based on the above assessment, Lowland Rainforest of Subtropical Australia is unlikely to be significantly impacted by the Project and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Threatened flora species

Clear Milkvine *Marsdenia longiloba* – Vulnerable EPBC Act

Clear Milkvine is a slender climber of the milk vine group, with pairs of very finely pointed leaves and 5-6 tiny glands at the base of the leaves. The stems of Clear Milkvine exude clear, watery sap when cut, unlike most of the milk vines which have milky sap. Clusters of small white star-shaped flowers are produced and are followed by long, narrow seed-capsules that split to release many seeds with tufts of long silky hair (OEH 2018a, TSSC 2008a).

This species has been recorded within 500 metres of the study area. Clear Milkvine is found in scattered sites on the north coast of NSW north from Barrington Tops. Also occurs in south-east Queensland (OEH 2018, TSSC 2008a). Potential habitat for this species in the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD), includes:

- PCT670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion.
- PCT692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the North Coast.
- PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central North Coast.
- PCT747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion.
- PCT1244 Sydney Blue Gum Open Forest on Coastal Foothills and Escarpment of the North Coast.
- PCT1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.
- PCT1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion.

Approximately 38.10 hectares of potential habitat for Clear Milkvine occurs within the study area. The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the NSW Guide to Surveying Threatened Plants (OEH 2016) (refer Section 4.2).

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

Clear Milkvine has a scattered distribution on the north coast of NSW north from Barrington Tops into south-east Queensland (OEH 2018a, TSSC 2008a). The species was not recorded within the study area, notwithstanding this, its presence would not be considered to be part of an important population.

The Project will result in the direct removal of 38.10 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). However, the study area does not occur at or near the limit of the species' range, and if present its low population numbers, as confirmed through comprehensive field survey, would not be sufficient to be considered a key source for breeding or dispersal, or necessary for maintain genetic diversity for a species that occurs in a broad range of habitats over a large geographic area.

On the basis of the above, the Project is not considered likely to lead to a long-term decrease in the size of an important population of Clear Milkvine.

Is the action likely to reduce the area of occupancy of an important population?

The Project will reduce the area of occupancy of Clear Milkvine through the direct removal of 38.10 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). However, as outlined above, any occurrence of the species within the study area would not be considered an "important population". Further, the species is recorded from an approximately 350 kilometre stretch of the NSW north coast and up to approximately 100 kilometres inland.

As such any potential impact from the Project would not be considered likely to reduce the area of occupancy of an important population of Clear Milkvine.

Is the action likely to fragment an existing important population into two or more populations?

As outlined above, any occurrence of the species within the study area would not be considered an "important population". Notwithstanding this, two historic records of the species exist (from 1903) to the east of the study area, in areas now subject to residential and commercial development, that may be subject to

fragmentation by the Project from the species' habitats and known occurrences to the west of the study area in the Tuckers Nob State Forest.

Fragmentation of habitats may occur as a result of the Project; however, local habitat for the species occurs across an environment already fragmented by major roads, farmland and plantations, residential and commercial developments and historic vegetating clearing. Hence, the Project is considered unlikely to exacerbate fragmentation and substantially reduce the connectivity of potential habitat for the species at a landscape scale.

Therefore, it is considered unlikely that the Project will fragment an existing important population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines habitat critical to the survival of a species as areas necessary:

- For activities such as foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- Maintain genetic diversity and long term evolutionary development.
- For the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for Clear Milkvine has been listed on the DoEE Register of Critical Habitat. This species has been assigned to the Keep-watch species management stream under the Saving our Species program. Relatively large populations of this species occur within reserve locations (e.g. up to 1000 individuals estimated to occur in Bongil Bongil and New England National Parks and over 1000 in Yabbra National Park) where current management is sufficient to ensure their survival (OEH 2016).

Given the species was not recorded within the study area it is considered unlikely that the Project would adversely affect habitat critical to the survival of Clear Milkvine.

Is the action likely to disrupt the breeding cycle of an important population?

As outlined above, any occurrence of the species within the study area would not be considered an "important population". Notwithstanding this, given that the species was not recorded within the study area, and the significant amount of potential habitat present for the species within the locality, the impacts from the Project would be unlikely to disrupt the breeding cycle of the species.

As such, the Project is not considered likely to disrupt the breeding cycle of an important population of Clear Milkvine.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project will result in the direct removal of 38.10 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). With regard to these habitat associations, a further 8290 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

As outlined above, the species is known to occur along an approximately 350 kilometre stretch of the NSW north coast, and up to approximately 100 kilometres inland, and as such the removal of 38.10 hectares of habitat is not considered likely to result in impacts substantial enough cause the wide ranging extent of the species to decline.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (OEH 2018). Patches of vegetation within the study area are significantly impacted by weed species, with many areas showing significant levels of weed invasion due to past clearing practices. Forty-six weed species were recorded during field surveys and have the potential to spread following disturbance associated with the construction phase of the Project. However, strict hygiene measure will be implemented to prevent and mitigate the spread of weeds and reduce the potential of negative impact the threatened species habitats. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. The technical working papers for the Project will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere substantially with the recovery of the species?

To date no Recovery Plan or Threat Abatement Plan has been prepared for Clear Milkvine. Under the Saving our Species program, OEH considers that the species is secure without targeted management.

OEH (2018a) has identified a number of priority actions to help the recovery of this species. Those that are relevant to the proposed project are detailed below:

- Control weeds likely to spread into suitable habitat.
- Ensure roadside populations are identified and marked to protect them from roadworks and slashing.

OEH (2018a) also lists the follow threats to this species:

- Invasion of habitat by introduced weeds.
- Risk of local extirpation because populations are small.
- At risk from the use of herbicides in weed control activities.
- Roadside populations are at risk from road works.

The Project is not likely to interfere with the recovery of the species, as the action is not inconsistent with the above listed recovery actions if suitable mitigation measures are implemented.

Conclusion

Approximately 38.10 hectares of potential habitat for Clear Milkvine occurs within the study area. The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016). Based on the above assessment, Clear Milkvine is unlikely to be significantly impacted by the Project and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Hairy Jointgrass *Arthraxon hispidus* – Vulnerable EPBC Act

Hairy Jointgrass is a creeping grass with branching, erect to semi-erect purplish stems. Leaf-blades are 2–6 centimetres long, broad at the base and tapering abruptly to a sharp point. Long white hairs project around the edge of the leaf. The seed-heads are held above the plant on a long fine stalk. This grass is considered to be a perennial but tends to die down in winter.

This species has not previously been recorded within the study area with a single record occurring within the locality, approximately 4 kilometres to the south.

The species is found in or on the edges of rainforest and wet eucalypt forest, often near creeks or swamps (OEH 2018a). Potential habitat for this species in the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD), includes:

- PCT670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion.
- PCT692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the North Coast.
- PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central North Coast.
- PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.
- PCT1244 Sydney Blue Gum Open Forest on Coastal Foothills and Escarpment of the North Coast.
- PCT1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast.
- PCT1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.
- PCT1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion.

Approximately 37.55 hectares of potential habitat for Hairy Jointgrass occurs within the study area. The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016) (refer Section 4.2).

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

Hairy Jointgrass occurs over a wide area in south-east Queensland, and on the northern tablelands and north coast of NSW, but is never common, it is known to occur as far south as Kempsey / Kunderang NSW, approximately 100 kilometres south of the study area (OEH2018a, TSSC 2008b). The study areas is considered to be near the limit of the species distribution and as such any population present with the stud area would be considered an “important population”.

The Project will result in the direct removal of approximately 37.55 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). With regard to these habitat associations, a further 8680 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Given the species was not recorded within the study area following comprehensive targeted survey, and the small proportion of potential habitat that would be directly or indirectly impacted by the Project (<0.5% within 10 kilometres of the study area), the action is not considered likely to lead to a long-term decrease in the size of an important population.

Is the action likely to reduce the area of occupancy of an important population?

The Project will reduce the area of occupancy of Hairy Jointgrass through the direct removal of 37.55 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). However, with regard to these habitat associations, a further 8680 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Given the species was not recorded within the study area following comprehensive targeted survey, and the small proportion of potential habitat that would be directly or indirectly impacted by the Project (<0.5% within 10 kilometres of the study area), the action is not considered likely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing important population into two or more populations?

As outlined above, the species was not recorded within the study area during comprehensive targeted survey, and one record of the species occurrence exists approximately 4 kilometres to the south of the study area.

Fragmentation of habitats may occur as a result of the Project; however, local habitat for the species occurs across an environment already fragmented by major roads, farmland and plantations, residential and commercial developments and historic vegetating clearing. Hence, the Project is considered unlikely to exacerbate fragmentation and substantially reduce the connectivity of potential habitat for the species at a landscape scale.

It is considered unlikely that an existing population of Hairy Jointgrass occurs within the study area and therefore it is considered unlikely that the Project will fragment an existing important population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines habitat critical to the survival of a species as areas necessary:

- For activities such as foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- Maintain genetic diversity and long term evolutionary development.
- For the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for Hairy Jointgrass has been listed on the DoEE Register of Critical Habitat, and no Recovery Plan has been prepared for the species. However, this species has been assigned to the Keep-watch species management stream under the OEH Saving our Species program (OEH 2018a). The species is also is well conserved in conservation reserves (TSSC 2008a) throughout its range.

Given the species was not recorded within the study area it is considered unlikely that the Project would adversely affect habitat critical to the survival of Hairy Jointgrass.

Is the action likely to disrupt the breeding cycle of an important population?

Given that the species was not recorded within the study area, and the significant amount of potential habitat present for the species 10 kilometres of the study area (up to 8680 hectares), the impacts from the Project would be unlikely to disrupt the breeding cycle of Hairy Jointgrass.

As such, the Project is not considered likely to disrupt the breeding cycle of an important population of Hairy Jointgrass.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

As outlined above, the Project will result in the direct removal of 37.55 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). With regard to these habitat associations, a further 8680 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

The species is known to occur from Kempsey NSW to Port Douglas QLD (over 2000 kilometres along the east coast of Australia) and inland to Carnarvon National Park in QLD (400 kilometres) and Glenn Innes in NSW (150 kilometres). As such, the removal of 37.55 hectares of habitat is not considered likely to result in impacts substantial enough cause the wide ranging extent of the species to decline.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (OEH 2018). Patches of vegetation within the study area are significantly impacted by weed species, with many areas showing significant levels of weed invasion due to past clearing practices. Forty-six weed species were recorded during field surveys and have the potential to spread following disturbance associated with the construction phase of the Project. However, strict hygiene measure will be implemented to prevent and mitigate the spread of weeds and reduce the potential of negative impact the threatened species habitats. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. The Construction Environment Management Plan for the Project will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan or Threat Abatement Plan has been prepared for Hairy Jointgrass. Under their Saving our Species program OEH considers that the species is secure without targeted management.

The Project is not likely to interfere with the recovery of the species given the small proportionate impact to potential habitat in the local area and the lack of direct impact on populations of Hairy Jointgrass.

Conclusion

Approximately 37.55 hectares of potential habitat for Hairy Jointgrass occurs within the study area. The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the NSW Guide to Surveying Threatened Plants (OEH 2016). Based on the above assessment, Hairy Jointgrass is unlikely to be significantly impacted by the Project and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Orara Boronia *Boronia umbellata* – Vulnerable EPBC Act

Orara Boronia is an erect multi-branched shrub, 1 – 2 metres tall. The fragrant, paired leaves are divided into one or two pairs of leaflets with a longer terminal leaflet. Dense hairs cover the underside of the leaves, branchlets and new shoots. Clusters of pale to bright pink, four-petalled flowers, 7 - 10 mm long, are held at the base of the leaves, and are produced in spring and early summer. The fruit is smooth and has four lobes. This species has not previously been recorded within the study area but there are several records within the locality.

This species occurs in coastal ranges, in sclerophyll forest on sandstone and metasediments at 100-600 metres. Variable geology and soils are favoured (DoEE 2018). Found at only a few locations between Glenreagh and Lower Bucca, north of Coffs Harbour, but it is locally common in the restricted area where it occurs.

Potential habitat for this species in the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD), includes:

- PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central North Coast.
- PCT1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.

Approximately 13.51 hectares of potential habitat for Orara Boronia occurs within the study area. The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the NSW Guide to Surveying Threatened Plants (OEH 2016) (refer Section 4.2).

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

The known distribution of this species is restricted to only a few locations between Glenreagh and Lower Bucca, north of Coffs Harbour, but it is locally common in the restricted area where it occurs (TSSC 2008b). If the species was recorded within the study area this would be an extension of the species distribution, with the study area at the southern limit of the species geographic range.

The proposed works will result in the direct removal of approximately 13.51 hectares of potential habitat for the species based on the plant community habitat association contained in the study area. With regard to these habitat associations, a further 3,067 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Given the species was not recorded within the study area following a targeted survey, and the small proportion of potential habitat that would be directly or indirectly impacted by the Project, the action is not considered likely to lead to a long-term decrease in the size of an important population.

Is the action likely to reduce the area of occupancy of an important population?

The Project will reduce the area of occupancy of Orara Boronia through the direct removal of 13.51 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). However, with regard to these habitat associations, a further 3,067 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Given the species was not recorded within the study area following comprehensive targeted survey, and the small proportion of potential habitat that would be directly or indirectly impacted by the Project (<0.3% within 10 kilometres of the study area), the action is not considered likely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing important population into two or more populations?

No known records of the species would be directly impacted. Whilst there is a record of the species east of the Pacific Highway near the Harbour, this record dates to 1953. Due to previous clearing for urban development and agriculture, the species is considered a low likelihood of occurring east of the Pacific highway.

Fragmentation of habitats may occur as a result of the Project; however, local habitat for the species occurs across an environment already fragmented by major roads, farmland and plantations, residential and commercial developments and historic vegetating clearing. Hence, the Project is considered unlikely to exacerbate fragmentation and substantially reduce the connectivity of potential habitat for the species at a landscape scale.

On the basis of the above, the proposed project is not likely to result in the fragmentation of an important population of Orara Boronia or any potential habitat for the species.

Is the action likely to adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines critical habitat as:

- Habitat that supports activities such as foraging, breeding, roosting, or dispersal.
- Habitat for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- Habitat to maintain genetic diversity and long term evolutionary development.
- Habitat for the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for Orara Boronia has been listed on the DoEE Register of Critical Habitat, and no Recovery Plan has been prepared for the species. However, this species has been assigned to the Keep-watch species management stream under the Saving our Species program. The species is known to occur in much larger populations (e.g. 3000 to 10 000 individuals recorded in over ten locations) and is more widespread than at the time of listing as threatened (OEH 2016).

Given the species was not recorded within the study area it is considered unlikely that the Project would adversely affect habitat critical to the survival of Orara Boronia.

Is the action likely to disrupt the breeding cycle of an important population?

Orara Boronia grows as an understorey shrub in and around gullies in wet open forest (TSSC 2008). It appears to regenerate well after disturbance, but it is not known whether prolonged or repeated disturbance affects long-term persistence (OEH 2016a). The species is widely distributed throughout the locality, with numerous records to the north and west of the study area in NSW.

Given that the species was not recorded within the study area, and the significant amount of potential habitat present for the species north and west of the, the impacts from the Project would be unlikely to disrupt the breeding cycle of the species.

As such, the Project is not considered likely to disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed project would result in the removal of up to 13.51 hectares of potential habitat for Orara Boronia. The area of habitat to be removed as part of the proposed project equates to <0.3% of potential habitat within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the locality, the removal of 13.51 hectares of potential habitat is not likely to result in the decline of the Orara Boronia.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (OEH 2018). Patches of vegetation within the study area are significantly impacted by weed species, with many areas showing significant levels of weed invasion due to past clearing practices. Forty-six weed species were recorded during field surveys and have the potential to spread following disturbance associated with the construction phase of the Project. However, strict hygiene measure will be implemented to prevent and mitigate the spread of weeds and reduce the potential of negative impact the threatened species habitats. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. The Construction Environment Management Plan for the Project will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan or Threat Abatement Plan has been prepared for Orara Boronia. Under the Saving our Species program, OEH considers that the species is secure without targeted management. Further, OEH (2016) has identified a number of priority actions to help the recovery of this species. Those that are relevant to the proposed project are detailed below:

- Protect habitat from frequent fire: the proposed project is not likely to increase fire frequency in the local area.
- Identify populations along roadsides and protect them during road-works: The implementation of the proposed project would contribute with the identification of potential populations along the roadsides. If populations are identified, they should be protected during roadworks.

The Project is not likely to interfere with the recovery of the species given the small proportionate impact to potential habitat in the local area and the lack of direct impact on populations of Orara Boronia.

Conclusion

Approximately 13.51 hectares of potential habitat for Orara Boronia occurs within the study area. The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the NSW Guide to Surveying Threatened Plants (OEH 2016). Based on the above assessment, Orara Boronia is unlikely to be significantly impacted by the Project and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Samadera sp. Moonee Creek (J. King s.n. Nov. 10949) – Endangered EPBC Act

Samadera sp. Moonee Creek is a slender or bushy shrub growing to about 1.5 metres tall with stems that are often kinked, showing periodic halts to growth. Its tough leaves are narrow, about 10 centimetres long, alternately arranged along the stems. Leaves are glossy dark green above and paler below, with numerous veins at a wide angle. Flowers are small and green tinged reddish; developing into distinctive finely hairy fruits made up of one to five radiating segments which are red when mature (OEH 2016a).

Samadera sp. Moonee Creek grows in the shrubby layer below tall moist eucalypt forest and tall dry eucalypt forest, including forest edges, mostly at lower altitudes (OEH 2016a).

The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016) (refer Section 4.2). However a large population has previously been recorded approximately 2.5 kilometres north of the study area.

Potential habitat for this species in the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD), includes:

- PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central North Coast.
- PCT1244 Sydney Blue Gum Open Forest on Coastal Foothills and Escarpment of the North Coast.
- PCT1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.

Approximately 14.45 hectares of potential habitat for Samadera sp. Moonee Creek occurs within the study area.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

There are a total of 18 known populations of this species, none of them within the study area. The closest population of the species relevant to the Project is located 2.5 kilometres north of the study area, west of Moonee Beach.

The proposed works will result in the direct removal of approximately 14.45 hectares of potential habitat for the species based on the plant community habitat association contained in the study area. With regard to these habitat associations, a further 3,067 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Given the species was not recorded within the study area following comprehensive targeted survey, and the small proportion of potential habitat that would be directly or indirectly impacted by the Project, the action is not considered likely to lead to a long-term decrease in the size of an important population

Is the action likely to reduce the area of occupancy of an important population?

The Project will reduce the area of occupancy of Samadera sp. Moonee Creek through the direct removal of 14.45 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). However, with regard to these habitat associations, a further 3067 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Given the species was not recorded within the study area following comprehensive targeted survey, and the small proportion of potential habitat that would be directly or indirectly impacted by the Project (0.3 percent within 10 kilometres of the study area), the action is not considered likely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing population into two or more populations?

Samadera sp. Moonee Creek was not recorded within the study area during a targeted survey, and one record of the species occurrence exists approximately 2.5 kilometres north of the study area.

Fragmentation of habitats may occur as a result of the Project; however, local habitat for the species occurs across an environment already fragmented by major roads, farmland and plantations, residential and commercial developments and historic vegetating clearing. Hence, the Project is considered unlikely to exacerbate fragmentation and substantially reduce the connectivity of potential habitat for the species at a landscape scale.

It is considered unlikely that an existing population of Samadera sp. Moonee Creek occurs within the study area and therefore it is considered unlikely that the Project will fragment an existing important population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines critical habitat as:

- Habitat that supports activities such as foraging, breeding, roosting, or dispersal.
- Habitat for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- Habitat to maintain genetic diversity and long term evolutionary development.
- Habitat for the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for Samadera sp. Moonee Creek has been listed on the DoEE Register of Critical Habitat. The Recovery Plan for Samadera sp. Moonee Creek states that critical habitat has not been declared for this species. The declaration of critical habitat in NSW is not considered to be a priority for this species at this stage, as other mechanisms provide for its protection.

Given the species was not recorded within the study area it is considered unlikely that the Project would adversely affect habitat critical to the survival of the species.

Is the action likely to disrupt the breeding cycle of a population?

Given that the species was not recorded within the study area, and the significant amount of potential habitat present for the species 10 kilometres of the study area (up to 3057 hectares), the impacts from the Project would be unlikely to disrupt the breeding cycle of the species.

As such, the Project is not considered likely to disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project will result in the direct removal of 14.45 hectares of potential habitat for the species based on the plant community habitat associations contained in the study area. With regard to these habitat associations, a further 3067 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area.

The species is known to occur in two disjunct locations: north of Coffs Harbour and east of Grafton at Macraes Knob. North of Coffs Harbour, the population is bounded by Timbertop, Kungala, Woolgoolga and Moonee Beach. The population at Macraes Knob may now be extinct, but other populations may occur in the area. As such, the removal of 14.45 hectares of potential habitat (outside of recorded species locations) is not considered likely to result in impacts substantial enough cause the wide ranging extent of the species to decline (DoEE 2018).

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (OEH 2018). Patches of vegetation within the study area are significantly impacted by weed species, with many areas showing significant levels of weed invasion due to past clearing practices. Forty-six weed species were recorded during field surveys and have the potential to spread following disturbance associated with the construction phase of the Project. However, strict hygiene measure will be implemented to prevent and mitigate the spread of weeds and reduce the potential of negative impact the threatened species habitats. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline, or?

The Project is not likely to introduce disease that may cause the species to decline. The Construction Environment Management Plan for the Project will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere substantially with the recovery of the species?

A Recovery Plan has been prepared for Samadera sp. Moonee Creek *(*OEH 2005), and lists five objectives to assist in the recovery of the species. Of these, one is considered relevant to the proposed project as follows:

- Retention of each known population at its current size.

The Recovery Plan lists the following threats to Samadera sp. Moonee Creek *(*OEH 2005):

- Destruction, degradation and fragmentation of forest habitat in coastal areas through clearing, urban development and repeated disturbance.
- Frequent fire.
- Timber harvesting and associated road-works.
- Invasion of weeds, particularly Lantana.
- Risk of local extinction because populations are small.

The Project is not likely to interfere with the recovery of the species given the small proportionate impact to potential habitat in the local area and the lack of direct impact on populations of the species.

Conclusion

Approximately 14.45 hectares of potential habitat for Samadera sp. Moonee Creek occurs within the study area. The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the NSW Guide to Surveying Threatened Plants (OEH 2016). Based on the above assessment, Samadera sp. Moonee Creek is unlikely to be significantly impacted by the Project and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Southern Swamp Orchid *Phaius australis*

Southern Swamp Orchid is an orchid with flower stems up to 2 metres tall with large broad leaves with a pleated appearance, both arising from a fleshy bulb near ground level. The large, showy flowers, with up to 20 per stem, have four petals which are white on the outside and brown with white or yellow veins on the inside. The central tongue of the flower is pink and yellow with lobes slightly curved inwards (OEH 2018a, TSSC 2014).

Southern Swamp Orchid is found in coastal wet heath/sedgeland wetlands, swamps, in sclerophyll forest, swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas (OEH 2018a, TSSC 2014). It is often found in association with dominated by Melaleuca quinquinervia, Meleleuca leucadendra or Eucalyptus robusta.

Southern Swamp Orchids was recorded once within the study area during targeted flora transect surveys undertaken in accordance with the NSW Guide to Surveying Threatened Plants (OEH 2016) (refer Section 4.2). The single individual was found approximately 750 metres north of North Boambee Road within PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion vegetation, adjacent to more typical habitats for the species consisting of Swamp Sclerophyll Forest vegetation.

There are two more records of the Southern Swamp Orchid to the immediate south-west of the southern extent of study area north of Boambee. These records are dated to 1958 and 1975. Four other records of the Southern Swamp Orchid occur within 2.5 kilometres east of the study area within coastal sections of Coffs Harbour township.

Potential habitat for this species in the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD), includes:

- PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.

Approximately 2.12 hectares of known (PCT695) and a further 3.65 hectares of potential (PCT1064) habitat for Southern Swamp Orchid occurs within the study area.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

OEH BioNet and the EPBC Act Approved Conservation Advice for the species (OEH 2018a, TSSC 2014) state that there are 14 known populations of this species. When the geographic spread of known records and the species' occurrence from Southwest Rocks NSW to eastern Queensland with a disjunct population from Kirrima to Mackay QLD are considered, all individuals within the Coffs Harbour area would be considered to comprise a single population.

Information as to the number of individual plants present at each of the recorded locations around Coffs Harbour is not available, and it is known that determining the number of plants in a population is difficult as this species grows in clumps of pseudobulbs and leafy stems, making it difficult to distinguish between individual plants. Approximately half the populations contain few individuals (1-50 plants) (TSSC 2014, Benwell, 1994).

Removal of one individual recorded within the study area may result in a long-term decrease in the size of the local population of the species however a commitment has been made to translocate the species into an area of suitable habitat in a location that provides for the long-term protection of the species ie. within a local offset site to be established as part of the Projects' Biodiversity Offset Strategy. Translocation of the species is known to be successful and achievable (Andrew Benwell pers. comm (2018)) and would be managed by the Threatened Species Management Plan (Arup 2018).

As effective translocation of the species can be expected, the size of the population would therefore be maintained and a significant impact would likely be avoided.

Is the action likely to reduce the area of occupancy of the species?

The Project will result in the removal of up to 2.12 hectares of habitat known to support the local population of Southern Swamp Orchid, and a further 3.65 hectares of potential habitat. However the species occurs over a wide geographic area, from Southwest Rocks NSW to eastern Queensland, of which the study area

does not occur at or near the southern limit of this range. As such the removal of habitat within the study area in not considered likely to reduce the area of occupancy of Southern Swamp Orchid.

Is the action likely to fragment an existing population into two or more populations?

As outlined above, all records of Southern Swamp Orchid within the Coffs Harbour locality are considered to comprise a single population. This population occurs in a landscape currently fragmented by road infrastructure associated with the existing Pacific Highway alignment and residential and commercial development of the Coffs Harbour urban area. It is therefore considered that it is unlikely the Project would exacerbate fragmentation for the existing population resulting in it being split into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines habitat critical to the survival of a species as areas necessary:

- For activities such as foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- Maintain genetic diversity and long term evolutionary development.
- For the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for Southern Swamp Orchid has been listed on the DoEE Register of Critical Habitat. A Recovery Plan for Southern Swamp Orchid is currently being prepared, but is not yet available to the public.

Known and potential habitat for the species to be directly impacted by the Project comprises 5.77 hectares across two separate PCTs, towards the southern extent of the Coffs Harbour population of the species. As outlined above the species occurs across 14 known populations in NSW and QLD, with many populations supporting only low numbers of plants, however the largest population of the species supports between 200 – 2000 individuals (TSSC 2014). Seven of the 14 known populations are occur within national or conservation parks.

Known and potential habitat within the study area is not considered to be habitat critical to the survival of the species due to the broad geographic range of the species and its habitats, the existence of other areas of habitat known to support the species within the local Coffs Harbour population, and the security of half of the existing population's habitat within conservation reserves.

Is the action likely to disrupt the breeding cycle of a population?

The Southern Swamp Orchid flowers in spring (September–November) and can reproduce sexually (by pollination) and asexually (by dormant buds along the flower spikes). Although vegetative reproduction is thought to occur only infrequently in the wild, it is common in cultivation. Most flowers of the Southern Swamp Orchid set fruit and like most orchids, thousands of tiny seeds may be produced within each fruit (TSSC 2014).

Information on the pollination biology of this species is limited, but it is thought that members of this genus are pollinated by bees. Other members of the genus Phaius have a 'rostellum', a structure that acts like a cap and prevents the male and female parts of an individual flower coming into contact, but is removed by the pollinator to enable cross-pollination. The Southern Swamp-orchid lacks this cap and it is possible that the abundant fruit set of this species is indicative of self-pollination (TSSC 2014).

As outlined above, the local population relevant to the Project comprises the seven records within the Coffs Harbour area. Successful translocation of the Southern Swamp Orchid individual into a local offset site (or similar) will prevent substantial disruption of the breeding cycle to the species (able to self-pollinate), and hence prevent significant impact to the local population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

As outlined above, the Project will result in the removal of 2.12 hectares of known and a further 3.65 hectares of potential habitat for the local population of Southern Swamp Orchid. However, the species and its habitats are known to occur from Southwest Rocks NSW to eastern Queensland, of which the study area is not considered to support habitats critical to the survival of the species. As such the removal of habitat within the study area is not likely to be considered likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

Infestation of habitat by introduced weeds and road/track works disturbance have been identified as a threats to this species (OEH 2016a). Patches of vegetation within the study area are already significantly impacted by weed species, with many areas showing significant levels of weed invasion due to past clearing practices. Forty-six weed species were recorded during field surveys and have the potential to spread following disturbance associated with the construction phase of the Project. However, strict hygiene measure will be implemented to prevent and mitigate the spread of weeds and reduce the potential of negative impact the threatened species habitats. The Construction Environment Management Plan for the Project will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. The Construction Environment Management Plan for the Project will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere with the recovery of the species?

To date, no Recovery Plan or Threat Abatement Plan has been prepared for Southern Swamp Orchid. Under their Saving our Species program OEH identifies five management sites important to the survival of this species. The Project will not impact on these sites.

The Project is not likely to interfere with the recovery of the species.

Conclusion

Based on the above assessment, and the successful translocation of the Southern Swamp Orchid species recorded within the study area, the Project is not considered likely to significantly impact upon the species. As such additional offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Cryptic Forest Twiner *Tylophora woollsii*

Cryptic Forest Twiner *Tylophora woollsii* is a slender woody climber that grows to 3 metres long. The paired leaves are on stalks 7 - 20 millimetres long, and are an elongated heart-shape with a firm texture. Cryptic Forest Twiner grows in moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins (OEH 2018).

This species has not been recorded in the study area, but has previously been recorded within 5 kilometres. Potential habitat for this species in the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD), includes:

- PCT692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the North Coast.
- PCT747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion.
- PCT1244 Sydney Blue Gum Open Forest on Coastal Foothills and Escarpment of the North Coast.
- PCT1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.

Approximately 25.20 hectares of potential habitat for Cryptic Forest Twiner occurs within the study area. The species was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the NSW Guide to Surveying Threatened Plants (OEH 2016) (refer Section 4.2).

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Cryptic Forest Twiner is found in the Northern Rivers NSW and Border Rivers Maranoa–Balonne Queensland Natural Resource Management Regions. There is limited information known about Cryptic Forest Twiner and no definitive population or occupancy estimates are available for this species (TSSC 2008).

The study area contains approximately 25.20hectares of potential habitat for Cryptic Forest Twiner based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). With regard to these habitat associations, a further 5436 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour KGA mapping project (OEH 2012).

Given the species was not recorded within the study area following comprehensive targeted survey, and the small proportion of potential habitat that would be directly or indirectly impacted by the Project (<0.4% within 10 kilometres of the study area), the action is not considered likely to lead to a long-term decrease in the size of an important population.

Is the action likely to reduce the area of occupancy of the species?

The proposed works will reduce the area of occupancy for Cryptic Forest Twiner, by removing a total of 25.20 hectares of potential habitat within the study area. With regard to these habitat associations, a further 5436 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour KGA mapping project (OEH 2012).

Given the species was not recorded within the study area following comprehensive targeted survey, and the small proportion of potential habitat that would be directly or indirectly impacted by the Project (<0.4% within 10 kilometres of the study area), the action is not considered likely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing population into two or more populations?

As outlined above, the species was not recorded within the study area during comprehensive targeted survey. Fragmentation of habitats may occur as a result of the Project however, local habitat for the species occurs across an environment already fragmented by major roads, farmland and plantations, residential and commercial developments and historic vegetating clearing. The Project is considered unlikely to exacerbate fragmentation and substantially reduce the connectivity of potential habitat for the species at a landscape scale.

It is considered unlikely that an existing population of Cryptic Forest Twiner occurs within the study area and therefore it is considered unlikely that the Project will fragment an existing important population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

- Commonwealth of Australia (2013) defines critical habitat as:
- For activities such as foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- Maintain genetic diversity and long term evolutionary development.
- For the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for Cryptic Forest Twiner has been listed on the DoEE Register of Critical Habitat, and no Recovery Plan has been prepared for the species. However, the Office of Environment and Heritage has established five management sites under the Saving our Species program where conservation activities need to take place to ensure the conservation of this species. None of these sites are relevant to the study area, and do not include records located within the locality.

Given the species was not recorded within the study area it is considered unlikely that the Project would adversely affect habitat critical to the survival of Cryptic Forest Twiner.

Is the action likely to disrupt the breeding cycle of a population?

Given that Cryptic Forest Twiner was not recorded within the study area, and the significant amount of potential habitat present for the species 10 kilometres of the study area (up to 5436 hectares), the impacts from the Project would be unlikely to disrupt the breeding cycle of the species.

As such, the Project is not considered likely to disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

As outlined above, the Project will result in the direct removal of 25.20 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). With regard to these habitat associations, a further 5436 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour KGA mapping project (OEH 2012).

The species is known to occur found in the Northern Rivers NSW and Border Rivers Maranoa–Balonne Queensland Natural Resource Management Regions. As such, the removal of 25.20 hectares of potential habitat is not considered likely to result in impacts substantial enough cause the wide ranging extent of the species to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (OEH 2018). Patches of vegetation within the study area are significantly impacted by weed species, with many areas showing significant levels of weed invasion due to past clearing practices. Forty-six weed species were recorded during field surveys and have the potential to spread following disturbance associated with the construction phase of the Project. However, strict hygiene measures will be implemented to prevent and mitigate the spread of weeds and reduce the potential of negative impact the threatened species habitats. The Construction Environment Management Plan for the Project will include measures to ensure appropriate weed and pathogen management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. The Construction Environment Management Plan for the Project will include measures to ensure appropriate weed and pathogen management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan has not been prepared for Cryptic Forest Twiner (DECCW 2010). This species has been assigned to the site-managed species management stream under the Saving our Species program. OEH has established five management sites where conservation activities need to take place to ensure the conservation of this species. The following activities are recommended to assist the survival of this species:

- Identify and mark all known roadside populations.
- Protect known habitat from clearing.
- Undertake weed control works ensuring careful use of herbicides.
- Enhance information on the species' identification and raise awareness of conservation significance of this species.
- Ensure frequent agricultural burning does not occur in known habitat and that fire regimes implemented are as per the recommendations for the habitat in which the population occurs.
- Prevent spread of disease through appropriate site management.

Provided suitable mitigation measures can be put in place to ensure edge effects are managed and that weed and pathogens are not introduced to the site and areas of retained vegetation, the Project is not likely to interfere with the recovery of the species, as the Project is not inconsistent with the above listed recovery objectives.

Conclusion

Cryptic Forest Twiner was not recorded within the study area during targeted flora transect surveys undertaken in accordance with the NSW Guide to Surveying Threatened Plants (OEH 2016) (refer Section 4.2.1). Approximately 25.20 hectares of potential habitat for Cryptic Forest Twiner occurs within the study area. This is considered a small proportion of potential habitat (<0.4%) within 10 kilometres of the study area.

Based on the above assessment, Cryptic Forest Twiner is unlikely to be significantly impacted by the Project and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Threatened fauna species

Giant Barred Frog *Mixophyes iterates* – Endangered EPBC Act

The Giant Barred Frog is found along freshwater streams with permanent or semi-permanent water, at elevations below 1000 metres. Although generally found within about 20 metres of the stream, outside the breeding season, the Giant Barred Frog may disperse away from the stream (e.g. 50 metres or further). Moist riparian habitats such as rainforest or wet sclerophyll forest are favoured for the deep leaf litter that they provide for shelter and foraging, as well as open perching sites on the forest floor. However, Giant Barred Frogs will also sometimes occur in other riparian habitats, such as those in drier forest or degraded riparian remnants, and even occasionally around dams (OEH, 2018).

Potential habitat for this species in the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD), includes:

- PCT670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion.
- PCT692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion.
- PCT747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion.
- PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion.
- PCT1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast.
- PCT1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast.
- PCT1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.
- PCT1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion.

Approximately 4.79 hectares of potential habitat for Giant Barred Frog occurs within the study area asscoaited with vegetated riparian zones of a second of higher watercourses. A single call was recorded within the study area along a tributary of Pine Brush Creek during targeted fauna surveys undertaken in accordance with the Survey guidelines for Australia's threatened frogs: Guidelines for detecting frogs listed as threatened under the EPBC Act (DEWHA 2010). The species is also known to occur along Newports Creek, and therefore a precautionary approach has been taken and the species has been assumed to be present within the aforementioned PCT's within the study area.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

The Coffs Harbour – Dorrigo area supports a large population of Giant Barred Frog and is noted to be a stronghold for the species (OEH 2018). The species is known to occur within the study area, with dozens of records within a 10 kilometre radius.

The Project will result in the removal of 3.28 hectares of known and a further 1.51 hectares of potential habitat, in two separate locations, within the study area. The total impact area incudes riparian vegetation within 500 metres of known Giant Barred Frog records within the study area, centred around the Kororo Nature Reserve at the northern end of the study area. Riparian habitats along Newports Creek, south of North Boambee Road have also been included due to the high likelihood of the species' occurrence in the area based on the proximity of the habitat to the known population present in that waterway to the east of the study area.

Impacts associated with the direct removal of riparian habitats, known and considered likely to support the species, have the potential to be compounded by the proposed realignment of Newports Creek. Newports Creek supports a known population of the species and is likely to provide breeding habitat within the watercourse and on its banks. Realignment of the watercourse has the potential to disturb this breeding habitat and as such may lead to long-term impacts to the population of frogs living in the area.

Indirect impacts may occur due to impacts to water flow regimes and degradation of water quality; however, hydrological flows will not be substantially altered, and mitigation measure will be implemented to manage water quality. There is also potential for fragmentation and impacts to connectivity, however this will be managed through construction of connectivity measures in areas of habitat.

Therefore, the Project has the potential to lead to a long-term decrease in the size of a population of a species.

Is the action likely to reduce the area of occupancy of the species?

The study area provides approximately 4.79 hectares of known and potential habitat for the Giant Barred Frog. There is an additional 372 hectares of commensurate potential habitat for the species within a 10 kilometre radius. This estimate is based on the length of 2nd order streams and above, within the seven PCTs present within study area and 10 kilometre buffer.

The Project will reduce the area of occupancy of the species by removing 3.28 hectares of known and 1.51 hectares of potential habitat, in two separate locations, within the study area. This equals 0.4% of potential habitat within the locality. Indirect impacts to downstream habitat is not anticipated as hydrological flows will not be substantially altered and mitigation measure will be implemented to manage water quality. Bridging on known habitat at Newports Creek and Pine Brush Creek and construction of fauna connectivity structures targeted to Giant Barred Frog will also mitigate against fragmentation.

Is the action likely to fragment an existing population into two or more populations?

The Giant Barred Frog has previously been recorded in close proximity to Kororo Nature Reserve at the northern end of the study area, and riparian habitats along Newports Creek, south of North Boambee Road. The Project may result in impacts to connectivity for this species, with the Project dissecting these two areas of habitat. The works associated with the realignment of Newports Creek have the potential to substantially disrupt connectivity during construction. However, bridging on known habitat at Newports Creek and Pine Brush Creek and construction of fauna connectivity structures targeted to Giant Barred Frog will reduce the severity of potential fragmentation.

It is considered that the Project has the potential to fragment an existing population of Giant Barred Frog, subject to effectiveness of the mitigation measures proposed.

Is the action likely to adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines critical habitat as:

- For activities such as foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- Maintain genetic diversity and long term evolutionary development.
- For the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for the Giant Barred Frog has been listed on the DoEE Register of Critical Habitat. The Coffs Harbour – Dorrigo area is noted as supporting a large population and is considered a stronghold for the species (OEH 2018). Given this, habitat within the study area would be considered important to the species long term survival.

The Project will result in the direct removal of 4.79 hectares of known and potential Giant Barred Frog habitat that contributes to a broader area of habitat considered important for the survival of the species. Whilst this is a small proportion of habitat available to the Coffs Harbour – Dorrigo population of the species, it is considered a substantial amount of habitat removal at a local scale, based on the relatively low abundance of high quality habitats within and immediately adjacent to the study area.

Indirect impacts may occur due to impacts to water flow regimes and degradation of water quality; however, hydrological flows will not be substantially altered, and mitigation measure will be implemented to manage water quality. There is also potential for fragmentation and impacts to connectivity to occur. However, bridging on known habitat at Newports Creek and Pine Brush Creek and construction of fauna connectivity structures targeted to Giant Barred Frog will reduce the severity of potential fragmentation.

The Project will result in the removal of habitat considered important to the long-term survival of the species due to its occurrence in an area considered a stronghold for the species. Given this, the Project has the potential to adversely affect habitat critical to the survival of a species, subject to effectiveness of the mitigation measures proposed.

Is the action likely to disrupt the breeding cycle of a population?

The Giant Barred Frog is a stream frog, breeding along permanent streams. The species deposits its eggs out of the water, under overhanging banks or on steep banks of large pools (DoEE 2018). Although generally found within about 20 metres of the stream, outside the breeding season, the Giant Barred Frog may disperse away from the stream (e.g. 50 metres or further).

The realignment of Newports Creek has the potential to impact breeding habitat, connectivity and dispersal habitat for a known population of the species. These impacts will be mitigated through ensuring creek realignments are constructed to natural flow conditions and carried out in accordance with the requirements of the DPI guidelines for fish conservation and management (NSW Fisheries 2003). Pre-clearance surveys prior to earthworks, and installation of sediment control and frog proof fences will also be implemented as part of the works. However, significant disruption is considered likely to occur during the construction phase of the Project.

As such, the Project has the potential to disrupt the breeding cycle of a population, subject to effectiveness of the mitigation measures proposed.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project will remove 3.28 hectares of known Giant Barred Frog habitat, in two separate locations, within the study area. The study area provides approximately 4.79 hectares of potential habitat for the species. There is an additional 372 hectares of commensurate potential habitat for the species within a 10 kilometre radius (OEH 2012).

Therefore, the Project will decrease the availability of habitat within the locality by 1%. Indirect impacts to downstream habitat is not anticipated as hydrological flows will not be substantially altered and mitigation measure will be implemented to manage water quality. Additional mitigation measures will be implemented including, bridging on known habitat at Newports Creek and Pine Brush Creek, construction of fauna connectivity structures targeted to Giant Barred Frog pre-clearance surveys prior to earthworks and installation of frog proof fences. Therefore, the proposed impacts are likely to be relatively isolated to a small area of the species distribution, known to be from Eumundi in south-east Queensland to Warrimoo in the Blue Mountains NSW, and would be unlikely to be of sufficient magnitude to result in a decline in the species.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

A number of species, including feral pigs and domestic stock, have been identified as a threat to the Giant Barred Frog. However, the Project will not result in the establishment of any of these species within the study area.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. Mitigation measures will be implemented to ensure appropriate pathogen management is undertaken during construction. This will include ensuring appropriate wash down procedures are in place to prevent the spread of Chytrid fungus. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere with the recovery of the species?

The following threats are listed in the species profile (OEH 2018) and considered relevant to the Project:

- Much of the habitat of the Giant Barred Frog occurs in the lower reaches of streams that are also the focus of agricultural and rural residential activities. Clearance of riparian vegetation is a major threat in these environments.
- Tall, dense weed infestations can decrease the quality and amount of habitat available, particularly where there are canopy gaps in the riparian vegetation. Lantana and exotic grasses decrease habitat suitability.
- Reduction in water quality or alterations to flow patterns. Embryos and tadpoles can be vulnerable to siltation.
- In some locations, the Giant Barred Frog is known to carry chronic infections of the fungal pathogen *Batrachochytrium dendrobatidis* that causes chytridiomycosis. This pathogen is a threat as it is a

known cause of decline in frog species; however it is unclear whether the Giant Barred Frog is currently declining from this cause.

There is no recovery plan for the Giant Barred Frog; however, it is currently managed under the 'Save our Species' program in NSW. No sites are currently being managed for the species. None of the identified actions are relevant to the Project.

The Project will result in the direct removal of riparian habitat known and predicted to support the species, as well as temporary, and potentially long-term disruptions to breeding and dispersal habitat through the realignment of Newports Creek. As such, the Project has the potential to impact the survival and ongoing recovery of the local population of the species, but due to these impacts being at this local scale the Project cannot be said to be likely to interfere with the recovery of the species as a whole.

Indirect impacts to downstream habitat is not anticipated as hydrological flows will not be substantially altered and mitigation measure will be implemented to manage water quality. Additional mitigation measures will be implemented including, bridging on known habitat at Newports Creek and Pine Brush Creek, construction of fauna connectivity structures targeted to Giant Barred Frog, pre-clearance surveys prior to earthworks and installation of frog proof fences. Therefore, the Project is not considered to interfere with the recovery of the species, subject to effectiveness of the mitigation measures proposed.

Conclusion

The Project will result in the removal of 3.28 hectares of known and potential habitat, in two separate locations, and a further 1.51 hectares of potential habitat within the study area. This will result in the removal of 1% of commensurate potential habitat within the locality. The Project has the potential to result in disruptions to the breeding cycle of the local population of the species and fragment habitats in this, and other locations within the study area.

Indirect impacts may also occur from impacts to water flow regimes and degradation of water quality; however, hydrological flows will not be substantially altered, and mitigation measure will be implemented to manage water quality. Additional mitigation measures will be implemented including bridging on known habitat at Newports Creek and Pine Brush Creek, construction of fauna connectivity structures targeted to Giant Barred Frog, pre-clearance surveys prior to earthworks and installation sedimentation controls and frog proof fences.

Despite these mitigation measures, the Project is considered to have the potential to result in a significant impact on the Giant Barred Frog. .

Grey-headed Flying-fox Pteropus Poliocephalus – Vulnerable EPBC Act and BC Act

The Grey-headed Flying-fox requires foraging resources and roosting sites. It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, Melaleuca swamps and Banksia woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas. The primary food source is blossom from Eucalyptus and related genera but in some areas it also utilises a wide range of rainforest fruits. None of the vegetation communities used by the Grey-headed Flying-fox produce continuous foraging resources throughout the year. As a result, the species has adopted complex migration traits in response to ephemeral and patchy food resources.

The species roosts in large 'camps' of up to 200,000 individuals. Camps are usually formed within 20 kilometres of a regular food source and are generally close to water and along gullies. However, the species has been known to form camps in urban areas. Key threats to the species are loss of roosting and foraging sites, electrocution on powerlines, entanglement in netting and on barbed-wire, heat stress, and conflict with humans (OEH 2018). There are records of the species within a 200 metres of the study area (OEH 2018), and suitable foraging habitat is located within the study area.

The Grey-headed Flying-fox is predicted to occur in the following vegetation communities within the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD):

- PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion
- PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the North Coast.
- PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central North Coast.
- PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion
- PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.
- PCT 1244 Sydney Blue Gum Open Forest on Coastal Foothills and Escarpment of the North Coast.
- PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of North Coast.
- PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion
- PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion.

Approximately 43.37 hectares of known and potential foraging habitat for Grey-headed Flying-fox occurs within the study area, and the species was recorded within the study area during targeted fauna surveys undertaken in accordance with the NSW Survey guidelines for Australia's threatened mammals (Commonwealth of Australia 2011). No known roosts were identified within the study area. There is potential that the study area is used occasionally by this species, although it is unlikely that individuals of this species are dependent upon resources in the study area.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An "*important population*" of a vulnerable species is defined in the guidelines (Commonwealth of Australia 2013) as "*a population that is necessary for a species' long-term survival and recovery*". There is a single interbreeding population of Grey-headed Flying-fox in Australia, and as such, any colony or individual of the species is an important population of the species.

The closest camp as presented on the DEE National Flying-fox Monitoring Viewer is located approximately 1 kilometre to the west of the study area, however it is noted as vacated, with no Flying-foxes being recorded in the last five years. A further two camps are present in the local area between 1.7 kilometres and 2 kilometres (approximately) from the study area. the "Toormina" camp is listed as Nationally Important in the monitoring viewer (Figure 13). No camps would be impacted. The study area does not support key source populations for breeding, populations necessary for maintaining genetic diversity, or populations near the limit of the species range. The study area would be used for foraging only.

The project would result in the removal of 43.37 hectares of known and potential foraging habitat, within the study area. A further 8,683 hectares of potential foraging habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Therefore, the proposed Project is not considered likely to lead to a long-term decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

There is a single interbreeding population of Grey-Headed Flying-Fox in Australia, and as such, any colony or individual of the species is an important population of the species. The Project will reduce the area of occupancy of the species by removing 43.37 hectares of known and potential foraging habitat, within the study area. However, the Project is unlikely to reduce the area of occupancy of an important population given that no campsites have been recorded within the study area and that extensive foraging habitat (8,683 hectares) exists in the surrounding landscape.

Is the action likely to fragment an existing important population into two or more populations?

There is a single interbreeding population of Grey-Headed Flying-Fox in Australia, and as such, any colony or individual of the species is an important population of the species.

Fragmentation of foraging habitat for the Grey-headed Flying-fox may occur as a result of the Project. However, local habitat for the species occurs across an environment already fragmented by major roads, farmland and plantations, residential and commercial developments and historic vegetating clearing. Hence, the Project is considered unlikely to exacerbate fragmentation and substantially reduce the connectivity of potential habitat for the species at a landscape scale.

Therefore, it is considered unlikely that the Project will fragment an existing important population into two or more populations.

Is there a real chance or possibility that the action will adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines critical habitat as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal.
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- to maintain genetic diversity and long term evolutionary development.
- for the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for Grey-headed Flying-fox has been listed on the DoEE Register of Critical Habitat. This species has been assigned to the Landscape species management stream under the Saving our Species program, as they are subject to threatening processes that generally act at the landscape scale rather than at distinct, definable locations. No management sites have currently been identified for this species. However, known camps and spring foraging resources are considered to be critical to the survival of the species.

The closest active camp is located approximately 1.7 kilometres from the study area (Coffs Creek) (Figure 13), and comprises foraging habitat critical to the survival of the Grey-headed Flying-fox.

The project would result in the removal of 43.37 hectares (0.4%) of known and potential foraging habitat, within the study area. However this vegetation is fragmented and not considered important to the species, given that known spring foraging resources are located in Boambee State Forest 3 kilometres west of the study area. A further 8,683 hectares of potential foraging habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Given the highly mobile nature of the species and the fact that the vegetation to be removed on site does not represent primary roosting habitat and extensive areas of habitat are present within the study area and LGA, the habitat to be removed is unlikely to be habitat critical to the survival of the Grey-headed Flying-fox.

Is the action likely to disrupt the breeding cycle of an important population?

There is a single interbreeding population of Grey-Headed Flying-Fox in Australia, and as such, any colony or individual of the species is an important population of the species. As no roosting habitat would be

removed or disturbed, it is unlikely the proposed work would disrupt the breeding cycle of an important population.

The project would result in the removal of 43.37 hectares (0.4%) of known and potential foraging habitat, within the study area. This is considered minimal and unlikely to affect the amount of resources available to any breeding individuals, given that known spring foraging resources are located in Boambee State Forest 3 kilometres west of the study area.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project will result in the direct removal of 43.37 hectares of known and potential foraging habitat for the Grey-Headed Flying-Fox based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). With regard to these habitat associations, a further 8,683 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

There could be limited disruption from noise or vibration to individuals and their habitat during construction and operation of the Project. However, given the distance to the nearest known camp site and the mobile and urban nature of the species, this is unlikey to cause a decrease in habitat quality such that the species is likely to decline.

Given the highly mobile nature of the species and the fact that the vegetation to be removed on site does not represent primary roosting or foraging habitat and extensive areas of foraging habitat are present adjacent to the study area and within the LGA, the proposed works will not modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

No Threat Abatement Plans relating to invasive species are listed as relevant to the Grey-headed Flying-fox.

The Project is unlikely to result in the establishment of invasive species in the study area.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere substantially with the recovery of the species?

A national draft recovery plan for the Grey-headed Flying-fox has been developed by the Department of the Environment and Energy (CoA 2017). The following recovery objectives are outlined as part of this plan:

- Identify, protect and enhance native foraging habitat critical to the survival of the Grey-headed Flying-fox.
- Identify, protect and enhance roosting habitat of Grey-headed Flying-fox.
- Determine population trends in Grey-headed Flying-foxes so as to monitor the species' national distribution and conservation status.
- Build community capacity to coexist with flying foxes and minimise the impacts on urban settlements from existing camps without resorting to dispersal.
- Increase public awareness and understanding of Grey-headed Flying-foxes and the recovery program, and involve the community in the recovery program where appropriate.
- Improve the management of Grey-headed Flying-fox camps in sensitive areas.
- Significantly reduce levels of deliberate Grey-headed Flying-fox destruction associated with commercial horticulture.
- Support research activities that will improve the conservation status and management of Grey-headed Flying-foxes.
- Assess and reduce the impact on Grey-headed Flying-foxes of electrocution on power lines, and entanglement in netting and on barbed wire.

The project is not likely to interfere with these recovery objectives as there are no known camps within the study area, and known and potential foraging resources are not critical to the survival or the species.

This species is also part of the OEH 'Saving our Species' Program and has been assigned to Landscape species management. None of the management sites where management of important populations is underway fall within or near the Project.

OEH (2018a) has identified a number of priority actions to help the recovery of this species. Those that are relevant to the proposed project are detailed below:

- Increase the extent and viability of foraging habitat.
- Negotiate agreements with landholders that promote the protection and retention of high quality habitat and roost sites.
- Rehabilitate degraded Flying-fox roost sites.
- Conduct dedicated engagement programs in communities affected by roost sites.
- Distribute public education materials to land managers and local community groups.
- Develop site-based heat response protocols for camps likely to be affected by heat stress events.

OEH (2018a) also lists the follow threats to this species:

- Loss of roosting and foraging sites.
- Electrocution on power lines, entanglement in netting and on barbed-wire.
- Heat stress.
- Conflict with humans.
- Incomplete knowledge of abundance and distribution across the species' range.

The Project is not likely to interfere with the recovery of the species, as no roosting or breeding habitat would be removed and extensive areas of foraging habitat are present adjacent to the study area and within the LGA.

Conclusion

The closest active camp is located approximately 1.7 kilometres from the study area (Coffs Creek) (Figure 13), and comprises foraging habitat critical to the survival of the Grey-headed Flying-fox. The project would result in the removal of 43.37 hectares (0.4%) of known and potential foraging habitat, within the study area. However this vegetation is fragmented and not considered important to the species, given that known spring foraging resources are located in Boambee State Forest 3 kilometres west of the study area. A further 8,683 hectares of potential foraging habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

Based on the above assessment, Grey-headed Flying-fox is unlikely to be significantly impacted by the Project and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Koala *Phascolarctos cinereus* – Vulnerable EPBC Act

The Koala is known from the study area, with 122 records within the locality, and the Coffs Harbour area noted as being a "hot spot" for Koala activity (OEH 2014). Preliminary assessments documented the use of the study area by Koalas. Koala was recorded within the study area. A total area of 45.91 hectares of habitat occurs within the study area which represents known and potential habitat for Koalas.

Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally. Preferred feed tree species in the Coffs Harbour area include Tallowwood *Eucalyptus microcorys*, Swamp Mahogany *Eucalyptus robusta*, Broad-leaved Paperbark *Melaleuca quinquenervia*, Flooded Gum *Eucalyptus grandis*, Forest Red Gum *Eucalyptus tereticornis* and Small Fruited Grey Gum *Eucalyptus propinqua,* with Tallowwood the most preferred. Blackbutt *Eucalyptus pilularis* and Camphor Laurel *Cinnamomum camphora* are regularly used as rest trees (Lunney et al 1999). The Koala was recorded in and is predicted to occur in the following vegetation communities within the study area:

- PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion.
- PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion.
- PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion.
- PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.
- PCT 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast
- PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast.
- PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.
- PCT 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion.

As Koala is known to use disturbed areas for dispersal, the following additional vegetation communities mapped by OEH (2012) within the study area are also considered potential habitat:

- Plantation - exotic/pine species
- Acacia pioneers
- Camphor Laurel
- Environmental plantings
- Native remnant vegetation
- Exotic vegetation.

Areas of Primary Koala Habitat are the most significant habitats available to Koalas in the Coffs Harbour LGA (Lunney et al 1999). The majority of this habitat (and the highest level of Koala records and activity) occurs in the south-east section of the LGA generally, south of Korora and Bruxner Park, east of Karangi, south through Boambee State Forest to the southern boundary of the LGA at Pine Creek State Forest. This includes the most populated and highly developed areas of the LGA. The vegetation in this section of the LGA is fragmented, and the Koala population is subject to a number of threats associated with urban expansion and other developments that remove or modify habitat and create barriers to movement. Threats from dogs, collisions with vehicles and health and welfare issues are also much more likely to occur in this part of the LGA (Lunney et al 1999). The importance of preserving the remaining viable koala habitat remnants in this area is critical to securing the Koala population in the LGA.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An "*important population*" of a vulnerable species is defined in the guidelines (Commonwealth of Australia 2013) as "*a population that is necessary for a species' long-term survival and recovery*".

The Coffs Harbour area is listed as an important Koala population centre on the NSW North Coast (DECC 2008) and is noted as being a "hot spot" for Koala activity (OEH 2014). Therefore, although this population is

not located at the limits of the species range, it may be considered a key source population for breeding or dispersal and for maintaining genetic diversity. Therefore, the Coffs Harbour Koala population would be considered an important population.

In their study on the causes of decline of Koalas in South East Queensland, Gonzales-Astudillo et al (2017) found that chlamydiosis, motor vehicle traumas and wasting were high risk areas for Koala disease and injury, with results suggesting that these set of causes are acting together as determinants for the continuing decline of Koalas. Removal of habitat, urbanisation and habitat fragmentation are known to be stressors on Koala health, leading to increased cases of disease in otherwise healthy populations. In their study of more than 20,000 cases from three separate hospitals, Gonzales-Astudillo et al (2017) found that road strike accounted for a high proportion of Koala deaths and that the majority of these dead or euathanased individuals were healthy prior to being hit by a vehicle. Breeding season was correlated with increased road strikes, with dispersal at this time predicted to be the main cause in the increase at this time.

The Project will result in the removal of 43.37 hectares known and potential Koala habitat. Areas to the east of the proposed bypass could also be impacted by encroachment of urban expansion into new areas following the bypass construction. This would result in an increase in threats such as animal – vehicle interactions and dog attacks.

The Project has the potential to result in a long-term decrease in the size of the important population through the following direct and indirect impacts:

- Direct reduction in area of available habitat within the LGA
- Vehicle strike
- Removal of movement corridors
- Fragmentation of habitat
- Removal of primary habitat areas
- Removal of feed trees
- Dog attack
- Increased disease incidence through habitat stress.

Is the action likely to reduce the area of occupancy of an important population?

As discussed above, the Coffs Harbour area is considered an important population.

The Project will result in the removal of 43.37 hectares of known and potential Koala habitat. Other habitat areas to be removed include known habitat corridors as identified in the Koala Plan of Management (Lunney et al 1999). The action is therefore likely to reduce the area of occupancy of the local important population of Koalas.

Is the action likely to fragment an existing important population into two or more populations?

The Project has the potential to result in fragmentation of the Coffs Harbour Koala population, with the potential fragmentation of animals east and west of the proposed bypass.

Is the action likely to adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2014) defines critical habitat to the survival of the Koala through the Koala habitat assessment tool. An assessment of Koala habitat in the study area is provided below.

Attribute	Score	Rationale
Koala occurrence	2 (high)	There is evidence of more than one Koala in the last 2 years
Vegetation composition	2 (high)	The study area has forest and woodland with more than two known feed tree species.
Habitat connectivity	2 (high)	The vegetation in the study area is part of a large area of contiguous habitat greater than 500 hectares.

Attribute	Score	Rationale
Key existing threats	1 (medium)	Whilst no mortality data was collected as a part of the current assessment, it is assumed that there would be frequent road and dog strikes, common to all urban Koala populations.
Recovery value	2 (high)	The Coffs Harbour area has been identified as an area important to the recovery of the Koala.

As the habitat in the study area scores more than five, it is considered habitat critical to the survival of the species.

Is the action likely to disrupt the breeding cycle of an important population?

The Project has the potential to impact the breeding cycle of the important population of Koalas in Coffs Harbour by removal of primary and secondary habitat that could be used during breeding, fragmentation of areas utilised for male movements during the breeding season and disruption to the dispersal of juveniles seeking new territories.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project will result in the removal of 43.37 hectares consisting of known habitat andpotential foraging, shelter and movement habitat for the Koala. Modification of remaining habitats through edge effects and isolation have the potential to decrease the quality of habitat for the Koala.

Therefore, the Project is likely to modify, isolate and decrease the availability and quality of habitat available to the Koala in the local area. This could potentially lead to a decline in the local species.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Fragmentation of Koala habitat could result in increases in invasive species including woody weed such as Lantana, which could restrict Koala movement and tree access. Forty-six weed species were recorded during field surveys and have the potential to spread following disturbance associated with the construction phase of the Project. However, strict hygiene measure will be implemented to prevent and mitigate the spread of weeds and reduce the potential of negative impact the threatened species habitats. The Construction Environment Management Plan for the Project will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

The Construction Environment Management Plan for the Project will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

The Project has the potential to indirectly affect the incidence of disease in the local Koala population. Koalas are susceptible to Chlamydia and Koala retrovirus, which is often induced and exacerbated by stress including vehicle strike, habitat removal and habitat fragmentation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no EPBC Recovery Plan or Threat Abatement Plan has been prepared for the Koala. There is however a NSW Recovery Plan (DECC 2008). The objectives of this plan are listed below:

- To conserve koalas in their existing habitat.
- To rehabilitate and restore koala habitat and populations.
- To develop a better understanding of the conservation biology of koalas.
- To ensure that the community has access to factual information about the distribution, conservation and management of koalas at a national, state and local scale.
- To manage captive, sick or injured koalas and orphaned wild koalas to ensure consistent and high standards of care.

- To manage over browsing to prevent both koala starvation and ecosystem damage in discrete patches of habitat.
- To coordinate, promote the implementation, and monitor the effectiveness of the NSW Koala Recovery Plan across NSW.

The DECC (2008) also lists the follow threats to this species:

- Habitat loss and fragmentation
- Habitat degradation
- Road kill
- Dog attacks
- Fire
- Logging
- Disease
- Severe weather conditions
- Swimming pools
- Over browsing.

The project has the potential to result in further habitat loss, fragmentation and road kill. Mitigation measures will be developed to reduce the impact of these threats on the Koala.

Conclusion

Based on the above assessment, there is potential for the Project to result in a significant impact to the Koala, particularly where the roadway is likely to interrupt movement corridors. The residual impact of the Project on the Koala will be reduced using mitigation measures as detailed in the Section 9.

Long-nosed Potoroo *Potorous tridactylus tridactylus* – Vulnerable EPBC Act and BC Act

This species inhabits coastal heath and wet and dry sclerophyll forests and is generally found in areas with rainfall greater than 760 millimetres. The Long-nosed Potoroo requires relatively thick ground cover where the soil is light and sandy (OEH 2017).

Long-nosed Potoroos are found on the south-eastern coast of Australia, from Queensland to eastern Victoria and South Australia. This species has previously been recorded within one kilometre of the study area (OEH 2018a).

The Long-nosed Potoroo is predicted to occur in the following vegetation communities within the study area, based on data contained in the OEH Threatened Species Profile Database (TSPD):

- PCT 670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion
- PCT 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the North Coast.
- PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central North Coast.
- PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion
- PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.
- PCT 1244 Sydney Blue Gum Open Forest on Coastal Foothills and Escarpment of the North Coast.
- PCT 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of North Coast.
- PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion
- PCT1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion.

Approximately 43.37 hectares of potential habitat for Long-nosed Potoroo occurs within the study area. The species was not recorded within the study area during targeted fauna surveys undertaken in accordance with the NSW Survey guidelines for Australia's threatened mammals (Commonwealth of Australia 2011).

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An "important population" of a vulnerable species is defined in the guidelines (Commonwealth of Australia 2013) as "a population that is necessary for a species' long-term survival and recovery".

The Long-nosed Potoroo is distributed in coastal heaths and forests east of the Great Dividing Range from Queensland to South Australia, with access to dense vegetation important. Key hot spots for the species in NSW appear to be the Dorrigo plateau, near Byron Bay and on the south Coast of NSW. The Long-nosed Potoroo has been recorded twice within the Project locality, with the most recent record in 2004. Given the scarcity of records in relation to the study area, it is unlikely that any population in relation to the study area would be considered an "important population". Therefore the proposed Project is not considered likely to lead to a long-term decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

As outlined above, any distribution of the species within the study area would not be considered an "important population", and therefore the Project is not considered likely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing important population into two or more populations?

As outlined above, any distribution of the species within the study area would not be considered an "important population", and therefore the Project is not considered likely to fragment an existing important population into two or more populations.

Is there a real chance or possibility that the action will adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines critical habitat as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal.
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- to maintain genetic diversity and long term evolutionary development.
- for the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for Long-nosed Potoroo has been listed on the DoEE Register of Critical Habitat. This species has been assigned to the Site-managed species management stream under the Saving our Species program, and no management sites fall within or near the study area.

Given the species was not recorded within the study area, is widely distributed, and the study area does not fall near the edge of the species' range, it is considered unlikely that the Project would adversely affect habitat critical to the survival of Long-nosed Potoroo.

Is the action likely to disrupt the breeding cycle of an important population?

As outlined above, any distribution of the species within the study area would not be considered an "important population", and therefore the Project is not considered likely to disrupt the breeding cycle of an important population. Regardless, given that the species was not recorded within the study area, and the significant amount of potential habitat present within the locality, the impacts from the Project would be unlikely to disrupt the breeding of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project will result in the direct removal of 43.37 hectares of potential habitat for the species based on the plant community habitat associations contained in the OEH TSPD (OEH 2018b). With regard to these habitat associations, a further 8683 hectares (approximate) of potential habitat occurs within a 10 kilometre buffer of the study area, as mapped by the Coffs Harbour LGA mapping project (OEH 2012).

As outlined above, the species is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and South Australia, and as such the removal of 43.37 hectares of habitat is not considered likely to result in impacts substantial enough to cause the wide ranging extent of the species to decline.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The Threat Abatement Plan for predation by Feral Cats (Commonwealth of Australia 2015) and Threat Abatement Plan for Predation by the European Red Fox (Commonwealth of Australia 2008) are both listed as relevant to the Long-nosed Potoroo. The Project is unlikely to result in the establishment of Feral Cats, Red Fox and Dogs in the study area.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere substantially with the recovery of the species?

To date, no state or federal Recovery Plan has been prepared for the Long-nosed Potoroo, however this species is part of the OEH 'Save Our species' Program and has been assigned Site-managed species management. The four listed management sites are Richmond Range, Mount Royal – Barrington Tops, Barren Grounds – Buderoo – Kangaroo Valley, and South East Forests. None of the four management sites occur within or near to the study area.

DECC (2008) also lists the follow threats to this species:

- Habitat loss and fragmentation from land clearing for residential and agricultural development.
- Predation from foxes, wild dogs and cats.
- Too frequent fires or grazing by stock that reduce the density and floristic diversity of understorey vegetation.

- Logging or other disturbances that reduce the availability and abundance food resources, particularly hypogeous fungi, and ground cover.
- Unplanned clearing in areas where the species occurs on private property is likely to degrade the species' habitat.
- Removal of wild dogs and dingoes potentially exposes potoroos to other threats (competition from other species of wallaby / fox predation) due to removal of top order predator.

The proposed upgrade will contribute to an increase in habitat loss and fragmentation for any local Long-nosed Potoroo. However, as the study area does not fall within the dedicated management zones of this species, it is unlikely that the Project will interfere with the recovering of the Long-nosed Potoroo.

Conclusion

Based on the above assessment, Long-nosed Potoroo is unlikely to be significantly impacted by the Project and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Regent Honeyeater Anthochchaera Phrygia – Critically Endangered EPBC Act

The species is endemic to mainland south-eastern Australia where it is now patchily distributed from 100km north of Brisbane to the Adelaide area. The species is mainly associated with woodland of the inland slopes of NSW and Victoria but also occurs at key coastal sites in NSW. The species feeds mainly on nectar from key eucalypt species and mistletoes and its movements are tied to the timing of flowering for these food tree species.

The main threat to the species is clearing, habitat fragmentation and degradation associated with agriculture and urban development. Other threats include firewood collection, invasive plants, grazing by livestock and predation by exotic predators. Woodland fragmentation has led to increased numbers of Noisy Friarbird and Red Wattlebird, which compete with Regent Honeyeaters for key nectar resources.

There are four key breeding areas for the Regent Honeyeater and a number of subsidiary areas which may be used in response to resource availability (CoA 2016).

Threats to the Regent Honeyeater as outlined in the National Recovery plan (CoA 2016) include:

- Small population size (350-400 individuals)
- Habitat loss and fragmentation (clearing of woodland and forest containing key eucalypt species)
- Habitat degradation (loss of mature trees and restriction of shrub and sapling growth)
- Competition (from other nectivorous birds)

Key objectives of the recovery plan are to:

- Reverse the long-term population trend of decline and increase the numbers of regent honeyeaters to a level where there is a viable, wild breeding population, even in poor breeding years; and to
- Enhance the condition of habitat across the regent honeyeaters range to maximise survival and reproductive success, and provide refuge during periods of extreme environmental fluctuation.

A total of 3.65 hectares of suitable swamp habitat as PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion occurs within the study area. These areas support key tree species known to be important food resources for Regent Honeyeater, including Swamp Mahogany. Diurnal bird surveys conducted during field assessment in Spring and Summer did not detect any Regent Honeyeater activity. Previous records within the locality are sporadic with primarily singular records occurring within years spanning from 1977 to 2014. It is assumed the study area may be used on occasion for foraging by the Regent Honeyeater, but that survey over any given year may be unable to detect the species given that the estimated total number of individual birds is less than 1000, their wide distribution across the south-east of Australia and the nomadic nature of the species (CoA 2016). The study area is considered unlikely to support breeding habitat given the areas identified as key and subsidiary breeding sites are located greater than 100 kilometres away, the number of records across years is low and that breeding has not been identified previously in the area.

Within a 10 kilometre buffer of the study area approximately 175 hectares of potential habitat, commensurate to that present within the study area, for the species occurs. This is based on the occurrence of PCT 1064 Paperbark swamp forest as mapped in the Coffs Harbour LGA vegetation mapping (OEH 2012)

Is the action likely to lead to a long-term decrease in the size of a population?

The study area does not include known or likely areas of significance for Regent Honeyeater. Within the surrounding 10 kilometres there is 175 hectares of potential habitat comprising the same PCT to be removed by the Project (PCT 1064). Removal of 3.65 hectares of potential habitat within the study area is unlikely to lead to further declines in the population of the species.

Is the action likely to reduce the area of occupancy of the species?

As outlined above, the species is patchily distributed from 100 kilometres north of Brisbane to the Adelaide area. The species is mainly associated with woodland of the inland slopes of NSW and Victoria but also occurs at key coastal sites in NSW. Coffs Harbour is not one of these key sites.

Within 10 kilometres of the study area, 175 hectares of potential foraging habitat for this species occurs as PCT 1064, the area does not contain known areas of breeding habitat. The construction will result in the

removal of 3.65 hectares of this potential forage habitat, the study area is not at the outer limits of the species range, and removal at this scale is unlikely to significantly reduce the area of occupancy of the species.

Is the action likely to fragment an existing population into two or more populations?

Due to its complex movement patterns typified by migration and local nomadism, the Regent Honeyeater has what is effectively a single national population. The species is highly mobile and individuals can move freely through areas of unsuitable and marginal habitat to seek out and exploit favourable habitat patches. The Project will not impact on known critical habitat and as a result, the proposal will not fragment the population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of the species.

Habitat critical to the survival of this species is defined in the Regent Honeyeater National Recovery Plan (Commonwealth of Australia 2016) as:

Any breeding or foraging habitat in areas where the species is likely to occur (as defined by the distribution map provided in Figure 2 of the National Recovery Plan); and

Any newly discovered breeding or foraging locations.

While the Project will result in the removal of areas of paperbark swamp that support tree species known to be used by Regent Honeyeater, vegetation within the construction footprint does not constitute known or likely breeding habitat. The study area supports 3.65 hectares of potential foraging habitat.

The study area lies over 100 kilometres to the east of areas identified as key breeding areas for the Regent Honeyeater in the national recovery plan (Commonwealth of Australia), and database records of the species within the vicinity of the Project are to the east of the alignment with the most recent record of an individual from 2014.

Is the action likely to disrupt the breeding cycle of a population?

The study area does not constitute any key Regent Honeyeater breeding sites. The closest known breeding habitat is a key breeding area located more than 100 kilometres to the west of Coffs Harbour. As outlined above, the species is considered to effectively comprise a single population and as such, impacts to a very small proportion (<0.01%) of the populations non-breeding habitat is not considered likely to result in any disruption of the pollution's breeding cycle.

Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project will result in the removal of approximately 3.65 hectares of potential foraging habitat (PCT 1064) for the Regent Honeyeater. A further 175 hectares (of PCT 1064) occurs within a 10 kilometre radius of the study area. The magnitude of the impact is small in the context of other causes of habitat loss operating across the species' range and in isolation, is unlikely to impact the species to the extent that it would cause a decline in the species.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

The project is unlikely to exacerbate the current level of invasive species threat operating within the study area to the point that they become harmful to the Regent Honeyeater. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

The proposed action is unlikely to introduce a disease that causes the Regent Honeyeater to decline. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere with the recovery of a species?

Given the study area is outside of any known breeding habitat and will impact on only 3.65 hectares of foraging habitat for the Regent Honeyeater, it is unlikely that it would interfere with the species' recovery.

Conclusion

Based on the assessment provided above, it is concluded that Regent Honeyeater is unlikely to be significantly impacted by the Project, and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Spotted-tailed Quoll *Dasyurus maculatus maculatus – Endangered EPBC Act, Vulnerable BC Act*

The Spotted-tailed Quoll uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests. Occasional sightings have also been made in open country, grazing lands, rocky outcrops and other treeless areas. Habitat requirements include suitable den sites such as hollow logs, rock crevices and caves, an abundance of food, and a large area of intact vegetation in which to forage. (OEH 2018a)

The Spotted-tailed Quoll has previously been recorded within approximately 820 metres of the study area, and has been recorded on 34 occasions within 5 kilometres of the study area, with the most recent record in 2014. The majority of these sights occur to the west of the study area on the escarpment, with only two occurring to the east.

The Spotted-tailed Quoll is predicted to occur in the following vegetation communities within the study area based on the information contained in the OEH Threatened Species Profile Database:

- PCT670 Black Booyong - Rosewood - Yellow Carabeen subtropical rainforest of the NSW North Coast Bioregion
- PCT692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the North Coast.
- PCT695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central North Coast.
- PCT747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion
- PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.
- PCT 1244 Sydney Blue Gum Open Forest on Coastal Foothills and Escarpment of the North Coast.
- PCT1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of North Coast.
- PCT1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion
- PCT1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion.

As Spotted-tailed Quoll may use disturbed areas for dispersal and foraging, the following additional vegetation communities mapped by OEH (2012) within the study area are also considered potential habitat:

- Acacia pioneers
- Environmental plantings
- Native remnant vegetation

Suitable habitat within the study area is likely to be mostly confined to larger patches of remnant vegetation. Approximately 43.37 hectares of potentially suitable habitat for Spotted-tailed Quoll occurs within the study area. The species was not recorded within the study area during targeted fauna surveys undertaken in accordance with the NSW Survey guidelines for Australia's threatened mammals (Commonwealth of Australia 2011).

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Commonwealth of Australia (2013) defines a population of a species as an occurrence of a species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations.

- a population, or collection of local populations, that occurs within a particular bioregion.

Given the large tracts of vegetation extending along the Dorrigo Plateau, west of Coffs Harbour, and extending into the study area, and the large home ranges of individual quolls, the population of the Spotted-tailed Quoll relevant to the Project is defined as the population in the north coast bioregion. However, given

the location of the study area in relation to peri-urban and urban environments, habitat in the study area is considered sub-optimal for this species, with higher quality habitat to the west.

The removal of 43.37 hectares of habitat considered sub-optimal for a species with a large home range, and part of a population that spans the North Coast bioregion, is not considered likely to lead to a long-term decrease in the population size. Large tracts of higher quality vegetation will remain unaffected by the Project which will continue to support the current population.

Is the action likely to reduce the area of occupancy of the species?

The study area provides approximately 43.37 hectares of potential habitat for the Spotted-tailed Quoll in the form of foraging habitat. No potential den sites were located during targeted fauna habitat surveys.

The Project will result in the removal of vegetation within the study area, along with indirect impacts including edge effects and impacts to habitat quality. The area to be directly impacted represents approximately 0.4 % of the estimated equivalent potential habitat for the Spotted-tailed Quoll within the locality, based on PCVTs mapped by OEH (2012) within a 10 kilometre buffer around the study area. Given the extent of habitat in the locality, particularly the Dorrigo plateau to the west, any habitat removal is unlikely to be significant.

Is the action likely to fragment an existing population into two or more populations?

The study area is currently likely to support movement corridors for this species, allowing movement of animals between coastal and plateau areas. However, it is noted that the existing Pacific Highway and areas of urban development are likely to have already resulted in fragmentation of habitats. There is potential for the Project to impact on movement corridors for this species, resulting in further fragmentation of habitat for this species.

The Project has the potential to result in further fragmentation of habitat for this species if suitable mitigation measures are not implemented. The assessment of the Project will require consideration of mitigation measures to ensure connectivity is retained along habitat corridors. This will include fauna underpasses or crossing structures. Provided suitable mitigation measures are put in place it is considered unlikely that the Project will fragment an existing population into two or more populations.

It is likely that any individuals along the escarpment provide a key source population for areas closer to the coast. Suitable measures to mitigate impacts of fragmentation will be included within the Construction Environment Management Plan.

Is the action likely to adversely affect habitat critical to the survival of a species?

Commonwealth of Australia (2013) defines critical habitat as:

- For activities such as foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- Maintain genetic diversity and long term evolutionary development.
- For the reintroduction of populations or recovery of the species or ecological community.

To date, no critical habitat for the Spotted-tailed Quoll has been listed on the DoEE Register of Critical Habitat. The species profile (Commonwealth of Australia 2016a) identifies den sites and connectivity between dens as being of "critical importance to the conservation of the subspecies, as the distribution of males appear to be largely influenced by the presence of breeding adult females". However, no potential den sites were identified within the study area during targeted habitat surveys.

In the absence of den sites it is most likely that the study area is currently used by Spotted-tailed Quolls for foraging, and to move between coastal and western sites, and thus does not make up critical habitat for the species. It is considered that the Project is unlikely to adversely affect habitat critical for the species' survival.

Is the action likely to disrupt the breeding cycle of a population?

The Commonwealth of Australia (2016a) identifies the retention of den sites and connectivity between den sites as important to the breeding cycle of this species. No potential den sites were identified within the study area during targeted fauna habitat surveys. It is likely that any individuals along the western escarpment provide a key source population for areas closer to the coast, and that individuals in coastal areas would most likely return to the more suitable habitat in the west to breed. If connectivity was lost between the two

areas, there could potentially be an impact on breeding cycles due to the inability of individuals to travel between these sites.

The assessment of the Project will require consideration of mitigation measures to ensure connectivity is retained along key habitat corridors. Provided suitable mitigation measures are put in place it is considered unlikely that the Project will result in a disruption to the breeding cycle of the Spotted-tailed Quoll population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Approximately 43.37 hectares of potential habitat for the Spotted-tailed Quoll has been identified within the study area. However, this habitat is considered sub-optimal and likely to support mostly movements of individuals between plateau and coastal areas. Given the extent of habitat available to the north coast bioregion population, particularly large tracts of vegetation on the Dorrigo plateau to the west, it is considered unlikely that this loss of habitat and any associated decline in habitat quality would cause the overall species decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The Threat Abatement Plan for predation by feral cats (Commonwealth of Australia 2015) and Threat Abatement Plan for Predation by the European Red Fox (Commonwealth of Australia 2008) are both listed as relevant to the Spotted-tailed Quoll.

The Project is unlikely to result in the establishment of Feral Cats, Red Fox and Dogs in the study area.

The Project Construction Environmental Management Plan will include measures to ensure appropriate management of pest animals is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

The Project is not likely to introduce disease that may cause the species to decline. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to interfere with the recovery of the species?

A National Recovery Plan has been prepared for the Spotted-tailed Quoll (Commonwealth of Australia 2016) and the following threats to the species are relevant to the Project:

- Habitat loss and modification.
- Fragmentation.
- Competition and predation from introduced predators.
- Road mortality.

The following objectives have been listed in the recovery plan and are relevant to the Project:

- Reduce the rate of habitat loss and fragmentation on private land.
- Determine and manage the threat posed by introduced predators (foxes, cats, wild dogs) and of predator control practices on Spotted-tailed Quoll populations.
- Reduce the frequency of Spotted-tailed Quoll road mortality.

Provided suitable mitigation measures are put in place it is considered unlikely that the Project will interfere with the recovery of the species.

Conclusion

Provided suitable mitigation measures are put in place to reduce the impacts of fragmentation on the Spotted-tailed Quoll the Project is considered unlikely to result in a significant impact to this species, and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

Swift Parrot *Lathamus discolour* – Critically Endangered EPBC Act

The Swift Parrot Lathamus discolor is a medium size, nectivorous parrot that is endemic to Australia. It is identified by its bright green colouration with patches of yellow, red and blue located on its throat, chin, face and wings. They breed in Tasmania and overwinter in mainland Australia (Saunders and Tzaros 2011). Breeding occurs between September and April in Tasmania in a range of forest types (Higgins 1999). Once breeding is complete, they disperse from breeding areas, across Tasmania, and to mainland Australia (Higgins 1999). Birds arrive in NSW as early as February and March, however most 'first' records for the year are from April (Higgins 1999). Most birds spend the winter in Victoria and New South Wales, but they are also known to extend as far north as Brisbane, although this is unusual (Higgins 1999). They disperse across broad landscapes, foraging on nectar, pollen and lerps in a variety of eucalypt species. (Saunders and Tzaros 2011). They return to Tasmania in August and September, with the largest number of 'returning' records from September (Higgins 1999).

Swift Parrots occur as a single population that is estimated to be approximately 1000 pairs which is most likely continuing to decline (Garnett et al. 2011; Saunders and Tzaros 2011). Swift Parrot is currently listed as 'Critically Endangered' under the EPBC Act and is also listed as a threatened species in all states and territories in which it occurs (New South Wales, Tasmania, Victoria, Queensland, ACT and South Australia).

Key factors contributing to their decline reported in the National Recovery Plan (Saunders and Tzaros 2011) include:

- Loss and alternation of habitat from forestry activities (firewood harvesting, residential clearing, agricultural and industrial developments).
- Attrition of old growth trees within agricultural landscapes.
- Suppression of forest regeneration and fire.
- Climate change.
- Food and nest competition.
- Flight collision hazards.
- Psittacine beak and feather disease.
- Illegal capture and trade.

On the mainland Swift Parrot mostly occurs on the inland slopes but occasionally occurs on the coast (DoE 2018). Key tree species within the locality include Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata,* Forest Red Gum E. *tereticornis,* and Blackbutt *Eucalyptus pilularis.* Blackbutt.

Priority habitats are those which are used for nesting, by large proportions of the swift parrot population, repeatedly between seasons (site fidelity) or for prolonged periods of time (site persistence) (Saunders and Tzaros 2011). Habitat critical to the survival of the Swift Parrot is likely to constitute areas with high site fidelity and site persistence as well as those areas in which breeding occurs (Tasmania only).

Within the study area a total of 3.65 hectares of potential foraging habitat occurs in the form of PCT 1064 *Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion,* within this PCT Swamp Mahogany is the main feed-tree species. Within a 10 kilometre radius (the locality) approximately 175 hectares of PCT 1064 occurs providing additional foraging habitat for the species. No previous records from the OEH Bionet Atlas occur within the study area, records from within the locality occur predominantly to the east of the study area, the most recent of these records is from 2010. The Swift Parrot has the potential to be an occasional visitor to the study area during autumn and winter. Other habitats may also be used opportunistically, habitat which reliably provides a large quantity and quality of resources is identified as habitat upon which the species can depend (Saunders and Tzaros 2011).

<u>Is the action likely to lead to a long-term decrease in the size of a population?</u>

The Swift parrot occurs as a single migratory population (Saunders and Tzaros, 2011) The study area does not include known or likely areas of significance for the Swift Parrot, and within the locality approximately 175 hectares of potential habitat, commensurate with that to be removed by the Project, exists consisting of PCT 1064 (OEH 2012). Removal of habitat at this small scale (3.65 hectares) within the study area is unlikely to lead to declines in the population of a wide ranging species such as Swift Parrot.

<u>Is the action likely to reduce the area of occupancy of the species?</u>

Within the wider locality 175 hectares of potential foraging habitat occurs for this species as PCT 1064 (OEH 212), the same PCT supporting habitats to be impacted by the Project. The area does not contain breeding habitat and the low number and sporadic occurrence of records within the locality suggests that the study area is unlikely to constitute habitat critical to the survival of the species. The Project will result in the removal of 4.50 hectares of this habitat. While this will result in a small reduction of available habitat the study area is not at the outer limits of the species range and removal at this scale is unlikely to significantly reduce the area of occupancy of the species.

Is the action likely to fragment an existing population into two or more populations?

Due to its migratory movement patterns typified by seasonal migration and local nomadism, Swift Parrot is considered to occur as a single national population (Saunders and Tzaros, 2011). The species is highly mobile and individuals can move freely through areas of unsuitable and marginal habitat to seek out and exploit favourable habitat patches. The Project will not impact on known critical habitat, or result is substantial barriers to the species' movement and as a result, the proposal will not fragment the population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of the species.

To date no critical habitat for Swift Parrot has been listed on the DoEE Register of Critical Habitat. The National Recovery Plan for Swift Parrot outlines priority habitats as those which are used for nesting, by large proportions of the swift parrot population, repeatedly between seasons (site fidelity) or for prolonged periods of time (site persistence) (Saunders and Tzaros 2011).

Habitat critical to the survival of this species is defined in the National Recovery Plan for the Swift Parrot National Recovery Plan (Saunders and Tzaros 2011) as:

Priority habitat for which the Swift Parrot has a level of site fidelity or which possess phenological characteristics likely to be of importance to the Swift Parrot

Areas otherwise identified by the Recovery Team

Database records of the species within the vicinity of the Project are primarily to the east of the Study Area and records within the locality occur sporadically from 1983-2010.

While the Project will result in the removal of areas of 3.65 hectares of paperbark swamp habitat that support tree species known to be used for foraging by species, vegetation within the study area does not constitute known or likely breeding habitat, is not listed as habitat critical to the survival of the species and is unlikely to have high site fidelity due to the low number of records spread across multiple decades within the locality. Therefore given the geographic distribution, highly mobile nature of the species and existence of a 175 hectares of commensurate habitat within the wider locality, the Project is considered unlikely to impact on habitat critical to the survival of the Swift Parrot.

Is the action likely to disrupt the breeding cycle of a population?

The Swift Parrot is seasonally migratory and breeds in Tasmania. No additional breeding sites have been identified on the mainland.

Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The construction footprint will result in the removal of approximately 3.65 hectares of potential foraging habitat (PCT 1064) for the Swift Parrot. A further 175 hectares (of PCT 1064) occurs within a 10 kilometre radius of the construction footprint. This species is highly mobile and nomadic following resource availability, the magnitude of the impact is small in the context of other causes of habitat loss operating across the species' range and in isolation, is unlikely to impact the species to the extent that it would cause a decline in the species.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

The project is unlikely to exacerbate the current level of invasive species threat operating within the study area to the point that they become harmful to the Swift Parrot. The Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects.

Is the action likely to introduce disease that may cause the species to decline?

Psittacine beak and feather disease is listed as a threat to the Swift parrot, this is a naturally occurring disease that is often fatal. This disease affects growth of feathers and the beak and may persist for long periods in tree hollows, it can be transmitted orally or through feaces and feathers (DoE 2004). The proposed action is unlikely to introduce or increase the spread of this disease to the Swift Parrot. Further, the Project Construction Environmental Management Plan will include measures to ensure appropriate biosecurity management is undertaken during construction. This is standard procedure for Roads and Maritime projects

Is the action likely to interfere with the recovery of a species?

Although removal of potential foraging habitat may contribute to cumulative effects of habitat loss, given that the study area is outside of any known breeding habitat, and the proposed action will impact on a small area of foraging habitat with significantly larger areas of commensurate and comparable habitat within the locality, it is unlikely that interfere with the species' recovery.

Conclusion

Based on the assessment provided above, it is concluded that Swift Parrot is unlikely to be significantly impacted by the Project, and as such offsetting in accordance with the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012) and the EPBC Act is not required.

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NSW GOVERNMENT | Transport Roads & Maritime Services

APPENDIX

I

Appendix I

Threatened Species Management Plan

Coffs Harbour Bypass

Threatened Species Management Plan

NSW GOVERNMENT

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1. Introduction

1.1 Overview

Roads and Maritime Services (Roads and Maritime) is seeking approval for the construction of the Coffs Harbour Bypass (the project) located to the west of the Coffs Harbour urban area in northern NSW. The project is located in the Coffs Harbour local government area (LGA) (Figure 1). Approval is being sought under Division 5.2 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) as Critical State Significant Infrastructure (CSSI).

The Coffs Harbour Bypass complements the Pacific Highway upgrade program which, when complete, will provide free flowing dual carriageway conditions for the Pacific Highway between Hexham and the Queensland border. The principal objectives of the Pacific Highway upgrade program are to:

- Improve traffic safety
- Reduce travel times and freight costs
- Engage the community and consider their issues
- Support economic development
- Support Ecologically Sustainable Development (ESD) principles
- Provide a safe workplace
- Achieve value for money.

The Pacific Highway upgrade program also seeks to create public value and ensure safety of its workers and travelling public.

An Environmental impact statement (EIS) has been prepared for the project. **Chapter 10, Biodiversity** and **Appendix H, Biodiversity assessment report** of the EIS provides a detailed assessment of impacts to terrestrial and aquatic biodiversity associated with the project and strategies to be implemented to avoid, mitigate and management these impacts during each project phase.

1.2 The Project

The project includes a 12 km bypass of Coffs Harbour from south of Englands Road to Korora Hill in the north and a two kilometre upgrade of the existing highway between Korora Hill and Sapphire. The project would provide a four-lane divided highway that bypasses Coffs Harbour, passing through the North Boambee Valley, Roberts Hill and then traversing the foothills of the Coffs Harbour basin to the west and north to Korora Hill.

The key features of the project include:

- Four-lane divided highway from south of Englands Road roundabout to the dual carriageway highway at Sapphire
- Bypass of the Coffs Harbour urban area from south of Englands Road intersection to Korora Hill
- Upgrade of the existing Pacific Highway between Korora Hill and the dual carriageway highway at Sapphire
- Grade-separated interchanges at Englands Road, Coramba Road and Korora Hill
- A one-way local access road along the western side of the project between the southern tie-in and Englands Road, connecting properties to the road network via Englands Road
- A new service road, located east of the project, connecting Solitary Islands Way with James Small Drive and the existing Pacific Highway near Bruxner Park Road

- Three tunnels through ridges at Roberts Hill (around 190 m long), Shephards Lane (around 360 m long), and Gatelys Road (around 450 m long)
- Structures to pass over local roads and creeks as well as a bridge over the North Coast Railway
- A series of cuttings and embankments along the alignment
- Tie-ins and modifications to the local road network to enable local road connections across and around the alignment
- Pedestrian and cycling facilities, including a shared path along the service road tying into the existing shared path on Solitary Islands Way, and a new pedestrian bridge to replace the existing Luke Bowen footbridge with the name being retained
- Relocation of the Kororo Public School bus interchange
- Noise attenuation, including low noise pavement, noise barriers and at-property treatments as required
- Fauna crossing structures including glider poles, underpasses and fencing
- Ancillary work to facilitate construction and operation of the project, including:
  - Adjustment, relocation and/or protection of utilities and services
  - New or adjusted property accesses as required
  - Operational water quality measures and retention basins
  - Temporary construction facilities and work including compound and stockpile sites, concrete/asphalt batching plant, sedimentation basins and access roads (if required).



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Park/Reserve

Coffs Harbour Bypass
Project area
Figure 1

0 0.45 0.9 1.35 km

Scale @A4: 1:48,565
GDA 1994 MGA Zone 56

N

1.3 Purpose

This TSMP has been prepared to inform the site-specific and species-specific mitigation measures and management protocols to be implemented during future phases of the project to further avoid or reduce project impacts to threatened flora and fauna. This plan provides an overarching management framework for any part of the project that is of relevance to the subject threatened flora and fauna species.

This TSMP will be a live document and will be reviewed and updated prior to construction and operation and as required as new information is identified and/or confirmed as a result of implementing the actions and mitigation measures detailed in this plan. It has been prepared as part of the EIS to refine the mitigation measures included in the impact assessment.

This plan informs future monitoring and reporting requirements to be implemented during future design, construction and operational phases. Details have been provided on how the final monitoring sites will be selected and specifies the monitoring methods and objectives.

This plan will operate in conjunction with the Construction Environmental Management Plan (CEMP) and the project specific flora and fauna management plan (FFMP) to be prepared prior to.

The TSMP includes:

- Setting out roles and responsibilities for the implementation and updating of the TSMP
- A description of the threatened flora and fauna species known to occur and be impacted by the project
- Description of potential impacts to threatened flora and fauna as a result of the project
- Established mitigation goals and targets for the management of threatened flora and fauna
- Management measures specific to threatened flora and fauna to be investigated and/or refined during the design and pre-construction, construction and operational phases of the project
- A monitoring program to assess success management measures and inform adaptive management.

1.4 Roles and responsibilities

The key environmental management roles and responsibilities for the project are described below. It is important to note that some roles and responsibilities are shared or overlap. General responsibilities for environmental management will be outlined in the CEMP and FFMP.

Prior to construction, the key environmental management roles will be updated to reflect the Contractor's organisational structure. However, key responsibilities will be assigned to relevant roles.

1.4.1 Environment Manager

Roles and responsibilities include:

a) Implementation of multi-disciplinary design review processes involving the Project Ecologist to review placement of infrastructure in relation to habitat for threatened flora and fauna

b) Ensure project design incorporates the implementation of fauna connectivity structures and suitable engineering solutions to facilitate fauna movement within the vicinity of threatened flora and fauna habitat

c) Investigate opportunities in design for installation of permanent fauna exclusion fencing along the alignment to funnel ground and arboreal fauna movements to safe crossing opportunities at the fauna crossing structures

d) Collaborate with design leads to ensure engineering/design solutions are developed to incorporate measures to maintain the background hydrology

e) Identify suitable locations for artificial microbat roosting sites and nest boxes within adjacent native vegetation, and incorporate the provision of artificial microbat roosting sites and nest boxes

f) Ensure progressive habitat restoration and revegetation in accordance with landscape specifications

g) Develop and facilitate induction, toolbox talks and other training programs regarding threatened species and their requirements for all site personnel.

1.4.2 Structures and drainage design lead

Roles and responsibilities include:

a) Design fauna connectivity structures and suitable engineering solutions to facilitate fauna movement within the vicinity of threatened flora and fauna habitat.

1.4.3 Civil design lead

Roles and responsibilities include:

a) Design measures to maintain the background hydrology

b) Design lighting to minimise amount of light spill into adjacent threatened flora and fauna habitat

c) Design of permanent fauna exclusion fencing along the alignment to funnel ground and arboreal fauna movements to safe crossing opportunities at the fauna crossing structures.

1.4.4 Project Ecologist

Roles and responsibilities include:

a) Identify habitat exclusion zones prior to clearing to guide the placement of infrastructure and ancillary facilities outside of threatened flora and fauna habitat areas, where possible

b) Carry out the approved fauna rehabilitation protocol

c) Carry out pre-clearing surveys undertaken in accordance with approved procedures

d) Supervise the removal of habitat trees during clearing

e) Develop and implement koala-specific management measures for the construction phase

f) Implement the approved monitoring program(s) and undertaking corrective actions when triggered by performance indicators.

1.4.5 Construction Manager

Roles and responsibilities include:

a) Prepare environmental work method statements according to requirements

b) Ensure all site workers are site inducted prior to commencement of works

c) Implement procedures detailed in the CEMP for pre-clearing and clearing activities

d) Progressively install permanent fauna fencing across the project

e) Implement koala-specific management measures for the construction phase

f) Ensure exclusion zones are clearly marked and visible on site

g) Implement measures for erosion and sediment control during construction, and containment of any spills.

h) Apply pathogen management requirements wherever pathogens are known or suspected to occur on or adjacent to the bypass, throughout construction and during maintenance works.

i) Undertake progressive habitat restoration and revegetation in accordance with landscape specifications

j) Stop activities where there is an actual or immediate risk of harm to a threatened species or threatened species habitat and advise the Environment Manager.

1.4.6 Transport for New South Wales

Roles and responsibilities include:

a) Prepare a salvage and establishment plan outlining procedures for the re-establishment of southern swamp orchid and rusty plum species impacted by the project. Identify suitable receiving sites for the species and apply any necessary protection/ stewardship arrangements

b) Prepare monitoring program(s), undertake reporting in consultation with relevant agencies and ensure corrective actions are implemented when triggered by performance.

2. Threatened flora

Two threatened flora species are addressed in this management plan, as summarised in **Table 1.**

Table 1: Threatened flora species

Scientific name	Common name	Conservation status^	
		EPBC Act	BC Act
Niemeyera whitei	Rusty plum	-	V
Phaius australis	Southern swamp orchid	E	E1

^ Conservation Status:

EPBC – Indicates the Commonwealth conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999*, coded as Extinct in the wild (XW), Critically Endangered (CE), Endangered (E), Vulnerable (V) or Conservation Dependent (CD).

BC Act – indicates conservation status under the *Biodiversity Conservation Act 2016*, coded as Critically Endangered (CE), Endangered species (E1), Endangered populations (E2), Endangered ecological communities (E3), Vulnerable (V). As the CHB project commenced in the transition period to the current *Biodiversity Conservation Act 2016*, the assessment of biodiversity offsets has been undertaken under the TSC Act.

2.1 Existing knowledge and key threats

2.1.1 Southern swamp orchid

The distribution of southern swamp orchid *Phaius australis* includes Queensland and north-east NSW as far south as Coffs Harbour. Historically, it extended further south, to Port Macquarie. In NSW, most of the populations occur between Coffs Harbour and Ballina where there are currently about 14 known populations. Only 50 per cent of these have records of plant numbers. Most populations have very few individuals with a total of only about 180 plants known in the wild (DoE 2014).

The southern swamp orchid is commonly associated with coastal wet heath/sedgeland wetlands (Barry 2005), swampy grassland or swampy forest (OEH 2017) and often where broad-leaved paperbark *Melaleuca quinquenervia* or swamp mahogany *Eucalyptus robusta* are found (NH NSW 2006; Sparshott & Bostock 1993). Typically, the southern swamp orchid is restricted to the swamp-forest margins, where it occurs in swamp sclerophyll forest (broad-leaved paperbark/swamp mahogany/swamp box, swampy rainforest (often with sclerophyll emergents), or fringing open forest. It is often associated with rainforest elements such as bangalow palm *Archontophoenix cunninghamiana* or cabbage tree palm *Livistona australis* (Benwell 1994b; Bishop 1996; Weston in Harden 1993). This orchid species is relatively adaptable in its requirements for light and soil type. Soils range from acidic waterlogged peat, with a pH of 4.2 to peaty-sand, with a pH of 7.0 (Sparshott & Bostock 1993).

Southern swamp orchid is one of Australia's most highly desired orchids and populations are particularly vulnerable to loss of species due to illegal collection (DoE 2014). The swamp habitats colonised by southern swamp orchid are particularly susceptible to changes in hydrology that may divert or impact surface water flows and interfere with natural wet/ dry cycles, such as swamps being drained, polluted or mined (OEH 2018).

2.1.2 Rusty plum

Rusty plum *Niemeyera whitei* occurs in the coast and adjacent ranges of northern NSW from the Macleay River into southern Queensland. Its distributional stronghold is on the mid north coast around Coffs Harbour (OEH 2018).

Rusty plum typically occurs in gullies of warm temperate or littoral rainforests and the adjacent understorey of moist eucalypt forest, on poor soils below an altitude of 600 metres above sea level (OEH 2018).

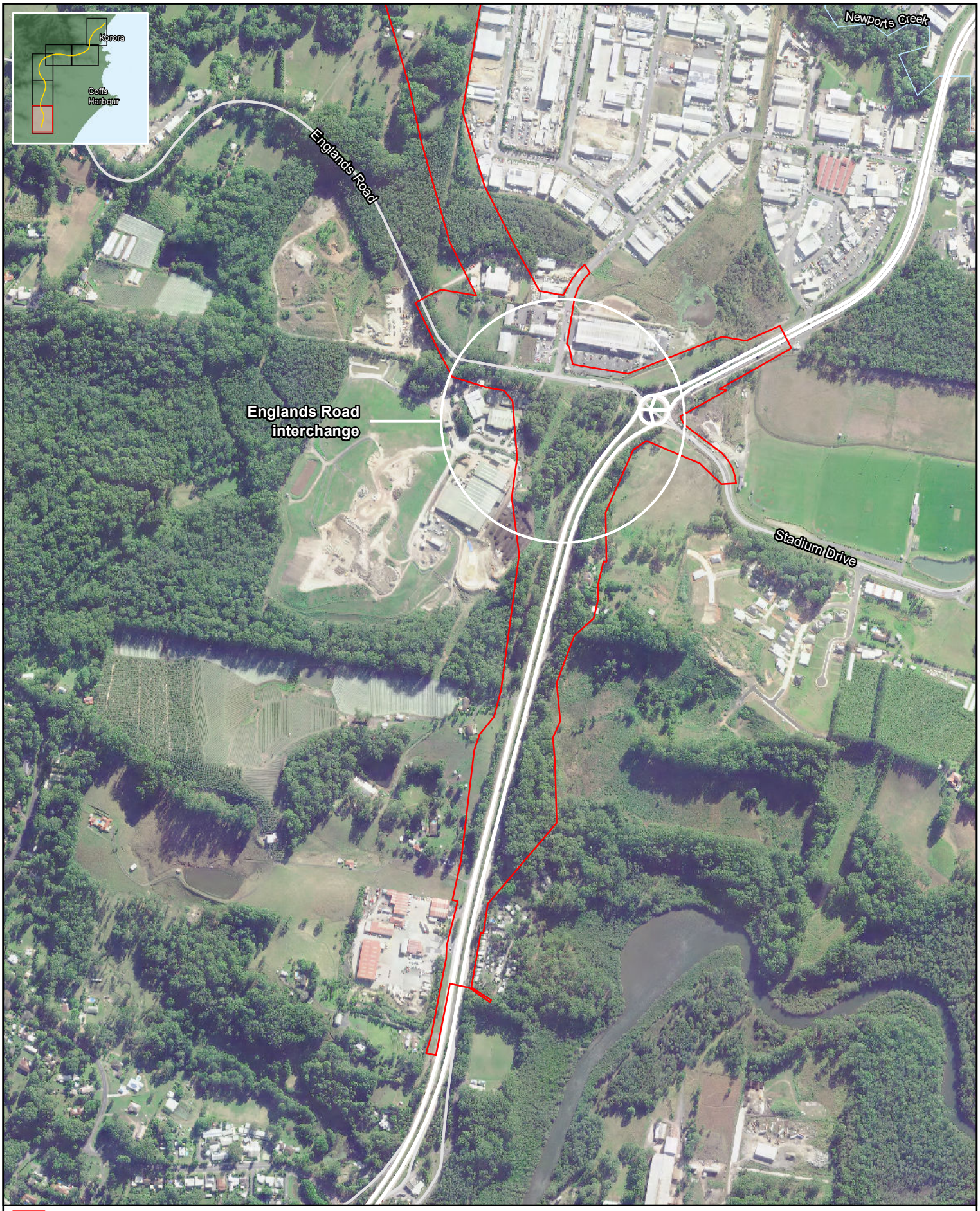
Habitat clearing, timber harvesting and trampling by domestic stock form key threats to this species. Disturbance due to weed invasion (predominantly lantana) and altered fire regimes are also known to impact the suitability of habitats for this species (OEH 2018).

2.2 Known or expected occurrence within the project area

Threatened flora known and expected occurrence is provided for the project area in Table 2 and shown in Figure 2. Note that Figure 2 only shows areas of the project where threatened flora are known to occur, and not the whole project area.

Table 2: Threatened flora records and habitat

Species	Habitat within project area	Number of records	Species credit polygon (ha)
Rusty plum	Predominantly in the northern extent of the project area in gullies and depressions associated with the riparian corridors of Pine Brush Creek and Jordans Creek. This species occurred across six PCTs including: • PCT 670 Black Booyong – Rosewood – Yellow Carabeen subtropical rainforest of the North Coast • PCT 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion • PCT 692 Blackbutt – Tallowwood moist ferny open forest of the coastal ranges of the North Coast • PCT 695 Blackbutt – Turpentine shrubby open forest of the coastal foothills of the central North Coast • PCT 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion • PCT 1302 White Booyong – Fig subtropical rainforest of the NSW North Coast	57	7.55 ha
Southern swamp orchid	Recorded in the project area north of North Boambee Road within a small patch of remnant vegetation consistent with PCT 695 Blackbutt – Turpentine shrubby open forest of the coastal foothills of the central North Coast. Potential habitat for the species also occurs within PCT 695 Blackbutt – Turpentine shrubby open forest of the coastal foothills of the central North Coast.	1	2.12 ha



Construction footprint
North Coast Railway
Watercourse

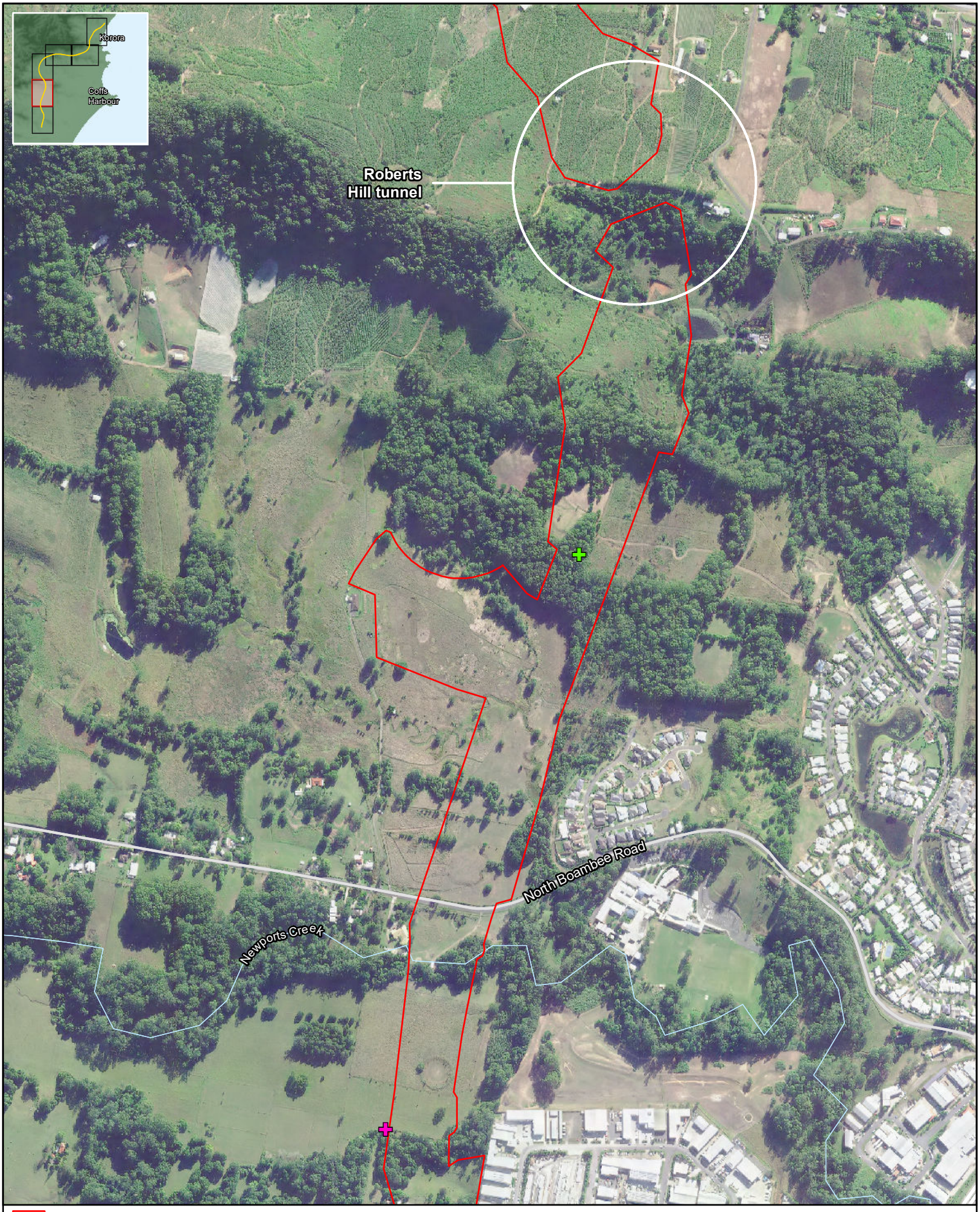
Species credit species habitat polygons
Rusty plum
Southern swamp orchid

Threatened flora species
Niemeyera whitei - rusty plum
Phaius australis - southern swamp orchid

Coffs Harbour Bypass
Threatened flora records and species credit habitat polygons
Figure 2-01

0 0.1 0.2 0.3 km
Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N



Construction footprint
North Coast Railway
Watercourse

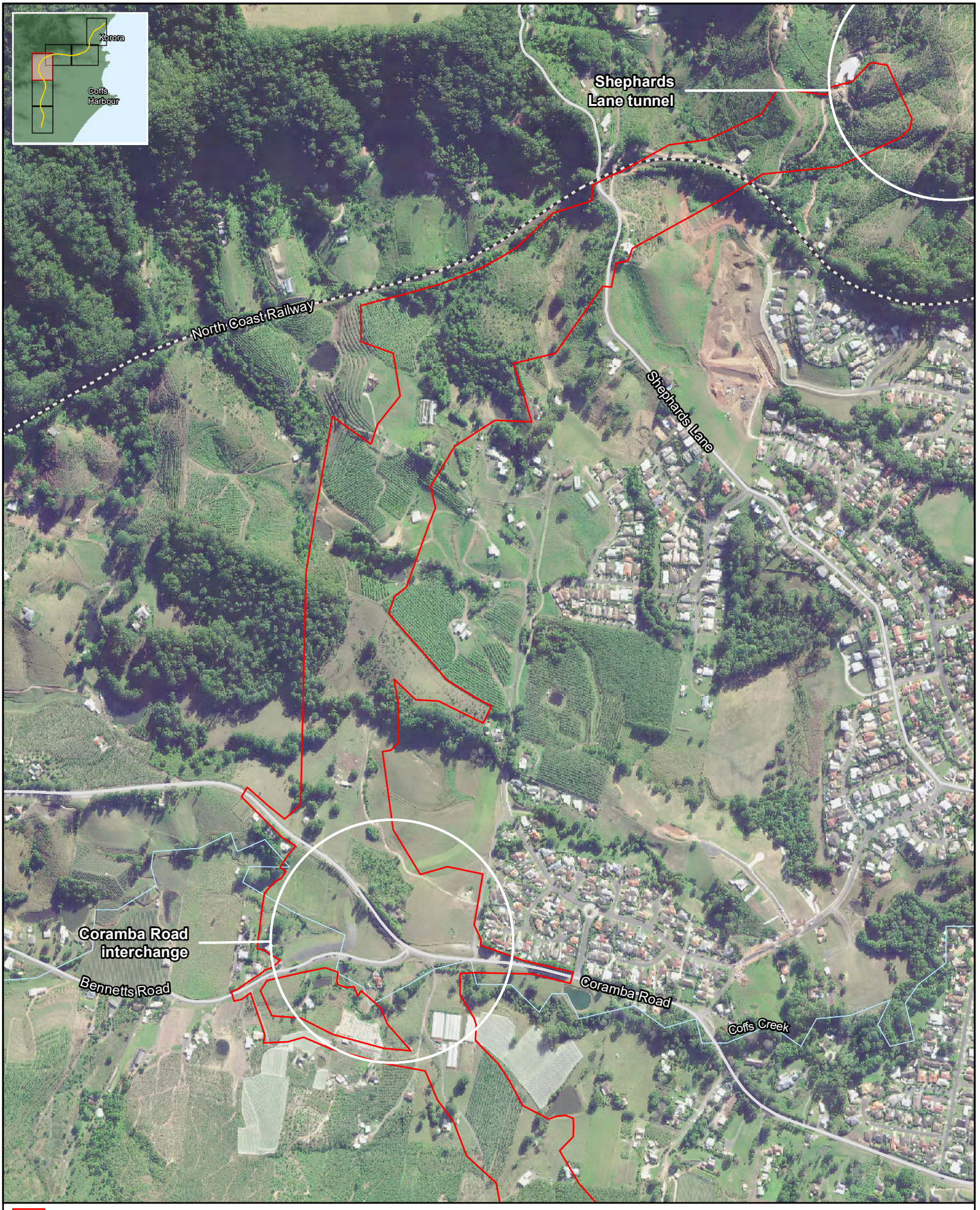
Species credit species habitat polygons
Rusty plum
Southern swamp orchid

Threatened flora species
Niemeyera whitei - rusty plum
Phaius australis - southern swamp orchid

Coffs Harbour Bypass
Threatened flora records and species credit habitat polygons
Figure 2-02

0 0.1 0.2 0.3 km
Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N



Construction footprint
North Coast Railway
Watercourse

Species credit species habitat polygons
Rusty plum
Southern swamp orchid

Threatened flora species
Niemeyera whitei - rusty plum
Phaius australis - southern swamp orchid

Coffs Harbour Bypass
Threatened flora records and species credit habitat polygons
Figure 2-03

0 0.1 0.2 0.3 km
Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N



Construction footprint
North Coast Railway
Watercourse

Species credit species habitat polygons
Rusty plum
Southern swamp orchid

Threatened flora species
Niemeyera whitei - rusty plum
Phaius australis - southern swamp orchid

Coffs Harbour Bypass
Threatened flora records and species credit habitat polygons
Figure 2-04

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Construction footprint
North Coast Railway
Watercourse

Species credit species habitat polygons
Rusty plum
Southern swamp orchid

Threatened flora species
Niemeyera whitei - rusty plum
Phaius australis - southern swamp orchid

Coffs Harbour Bypass
Threatened flora records and species credit habitat polygons
Figure 2-05

0 0.1 0.2 0.3 km
Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Construction footprint
North Coast Railway
Watercourse

Species credit species habitat polygons
Rusty plum
Southern swamp orchid

Threatened flora species
Niemeyera whitei - rusty plum
Phaius australis - southern swamp orchid

Coffs Harbour Bypass
Threatened flora records and species credit habitat polygons
Figure 2-06

0 0.1 0.2 0.3 km
Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N

3. Threatened fauna

Fourteen threatened fauna species were directly observed within the study area during targeted surveys completed in accordance with the FBA for the project EIS.

Table 3: Threatened fauna species

Scientific name	Common name	Conservation status^	
		EPBC Act	BC Act
Phascolarctos cinereus	Koala	V	V
Myotis macropus	Southern myotis	-	V
Falsistrellus tasmaniensis	Eastern false pipistrelle		V
Mormopterus norfolkensis	Eastern freetail bat	-	V
Scoteanax reuppellii	Greater broad-nosed bat	-	V
Pteropus poliocephalus	Grey-headed flying-fox	V	V
Miniopterus australis	Little bentwing-bat	-	V
Pachycephala olivacea	Olive whistler	-	V
Amaurornis moluccana	Pale-vented bush-hen	-	V
Lophoictinia isura	Square-tailed kite	-	V
Haliaeetus leucogaster	White-bellied sea-eagle	-	V
Mixophyes iteratus	Giant barred frog	E	E1
Litoria brevipalmata	Green-thighed frog	-	V
Petalura litorea	Coastal petaltail	-	E1

^ Conservation Status:

EPBC – Indicates the Commonwealth conservation status of each taxon under the Environment Protection and Biodiversity Conservation Act 1999, coded as Extinct in the wild (XW), Critically Endangered (CE), Endangered (E), Vulnerable (V) or Conservation Dependent (CD).

BC Act – Indicates the New South Wales conservation status of each taxon under the Biodiversity Conservation Act 2016 coded as Endangered species (E1), Vulnerable (V)

In addition to the species directly observed during the EIS field surveys, **Appendix H, Biodiversity assessment report** noted the potential for spotted-tailed quoll and regent honeyeater to move through the project area. As these species are MNES under the EPBC Act, mitigation measures have been included in this TSMP.

3.1 Existing knowledge and key threats

3.1.1 Mammals

Koala

The koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. It was briefly historically abundant in the 1890s in the Bega District on the south coast of NSW, although not elsewhere, but it now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands (OEH 2018b).

Koalas naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by Eucalyptus species (Martin & Handasyde 1999). Koala habitat can be broadly defined as any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. The distribution of this habitat is largely influenced by land elevation, annual temperature and rainfall patterns, soil types and the resultant soil moisture availability and fertility. Preferred food and shelter trees are naturally abundant on fertile clay soils. Koalas are also known to occur in modified or regenerating native vegetation communities, as well as urban and rural landscapes where food trees or shelter trees may be highly scattered.

Koalas are inactive for most of the day, feeding and moving mostly at night. They spend most of their time in trees, but will descend and traverse open ground to move between trees (OEH 2018b). Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. The koala is generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery.

Threats to the species include loss/modification/fragmentation of habitat, mortality due to dog attacks and vehicle strikes, climate change and drought affecting health and contracting of the species' range, and koala disease in particular Chlamydia and Koala Retrovirus (KoRV). Additional potential threats to koala habitat include Bell Miner Associated Dieback (BMAD) and myrtle rust, as well as intense prescribed burns or wildfires that scorch or burn the tree canopy.

Southern myotis

The southern myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers (OEH 2017e).

Southern myotis generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. They forage for insects and small fish at streams and pools.

Threats to the species include loss or disturbance of roosting sites, clearing adjacent to foraging areas, application of pesticides in or adjacent to foraging areas and reduction in stream water quality affecting food resources (OEH 2017e).

Eastern false pipistrelle

The eastern false pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. The species prefers moist habitats with trees taller than 20 m and generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. It hunts flying insects above or just below the tree canopy. The eastern false pipistrelle hibernates in winter. Females are pregnant in late spring to early summer (OEH 2017i).

Threats to the species include disturbance to winter roosting and breeding sites, loss of roosting habitat (primarily hollow-bearing eucalypts), loss and fragmentation of foraging habitat particularly extensive areas of continuous forest and areas of high productivity (OEH 2017i).

Eastern freetail bat

The eastern freetail-bat is found along the east coast from south Queensland to southern NSW. It occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. The eastern freetail-bat roosts mainly in tree hollows, but will also roost under bark or in man-made structures. It is usually solitary but has also been recorded roosting communally (OEH 2017j).

Threats to the species include loss of hollow-bearing trees, loss of foraging habitat, application of pesticides in or adjacent to foraging areas, artificial light sources spilling onto foraging and/or roosting habitat, and large-scale wildfire or hazard reduction burns on foraging and/or roosting habitat (OEH 2017j).

Greater broad-nosed bat

The greater broad-nosed bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW, the species is widespread on the New England Tablelands, however it does not occur at altitudes above 500 m (OEH 2017k).

The species utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although the greater broad-nosed bat usually roosts in tree hollows, it has also been found in buildings. It forages along creek and river corridors. Open woodland habitat and dry open forest suit the direct flight of this species as it searches for prey. Little is known of its reproductive cycle, however generally a single young is born in January. Females will congregate prior to the birth at maternity sites located in suitable trees.

Threats to this species include disturbance to roosting and summer breeding sites, foraging habitats being cleared for residential and agricultural developments (including clearing by residents within rural subdivisions), loss of hollow-bearing trees, pesticides and herbicides which may reduce the availability of insects or result in the accumulation of toxic residues in bat's fat stores, and changes to water regimes that impact food resources including the use of pesticides and herbicides near waterways (OEH 2017k).

Grey-headed flying-fox

The grey-headed flying-fox is Australia's only endemic flying-fox. Grey-headed flying-foxes are generally found within 200 km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia, though in times of natural resource shortages, they may be found in unusual locations (OEH 2017c).

It occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young.

Site fidelity to camps is high; some camps have been used for over a century. Grey-headed flying-fox can travel up to 50 km from the camp to forage; commuting distances are more often <20 km. The species feeds on the nectar and pollen of native trees, in particular eucalyptus, melaleuca and banksia, and fruits of rainforest trees and vines. It also forages in cultivated gardens and fruit crops.

There is currently incomplete knowledge of its abundance and distribution across the species' range.

Threats to the species include loss and fragmentation of habitat, heat stress, conflict with humans due to destruction of fruit crop, electrocution on power lines, indirect competition favouring other bat species, and possibly pathogens such as Australian bat Lyssavirus (ABL), Bat Paramyxovirus and Menangle Pig virus.

Little bentwing-bat

The little bentwing-bat occurs in the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Its habitats include moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, melaleuca swamps, dense coastal forests and banksia scrub. It is generally found in well-timbered areas (OEH 2018c).

Little bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the common bentwing-bat and, in winter, the two species may form mixed clusters.

Threats to the species include disturbance of colonies especially in nursery or hibernating caves which may be catastrophic, destruction of caves that provide seasonal or potential roosting sites, changes to habitat especially surrounding maternity/nursery caves and winter roosts, pesticide poisoning, predation from foxes and feral cats, exotic pathogens such as the white-nosed fungus, fire during the breeding season and fire impacting on foraging resources (OEH 2018c).

3.1.2 Birds

Olive whistler

The olive whistler inhabits the wet forests on the ranges of the east coast above 500 m though during the winter months they may move to lower altitudes. It has a disjunct distribution in NSW chiefly occupying the beech forests around Barrington Tops and the MacPherson Ranges in the north and wet forests from Illawarra south to Victoria. In the south it is found inland to the Snowy Mountains and the Brindabella Range (OEH 2017d).

Olive whistler forage in trees and shrubs and on the ground, feeding on berries and insects. Their nests are built in low forks of shrubs.

Threats to the species include clearing and fragmentation of habitat, inappropriate fire regimes causing changes to vegetation, predation by foxes and cats, loss of understorey and midstorey habitat via grazing or other disturbances, weeds, aggressive exclusion from forest and woodland habitat by over abundant noisy miners and climate change impacts including drought (OEH 2017d).

Pale-vented bush-hen

In Australia, the pale-vented bush-hen occurs mainly in coastal and subcoastal regions from the top end of the Northern Territory and Cape York Peninsula south through eastern Queensland to north-eastern NSW. There are a few records in the Kimberley Division of northern Western Australia. In NSW, bush-hens are an apparently uncommon resident from the Queensland border south to the Clarence River, though the species appears to be expanding its range southwards with recent records as far south as the Nambucca River (OEH 2018d).

The pale-vented bush-hen inhabits tall dense understorey or ground-layer vegetation on the margins of freshwater streams and natural or artificial wetlands, usually within or bordering rainforest, rainforest remnants or forests. It also occurs in secondary forest growth, rank grass or reeds, thickets of weeds, such as Lantana, and pastures, crops or other farmland, such as crops of sugar cane, and grassy or weedy fields, or urban gardens where they border forest and streams or wetlands, such as farm dams. They can also occur in and around mangroves, though rarely do so, if at all, in NSW.

Key elements of their habitat are dense undergrowth two to four metres tall and within 300 metres of water. Nests are built close to water in thick ground vegetation such as dense blady grass (*Imperata cylindrica*), mat rush (Lomandra) or reeds, often under or growing through shrubs or vine or beneath a tree (OEH 2018d).

Threats to the species include clearing/filling/draining of wetlands, pollution of wetlands from run-off including herbicides and pesticides, changes to wetlands caused by weed invasion, predation particularly by feral animals, destruction of habitat and predation by feral pigs, alteration to the natural flow regimes in their habitats, and loss of dense and rank understorey vegetation near streams and wetlands (OEH 2018d).

Square-tailed kite

The square-tailed kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March (OEH 2017h).

The species is found in a variety of timbered habitats including dry woodlands and open forests. It shows a particular preference for timbered watercourses. In arid north-western NSW, it has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. It appears to occupy large hunting ranges of more than 100km^2.

Nest sites during breeding season are generally located along or near watercourses, in a fork or on large horizontal limbs (OEH 2017h).

Threats to this species include clearing, logging, burning and grazing of habitats (resulting in a reduction in nesting and feeding resources), disturbance to or removal of potential nest trees near watercourses, illegal egg collection and deliberate shooting (OEH 2017h).

White-bellied sea-eagle

The white-bellied sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In NSW, it is widespread along the east coast, and along all major inland rivers and waterways (OEH 2017f).

Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. The species occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest).

Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nests are sometimes located in other habitats such as remnant trees on cleared land (Emison & Bilney 1982). Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as ‘guard roosts’. Nests are large structures built from sticks and lined with leaves or grass (OEH 2017f).

The main threats to the species include land clearing (this can force birds to nest in sub-optimal habitats where their breeding success is greatly reduced) and disturbance when nesting resulting in abandonment of young and nest sites.

Potential threats to the white-bellied sea-Eagle include poisoning, shooting, competition with wedge-tailed eagles, and the deterioration of inland water resources. Processes that affect the quality or availability of inland water systems (such as increased sediment input into rivers and streams due to erosion, drainage of wetlands for agriculture, flood mitigation works) could, potentially, have adverse effects on inland populations of the sea-eagle (Clunie 1994).

3.1.3 Frogs

Giant barred frog

The giant barred frog is distributed along the coast and ranges from Eumundi in south-east Queensland to Warrimoo in the Blue Mountains. Declines appear to have occurred at the margins of the species' range, with no recent records south of the Hawkesbury River and disappearances from a number of streams in QLD. Northern NSW, particularly the Coffs Harbour-Dorrigo area, is a stronghold (OEH 2017g).

Giant barred frogs are found along freshwater streams with permanent or semi-permanent water, generally (but not always) at lower elevation. Moist riparian habitats such as rainforest or wet sclerophyll forest are favoured for the deep leaf litter that they provide for shelter and foraging, as well as open perching sites on the forest floor. However, giant barred frogs will also sometimes occur in other riparian habitats, such as those in drier forest or degraded riparian remnants, and even occasionally around dams.

Breeding takes place from late spring to summer. Although generally found within about 20 m of the stream, outside the breeding season, the giant barred frog may disperse away from the stream (eg 50m or further).

A major threat to the species is clearance of riparian vegetation. Other threats to the species include weed infestations decreasing the quality and amount of habitat available, reduction in water quality or alterations to flow patterns, siltation, infections of the fungal pathogen *Batrachochytrium dendrobatidis*, and predation and disturbance of habitat or destruction of eggs by feral pigs (OEH 2017g).

Green-thighed frog

Green-thighed frogs are distributed across isolated localities along the coast and ranges from just north of Wollongong to south-east Queensland (OEH 2018e).

Green-thighed frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. It prefers wetter forests in the south of its range, but extends into drier forests in northern NSW and southern Queensland. Larger temporary pools and flooded areas are preferred breeding areas.

Threats to the species include changes to drainage patterns which reduce periodic local flooding, damage to semi-permanent and ephemeral ponds and flood-prone vegetation, clearing of habitat, reduction in water quality through pasture fertilisation, reduction in habitat and water quality as a result of grazing, and loss of leaf-litter and cover of fallen logs through burning for agricultural purposes (OEH 2018e).

3.1.4 Invertebrates

Coastal petaltail

The coastal petaltail is known from Byfield (near Yeppoon in Queensland) to Bonville (south of Coffs Harbour). In NSW it is known from a very small number of locations, including Brooms Head, Tucabia, Diggers Camp and Bonville (OEH 2017h).

The coastal petaltail occupies a variety of permanent to semi-permanent coastal freshwater wetlands. Adults spend most of their time settled on low vegetation on or adjacent to the swamp. Suitable egg laying sites are within the swamp. It is thought that the larvae use underwater entrances to hunt for food in the aquatic vegetation.

The key threat to the species is modification of swamp habitat. Threats include loss or modification of natural swamps/wetlands/sedgelands through regulation of river flows and changes in surface water flows and groundwater levels, damage to breeding habitat by feral pigs and domestic stock, weed invasion of wetland breeding sites, application of herbicides or pesticides in or adjacent to breeding habitat decreasing water quality of swamps through pollution/eutrophication/sedimentation, clearing and degradation of foraging and breeding habitat, and climate change (OEH 2017h).

3.2 Known or expected occurrence in the project area

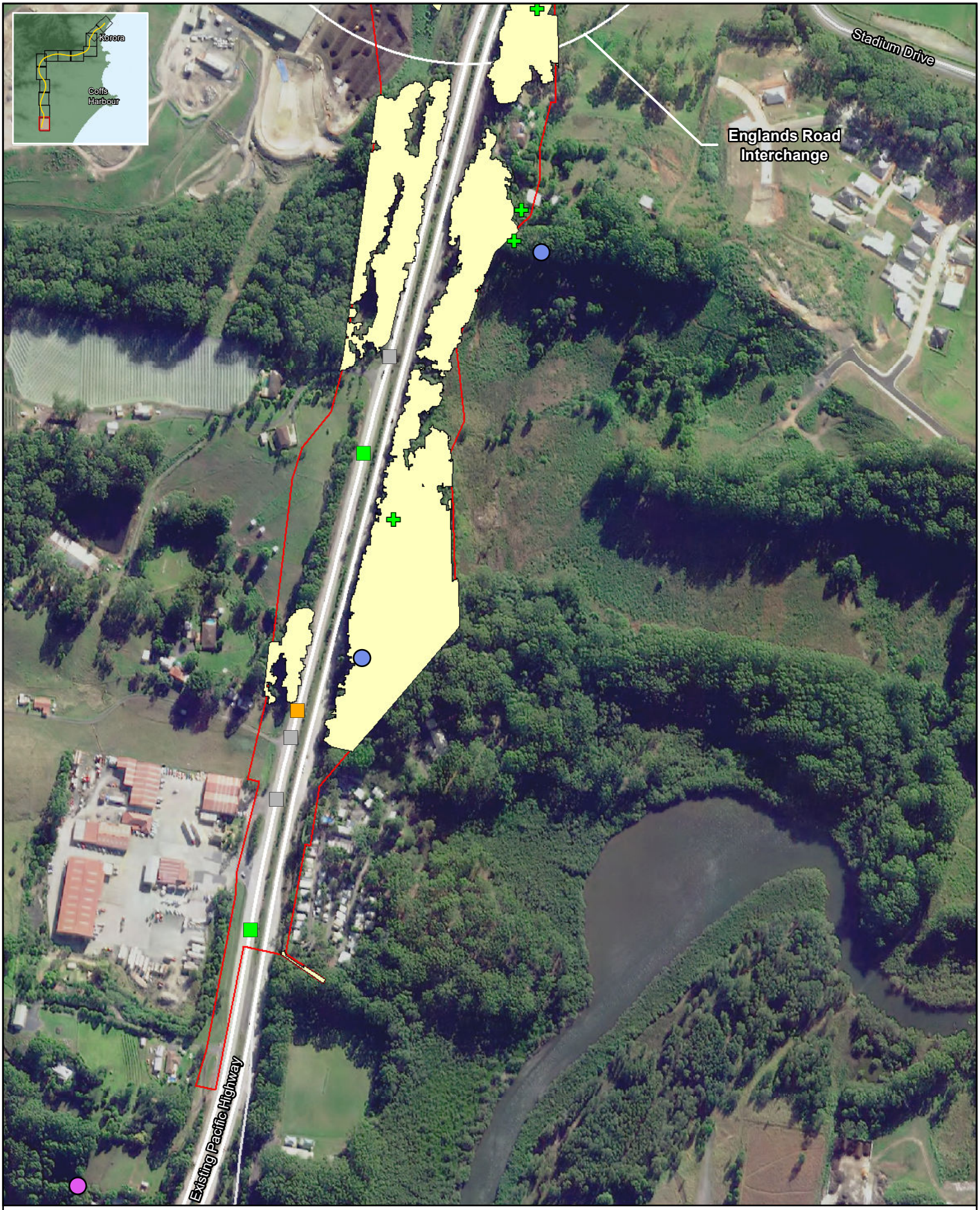
Known or expected occurrence of threatened fauna is provided for the project area in Table 4 and shown in Figure 3. Additional detail on project wide koala habitat, corridors and records is provided in Figure 4.

Table 4: Known or expected occurrence of threatened fauna and habitat area for the project area

Species	Habitat within project area
Koala	Koala were recorded throughout the project area in association with the following suitable habitats: • 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion. • 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. • 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion. • 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion. • 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast • 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast. • 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion. • 1302 White Booyong - Fig subtropical rainforest of the NSW North Coast Bioregion. • Modified riparian vegetation.
Southern myotis	Southern myotis were recorded adjacent to Coffs Creek (chainage 14600), an unnamed tributary (chainage 11200) and Jordans Creek (chainage 20300). Suitable habitat was also identified within the vicinity of Pine Brush Creek (chainage 21800 to 22800). Suitable habitat is located within the project area in association with the following vegetation communities: • 692 Blackbutt - Tallowwood moist ferny open forest of the coastal ranges of the NSW North Coast Bioregion.

	• 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. • 747 Brush Box - Tallowwood - Sydney Blue Gum tall moist forest of the ranges of the central NSW North Coast Bioregion. • 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion. • 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast • 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion. • Modified riparian vegetation.
Eastern false pipistrelle	Eastern false pipistrelle were recorded using ultrasonic detectors at approximate chainage 12500 and 16500. All vegetated areas within the project area offer potential habitat for this species
Eastern freetail bat	Eastern freetail bats were recorded using ultrasonic detectors at approximate chainage 15200 and 20300. All vegetated areas within the project area offer potential habitat for this species
Greater broad-nosed bat	A single greater broad-nosed bat was recorded outside the construction footprint using ultrasonic detectors at approximate chainage 13700. All vegetated areas within the project area offer potential habitat for this species
Grey-headed flying-fox	Grey-headed flying-fox were recorded throughout the project area with suitable habitat including vegetated areas within the project area.
Little bentwing-bat	Little bentwing-bat were recorded by means of harp trapping and within an existing culvert located adjacent to Coffs Creek (chainage 14600). All vegetated areas within the project area offer potential habitat for this species. Other existing culverts and approximately 87 hollow-bearing trees located within the project area may also offer suitable roosting sites.
Olive whistler	Recorded during diurnal bird surveys. All vegetated areas within the project area offer potential habitat for this species.
Pale-vented bush-hen	Remote camera traps detected pale-vented bush-hen at two sites (between chainages 17500 and 20000) in proximity to vegetated creek lines dominated by PCT 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. Modified riparian vegetation.
Square-tailed kite	Recorded during diurnal bird surveys. All vegetated areas within the project area offer potential habitat for this species.
White-bellied sea-eagle	This species was observed flying over the project area at chainage 13300. All vegetated areas within the project area offer potential habitat for this species.
Giant barred frog	Giant barred frog were recorded within the vicinity of Pine Brush Creek (chainage 22300) in association with the following vegetation communities: • 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. • 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion. • 1244 Sydney Blue Gum open forest on coastal foothills and escarpment of the North Coast • 1262 Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of the NSW North Coast.

	• Modified riparian vegetation. There are also recent Bionet records at Newports Creek where the proposed alignment crosses this waterway.
Green-thighed frog	Green-thighed frog were recorded within the vicinity of Pine Brush Creek (chainage 22300) in association with the following vegetation communities: • 695 Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central NSW North Coast Bioregion. • 1285 Turpentine moist open forest of the coastal hills and ranges of the NSW North Coast Bioregion.
Coastal petaltail	Approximately 50 dragonfly burrows likely to support coastal petaltail were recorded within a 0.5ha area adjacent to Highlander Drive off North Boambee Road (chainage 12600). Potential habitat for the species within the project area includes PCT 1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Grey-headed flying-fox
- Koala

Species credit species habitat polygons

- Koala

Culverts - potential microbat roost

- Medium
- Low
- None

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-01

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Koala
- Southern myotis

Species credit species habitat polygons

- Coastal petaltail
- Giant barred frog
- Southern myotis
- Koala

Culverts - potential microbat roost

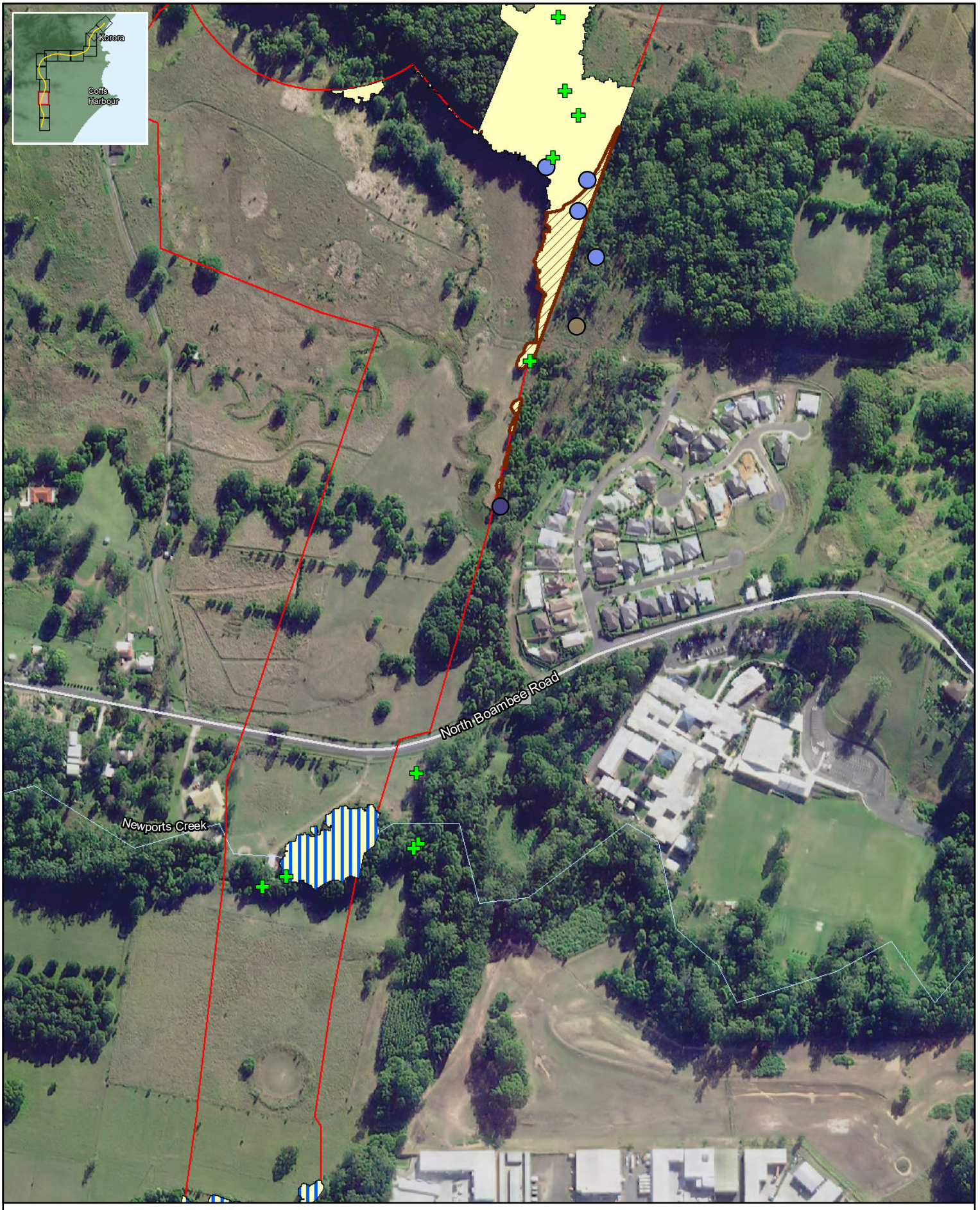
- High

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-02

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Eastern false pipistrelle
- Koala
- Coastal petaltail

Species credit species habitat polygons

- Coastal petaltail
- Giant barred frog
- Koala

Culverts - potential microbat roost

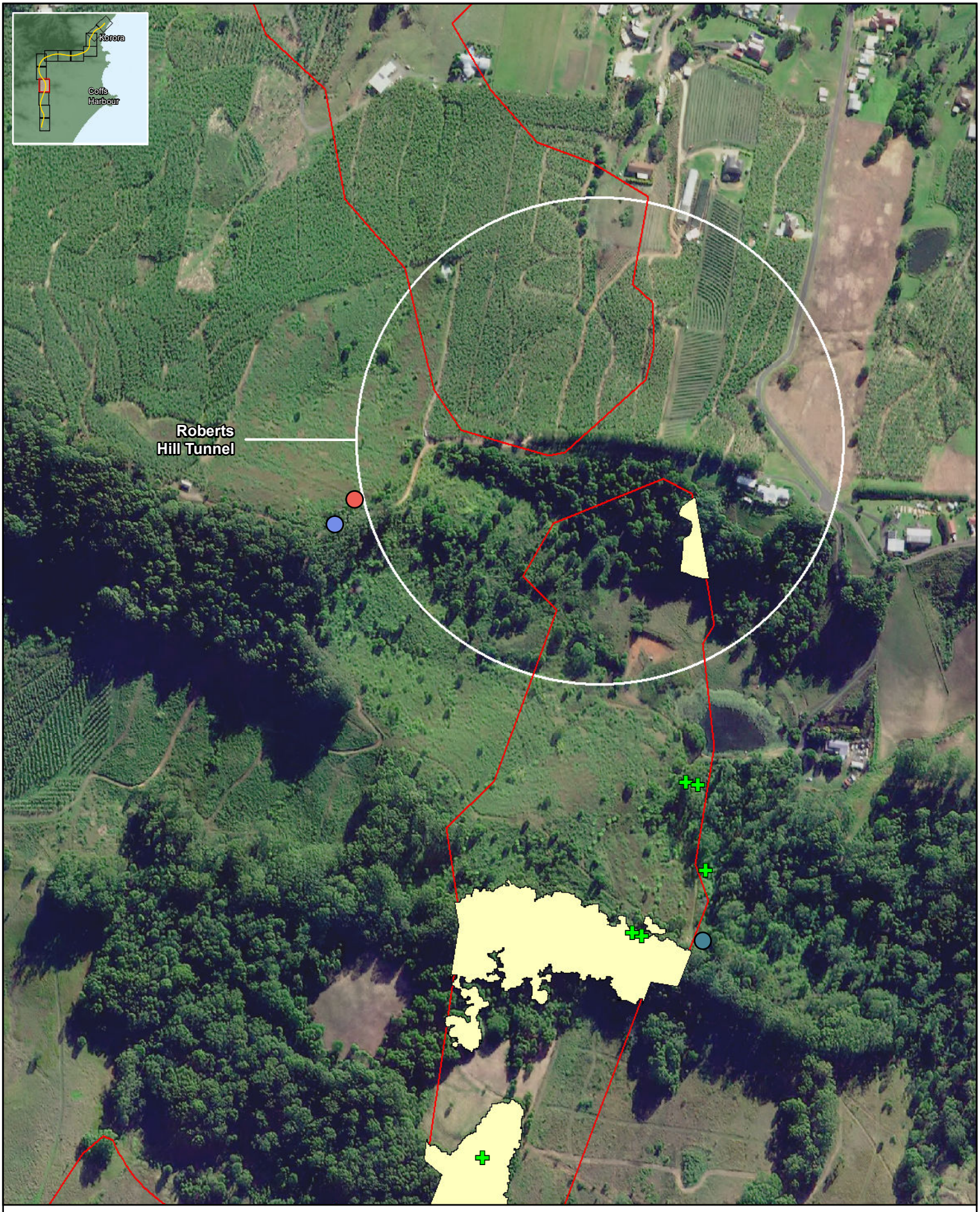
- None

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-03

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Greater broad-nosed bat
- Koala
- White-bellied sea-eagle

Species credit species habitat polygons

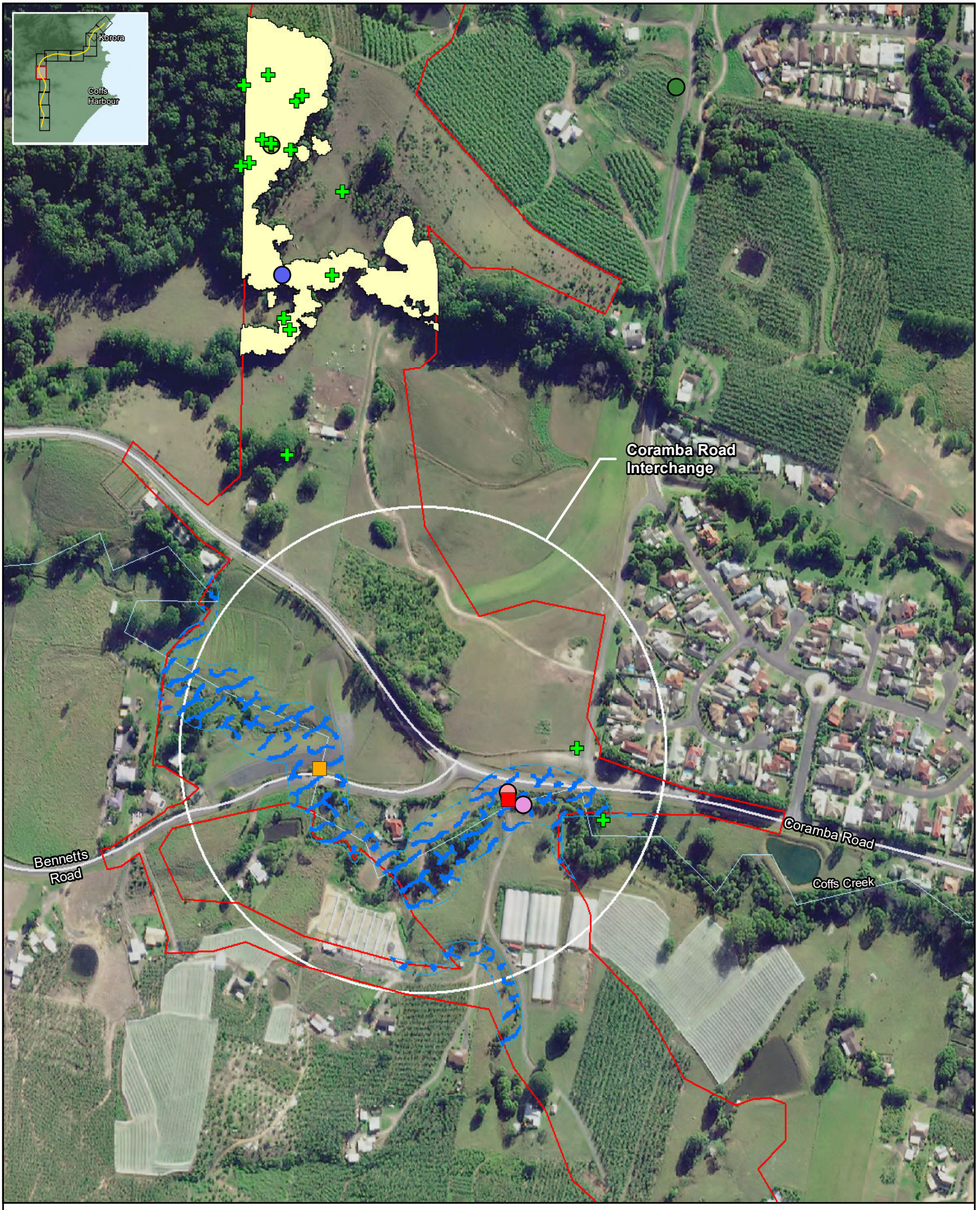
- Koala

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-04

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Little bentwing-bat
- Eastern freetail-bat
- Southern myotis
- Olive whistler
- Square-tailed kite

Species credit species habitat polygons

- Southern myotis
- Koala

Culverts - potential microbat roost

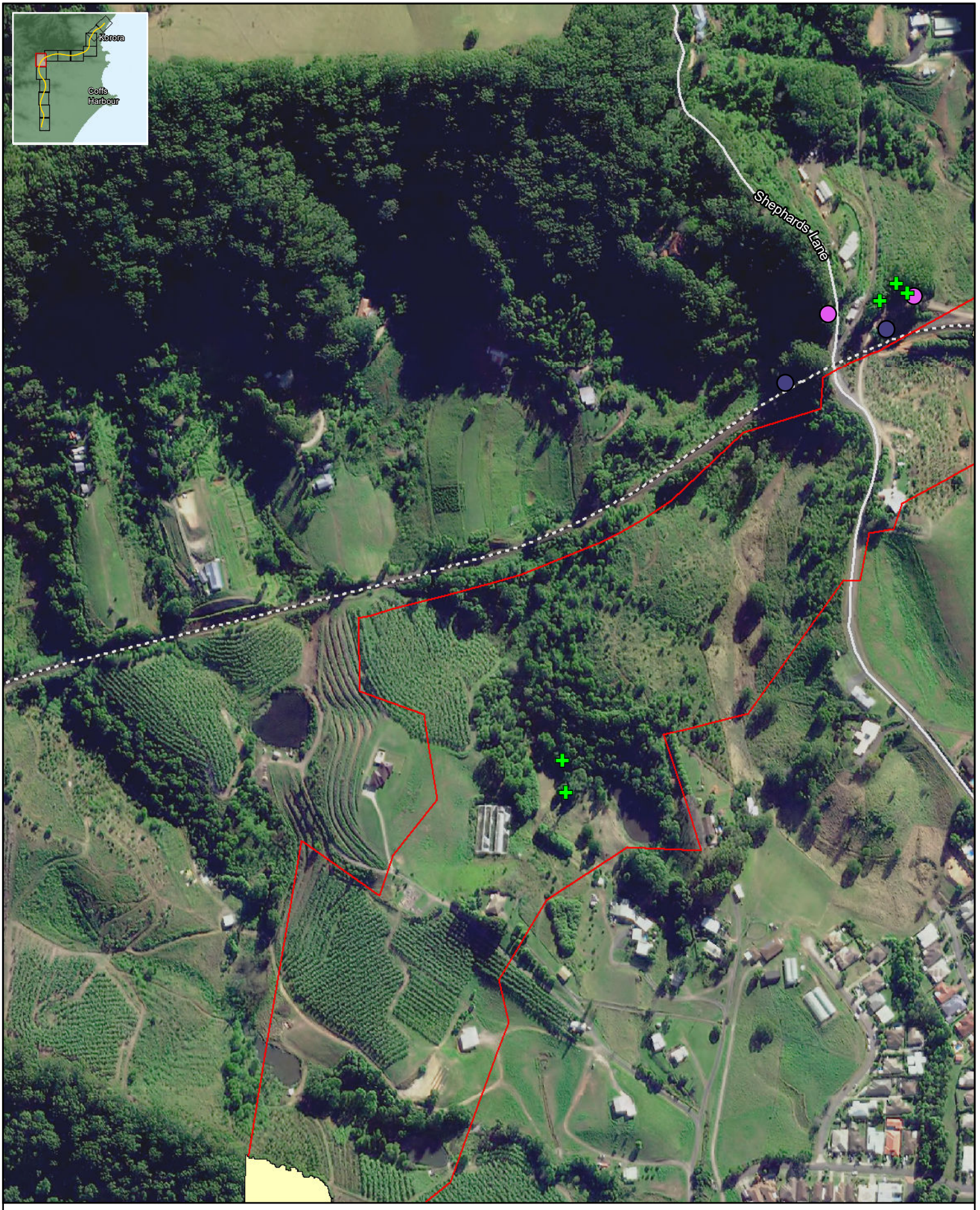
- High
- Medium

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-05

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Eastern false pipistrelle
- Grey-headed flying-fox

Species credit species habitat polygons

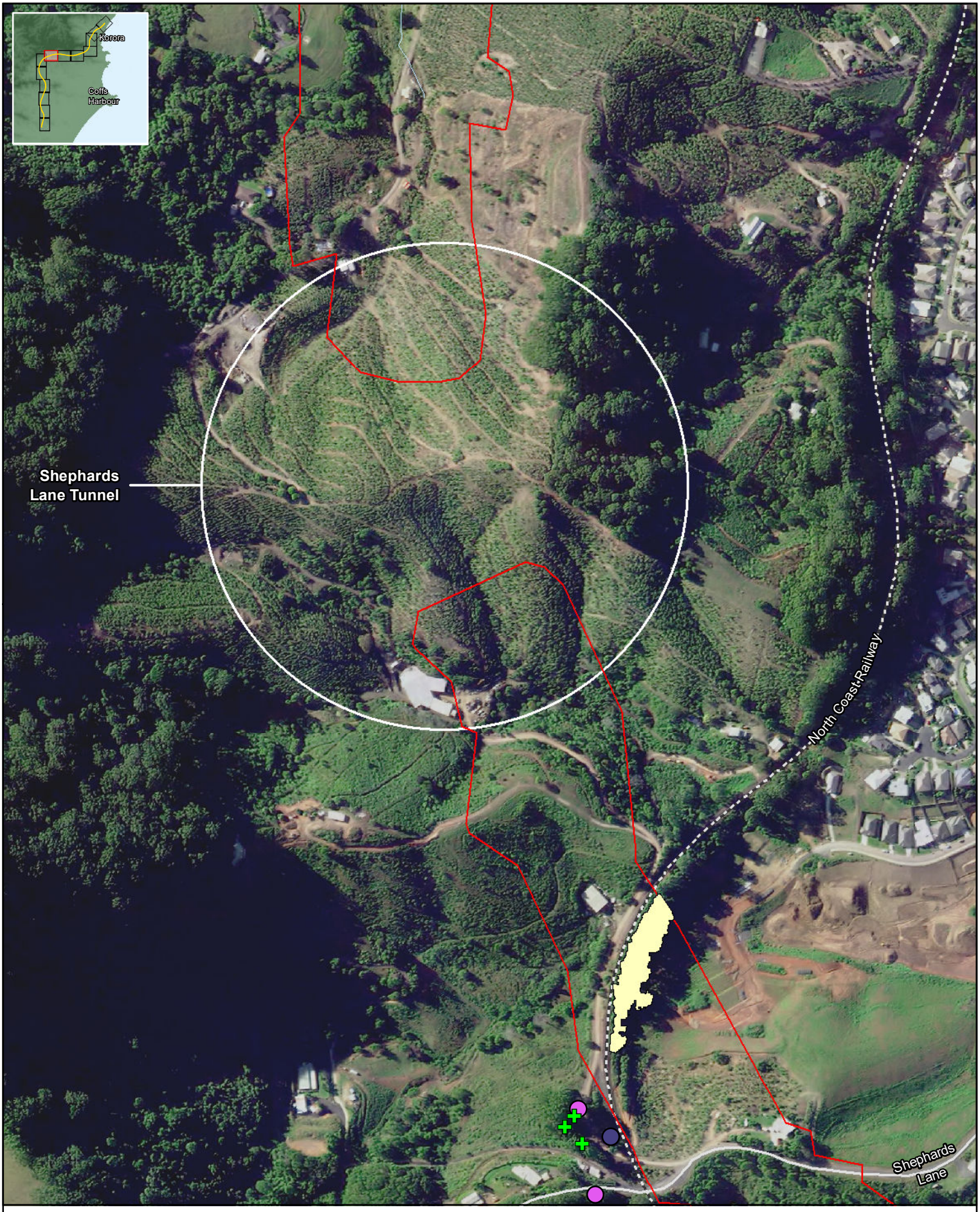
- Koala

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-06

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Eastern false pipistrelle
- Grey-headed flying-fox

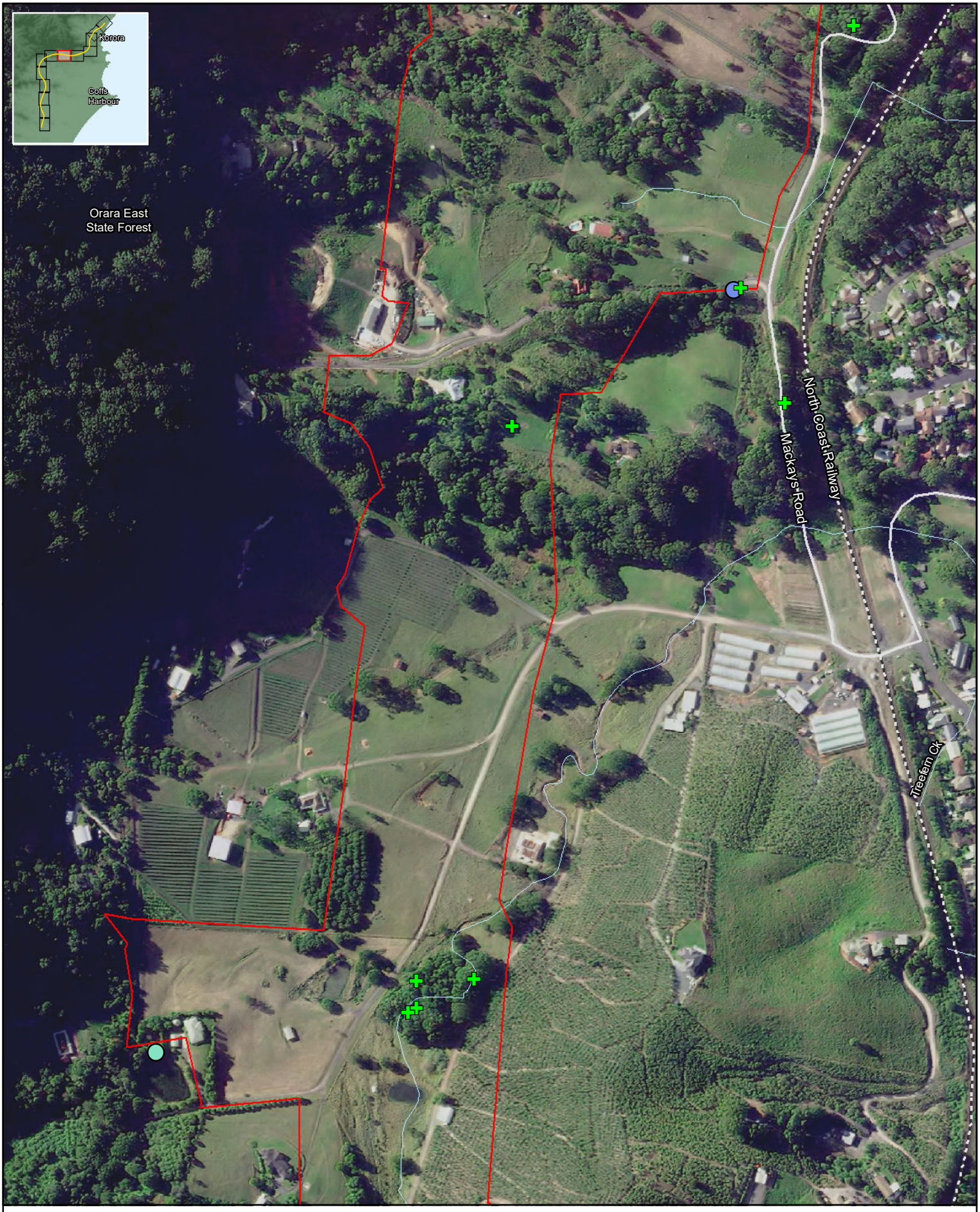
Species credit species habitat polygons

- Koala

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-07

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

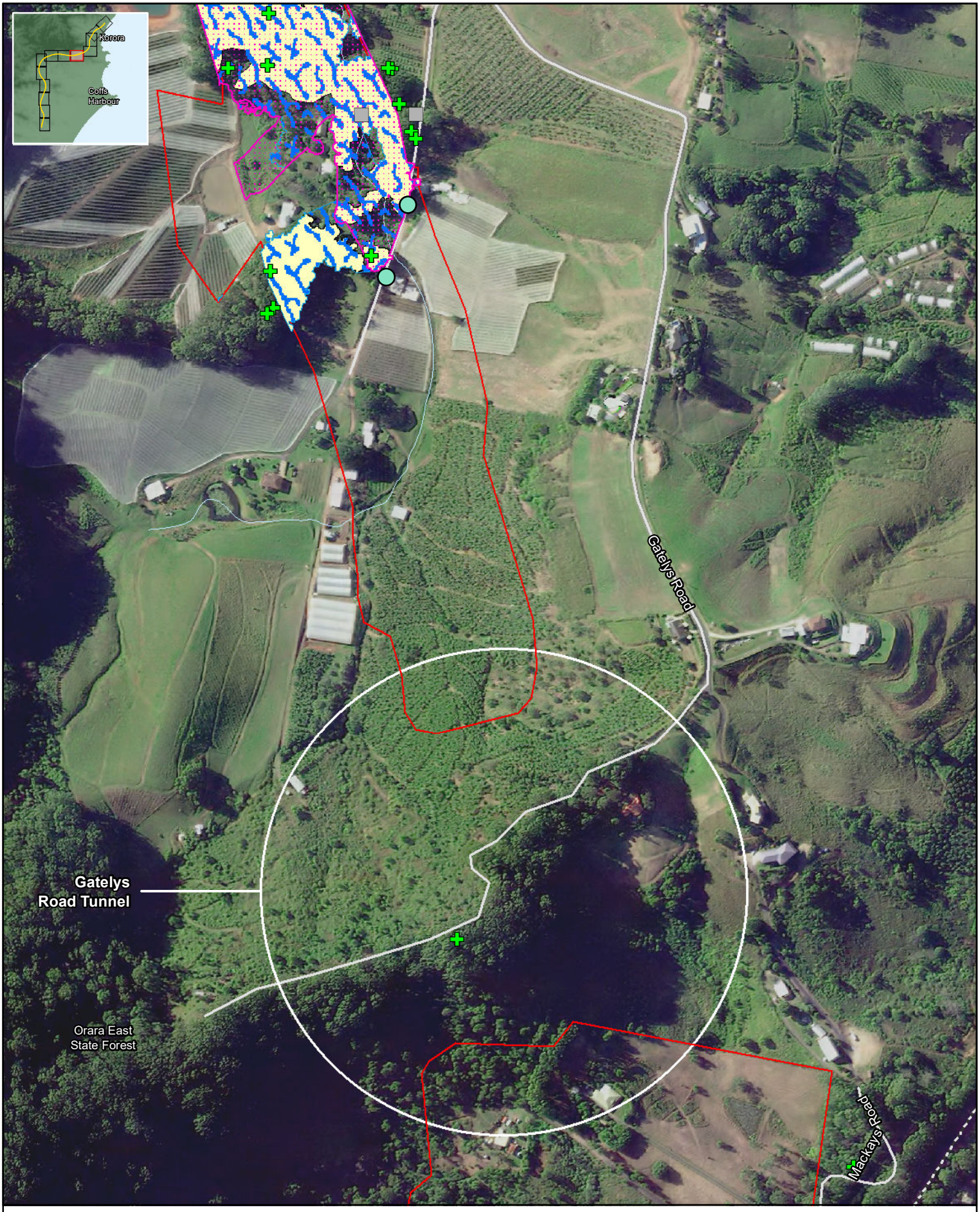
Threatened fauna records

- Koala
- Pale-vented bush-hen

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-08

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Pale-vented bush-hen

Species credit species habitat polygons

- Pale-vented bush-hen
- Southern myotis
- Koala

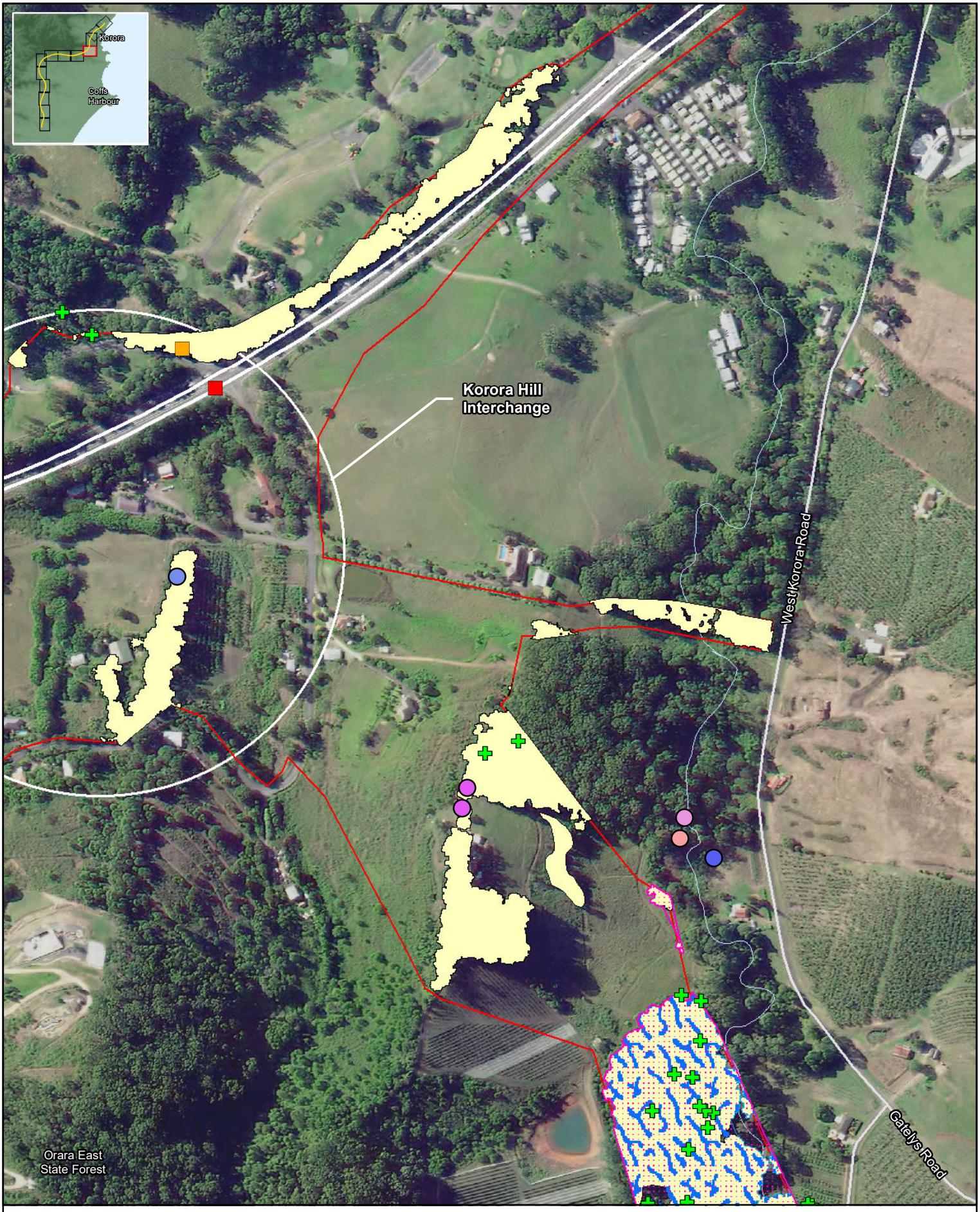
Culverts - potential microbat roost

- None

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-09

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Little bentwing-bat
- Eastern freetail-bat
- Grey-headed flying-fox
- Koala
- Southern myotis

Species credit species habitat polygons

- Pale-vented bush-hen
- Southern myotis
- Koala

Culverts - potential microbat roost

- High
- Medium

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-10

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Bentwing-bat (sp)
- Grey-headed flying-fox
- Southern myotis
- Giant barred frog
- Green-thighed frog

Species credit species habitat polygons

- Giant barred frog
- Green-thighed frog
- Southern myotis
- Koala

Culverts - potential microbat roost

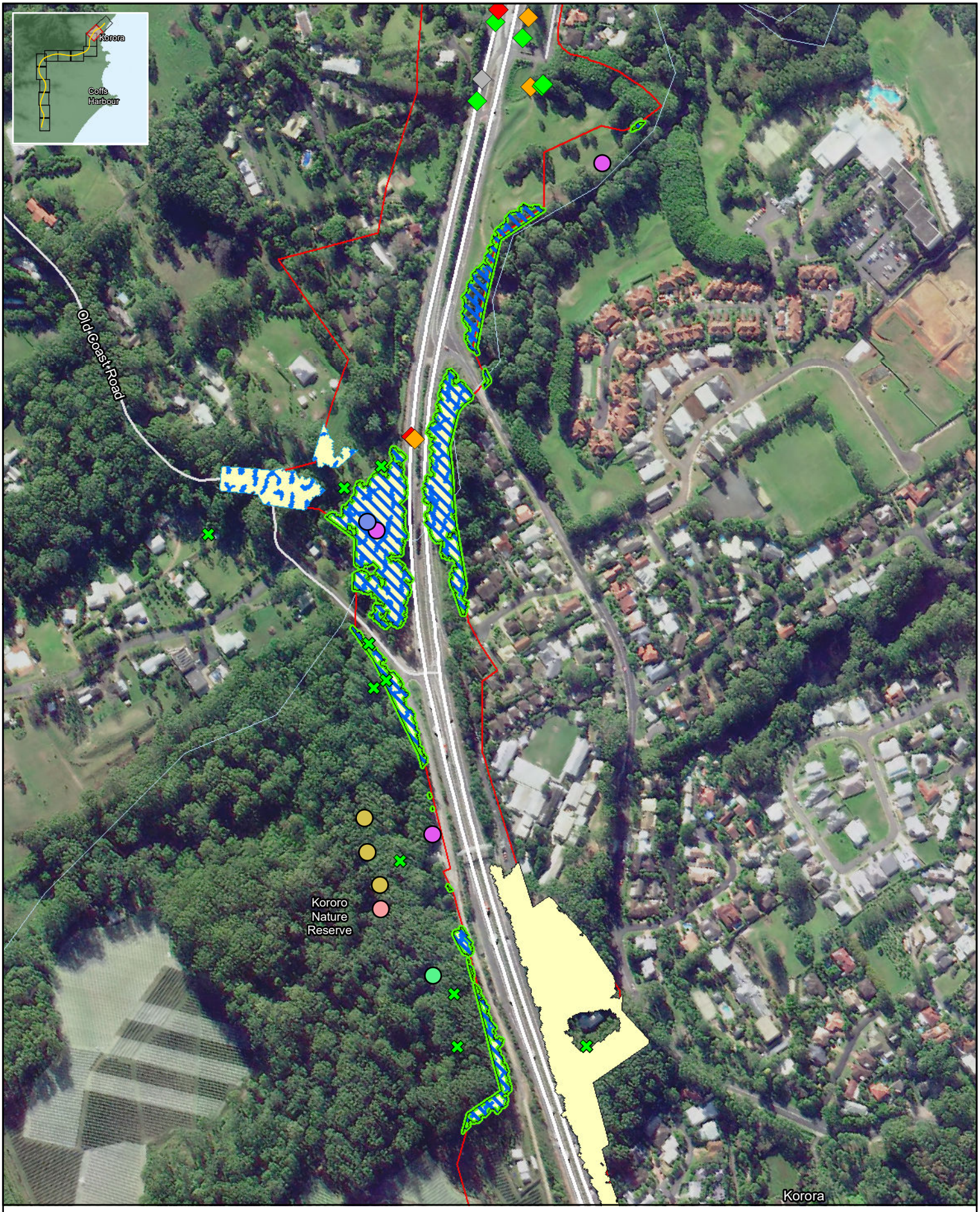
- High
- Unknown

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-11

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Threatened fauna records

- Grey-headed flying-fox
- Koala
- Southern myotis
- Giant barred frog
- Green-thighed frog

Species credit species habitat polygons

- Giant barred frog
- Green-thighed frog
- Southern myotis
- Koala

Culverts - potential microbat roost

- High
- Medium
- Low
- None

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-12

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Hollow bearing tree

Species credit species habitat polygons

- Koala

Culverts - potential microbat roost

- High
- Medium
- Low

Coffs Harbour Bypass
Threatened fauna records and species credit habitat polygons
Figure 3-13

0 0.05 0.1 0.15 km

Scale @A4: 1:5,000
GDA 1994 MGA Zone 56



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Park/Reserve
- Koala Records (EIS Targeted Survey)
- Koala Records (Bionet)
- Koala Habitat Polygons (EIS)
- Koala corridors

Coffs Harbour City Council Koala Habitat

- Primary
- Secondary
- Tertiary

Coffs Harbour Bypass
Koala records, habitat areas and dispersal corridors
Figure 4

0 0.45 0.9 1.35 km

Scale @A4: 1:48,565
GDA 1994 MGA Zone 56

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4. Potential impacts associated with the project

This section summarises potential impacts to threatened flora and fauna species as a result of the project. A more detailed assessment of project impacts to threatened flora and fauna is provided in **Appendix H, Biodiversity assessment report**. Chapters 5, 6 and 7 of this TSMP outlines the mitigation measures proposed to minimise these impacts during the detailed design, construction and operational phases of the project. Chapter 8 of this TSMP outlines the monitoring required to assess the effectiveness of the mitigation measures. Table 5 provides a summary of these impacts, proposed mitigation measures and monitoring requirements.

Table 5: Summary of impacts, mitigation measures and recommended monitoring

Impact	Applicable species	Mitigation measures	Monitoring
Direct loss of a single plant/s	Southern swamp orchid Rusty plum	Identify and implement exclusion zones. Salvage and re-establish threatened flora according to the approved savage and re-establishment plan	Pre-clearing surveys
Direct mortality of fauna	All species	Identify and implement habitat exclusion zones Fauna rehabilitation protocol in FFMP Pre-clearing surveys	Project ecologist
Disturbance and degradation of remaining habitats due to weed and pathogen invasion, altered fire regimes or changes in hydrology	Southern swamp orchid Rusty plum All fauna species	Landscaping plans to identify revegetation zones to buffer retained populations and habitats	Revegetation monitoring
Direct loss of known and potential habitat	All fauna and flora species	Establish exclusion to limit clearing extents. Landscaping design to include habitat restoration and revegetation elements	Revegetation monitoring
Loss of habitat elements providing potential breeding and roosting sites including stags, hollow-bearing trees and existing culvert and bridge structures.	All bat species and hollow-dependent fauna	Opportunities for providing roosting habitat for microbats in new bridge structures adjacent to areas of known microbat habitat would be investigated where future maintenance would not be compromised.	Nest box monitoring
Increased fragmentation of habitats and reduced connectivity	All species	Design and installation of fauna crossing structures and fencing. Landscape design to improve fauna connectivity along the road corridor.	Monitoring use and success of fauna crossing structures

Impact	Applicable species	Mitigation measures	Monitoring
Direct mortality due to vehicle strike	Koala Giant barred frog	Design and installation of fauna crossing structures and fencing. Installation of temporary fencing, to include escape structures, when adjacent to live traffic	Road mortality monitoring Monitoring use and effectiveness of structures. Ongoing monitoring and repair of fencing during operation.
Habitat disturbance during construction as a result of increased light, noise and vibration or wildfire.	All species	Minimise noise, light and dust during construction.	None proposed
Altered hydrological regimes and impacts to habitat quality	Giant barred frog Green-thighed frog Coastal petaltail	Detailed design to minimise changes to surface and ground water hydrology.	Water quality monitoring
Impacts to surface water quality	Giant barred frog Green-thighed frog Coastal petaltail	Detailed design to minimise changes to surface and ground water hydrology. Design and implement erosion and sediment control plans	Water quality monitoring
Spread of disease causing pathogens, including chytrid fungus, myrtle rust phytophthora during construction	Threatened frogs Fauna habitat	Management requirements in Guide 7: Pathogen management (RTA 2011) must be applied	If pathogen outbreaks are detected, monitoring for pathogens, eg infected plants or animals (laboratory analysis may be conducted for suspected infected areas or plants) may be required.

4.1 Threatened flora

4.1.1 Southern swamp orchid

Project impacts to southern swamp orchid are likely to include:

- Direct loss of a single plant
- Fragmentation of habitats and loss of pollination opportunities
- Disturbance and degradation of remaining habitats due to weed and pathogen invasion, altered fire regimes or changes in hydrology.

Impacts to this species are largely confined to an area of swamp vegetation located adjacent to North Boambee Road (between chainage 12800 and 13000).

4.1.2 Rusty plum

Project impacts to rusty plum are likely to include:

- Direct loss of plants
- Fragmentation of habitats and loss of pollination opportunities
- Disturbance and degradation of remaining habitats due to weed and pathogen invasion, altered fire regimes or changes in hydrology.

The species occurs throughout the project footprint associated with warm temperate or littoral rainforests and moist eucalypt forests located within gullies.

4.2 Threatened fauna

4.2.1 Mammals

Bat species

Project impacts to bat species are likely to include:

- Direct loss of known and potential habitat.
- Loss of habitat elements providing potential breeding and roosting sites including stags, hollow-bearing trees and existing culvert and bridge structures.

Opportunities to salvage and/or provide temporary replacement habitat for these microbat species to mitigate project impacts are to be investigated. Project impacts to this species are largely confined to areas supporting suitable vegetation communities and roosting habitats at:

- Englands Road in the south of the alignment (Culvert 8)
- Coramba Road beneath a property access road at 353 Coramba Road (Culvert 10)
- Culvert under the existing Pacific Highway about 800 m north of the intersection with James Small Drive (Culvert 28).

Grey-headed flying-fox

Project impacts to grey-headed flying-fox are likely to include:

- Direct loss of known and potential foraging habitat
- Increased fragmentation of habitats.

No roost sites were recorded within the project area and are unlikely to be impacted as a result of the project. Opportunities to mitigate the loss of foraging habitat for this species will be investigated as a part of landscape design and include replacement roadside planting with native species offering copious nectar and fruits.

Koala

Project impacts to koala are likely to include:

- Direct loss of known and potential habitat
- Loss of connectivity through habitat fragmentation and barriers to movement
- Direct mortality due to vehicle strike
- Edge effects leading to increased pest, weed and human disturbance
- Additional stress on koalas making the spread of diseases including Chlamydia or retrovirus more likely
- Habitat disturbance during construction as a result of increased light, noise and vibration or wildfire.

Measures proposed to mitigate project impacts to koala habitat connectivity and to facilitate safe movement of the species throughout the project area have been provided These include the provision of permanent fauna connectivity structures, fauna exclusion fencing and other measures to be implemented during construction and operation.

4.2.2 Birds

Olive whistler

Project impacts to olive whistler are likely to include:

- Direct loss of known and potential habitat
- Edge effects leading to increased pest, weed and human disturbance
- Habitat disturbance during construction as a result of increased light, noise and vibration or wildfire.

This species is unlikely to be impacted significantly as a result of the project however, habitat restoration and roadside planting works proposed during construction are intended to mitigate any potential impacts resulting from the project.

Pale-vented bush-hen

Project impacts to pale-vented bush-hen are likely to include:

- Direct loss of known and potential habitat
- Fragmentation and isolation of adjacent habitat
- Edge effects leading to increased pest, weed and human disturbance
- Habitat disturbance during construction as a result of increased light, noise and vibration or wildfire.

Project impacts to this species are largely restricted to riparian vegetation associated with Jordans Creek.

This species is considered transient and is unlikely to be impacted significantly as a result of likely project impacts. However, restoration of areas of disturbed riparian areas and replacement roadside plantings comprising native vegetation is proposed during construction.

Square-tailed kite

Project impacts to square-tailed kite are likely to include:

- Direct loss of potential habitat
- Habitat disturbance during construction as a result of increased light, noise and vibration or wildfire.

This species is considered transient and is unlikely to be impacted significantly as a result of likely project impacts. However, restoration of areas of disturbed riparian areas and replacement roadside plantings comprising native vegetation is proposed during construction.

White-bellied sea-eagle

Project impacts to white-bellied sea-eagle are likely to include:

- Direct loss of potential habitat
- Habitat disturbance during construction as a result of increased light, noise and vibration or wildfire.

This species is considered transient and is unlikely to be impacted significantly as a result of likely project impacts. However, restoration of areas of disturbed riparian areas and replacement roadside plantings comprising native vegetation is proposed during construction.

4.2.3 Frogs

Giant barred frog

Project impacts to giant barred frog are likely to include:

- Direct loss of known and potential habitat
- Fragmentation of two known areas of habitat
- Altered hydrological regimes and impacts to habitat quality
- Impacts to surface water quality
- Edge effects leading to increased pest and weed disturbance
- Disturbance of habitat and loss of individuals due to wildfire
- Potential for introduction of Chytrid virus

Project impacts are likely to be limited to riparian areas associated with Pine Brush Creek and Newports Creek. Measures proposed to mitigate project impacts to threatened frog habitat connectivity and to facilitate safe movement of the species throughout the project area have been provided. These include the provision of permanent fauna connectivity structures and fauna exclusion fencing. Other measures to be implemented during construction and operation include water quality management, eg erosion and sediment control.

Green-thighed frog

Project impacts to green-thighed frog are likely to include:

- Direct loss of known and potential habitat
- Fragmentation of two known areas of habitat

- Altered hydrological regimes and impacts to habitat quality
- Impacts to surface water quality
- Edge effects leading to increased pest and weed disturbance
- Disturbance of habitat and loss of individuals due to wildfire
- Potential for introduction of Chytrid virus

Project impacts are likely to be limited to riparian areas associated with Pine Brush Creek. Measures proposed to mitigate project impacts to threatened frog habitat connectivity and to facilitate safe movement of the species throughout the project area have been provided. These include the provision of permanent fauna connectivity structures and fauna exclusion fencing. Other measures to be implemented during construction and operation include water quality management, eg erosion and sediment control.

4.2.4 Invertebrates

Coastal petaltail

Project impacts to coastal petaltail are likely to include:

- Direct loss of known habitat
- Altered hydrological regimes and impacts to habitat quality
- Impacts to surface water quality
- Edge effects leading to increased pest and weed disturbance
- Disturbance of habitat and loss of individuals due to wildfire.

Project impacts are likely to be limited to areas of swamp vegetation adjacent to Highlander Drive off North Boambee Road (chainage 12600). Mitigation measures for management of hydrology and water quality during construction are discussed below.

5. Pre-construction and design management measures

5.1 Potential impacts during pre-construction and design

- Direct loss of threatened flora and fauna and their habitats
- Location of road infrastructure may impact flora and fauna habitats, habitat connectivity and habitat condition.

5.2 Mitigation goals

- Placement of infrastructure, including access tracks, haul routes and ancillary sites, to avoid threatened flora and fauna habitats where possible
- Project design is to include solutions for maintaining the connectivity of adjacent threatened flora and fauna habitats
- Project design is to minimise changes in hydrology within areas of adjacent threatened flora and fauna habitat
- Design lighting to minimise amount of light spill into adjacent threatened flora and fauna habitat
- Salvage and re-establish threatened flora species impacted by the project.

5.3 Management measures

The following management measures are recommended to address potential impacts to threatened flora and fauna prior to construction.

5.3.1 Permanent fauna connectivity structures

Data relating to the occurrence of threatened flora and fauna, suitable habitats and movement corridors within the project area was gathered during baseline surveys. This data has been used to inform requirements for permanent fauna crossing structure types to be developed as part of detailed design. Six different types of crossing structures are proposed to improve fauna connectivity within the project area, including:

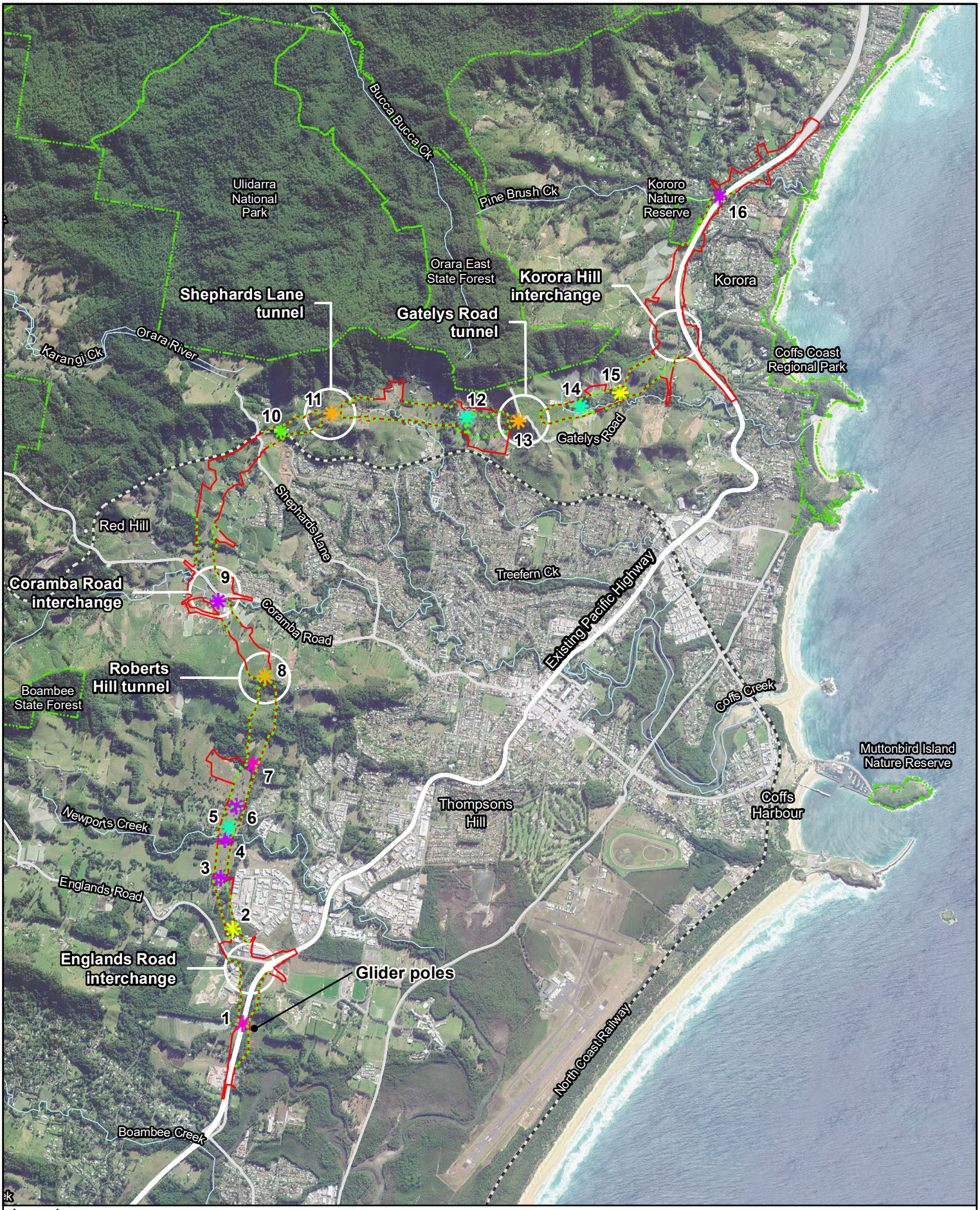
- Retained ridgelines over tunnels
- Dedicated fauna underpasses (culverts)
- Combined waterway bridges incorporating fauna underpasses
- Combined road bridges incorporating fauna underpasses
- Combined rail bridge incorporating fauna underpasses
- Combined fauna and drainage underpasses (culverts)
- Glider poles.

These structures have been proposed based on the requirements of the target species, the alignment and condition of fauna corridors and the design and topographic constraints of the project. Sixteen locations have been identified along the 14 km alignment where connectivity structures can be placed, as identified in Table 6 and shown in Figure 5. The location and final details of these structures will be subject to detailed design.

In addition to threatened species known to be impacted by habitat fragmentation as a result of the project, requirements for fish passage have also been considered during the design development. In accordance with the Department of Primary Industry guidelines, fish passage will be required on all Class 1, 2 and 3 waterways. This will include bridge crossings over Pine Brush Creek, which is the only Class 1 waterway assessed within the study area. Where culverts are proposed on Class 2 and 3 waterways, fish passage elements will be included in the design.

Opportunities for improving connectivity for gliders are included at the southern end of the study area. In areas where there are historical records of these species, and where there is movement and foraging habitat either side of the alignment, the installation of glider poles has been included in the design.

Detailed specifications to inform the design of each structure are provided in Table 7 to Table 12.



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Park/Reserve
- Indicative fauna fencing location

Fauna Structures

- Combined fauna and drainage underpass
- Combined rail bridge incorporating fauna underpass
- Combined road bridge incorporating fauna underpass
- Combined waterway bridge incorporating fauna underpass
- Dedicated fauna underpass
- Retained ridgeline over tunnel overpass

Coffs Harbour Bypass
Permanent fauna connectivity structures and fencing
Figure 5

0 0.45 0.9 1.35 km

Scale @A4: 1:48,565
GDA 1994 MGA Zone 56

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Table 6: Fauna connectivity structures

Site No.	Design chainage	Connectivity structure type	Description, indicative dimensions and target species
1	10150	Dedicated fauna underpass Glider poles	Extension of existing arch structure under Pacific Highway (2.8 m high, 5.5 m wide at base, length 83 m). Structure to be retained and extended, with new fauna furniture to be retrofitted and extended through new structure. Target species: koala, spotted-tail quoll, gliders
2	11100	Combined fauna and drainage underpass	Culvert crossing across unnamed tributary of Newports Creek (Class 2 waterway) (3 x 3000 W x 2700 H approx 75 m long). Target species: koala, spotted-tail quoll, giant barred frog, fish
3	11650	Combined waterway bridge incorporated fauna underpass	Bridge crossing across unnamed tributary of Newports Creek (Class 2 waterway) (80 m length x 24.5 m width). Target species: koala, spotted-tail quoll, giant barred frog, pale-vented bush hen, fish
4	12000	Combined waterway bridge incorporated fauna underpass	Bridge crossing Newports Creek (Class 2 waterway) (90 m length x 25 m width). Target species: koala, spotted-tail quoll, giant barred frog, pale-vented bush hen, fish
5	12150	Combined road bridge incorporating fauna underpass	Bridge crossing of North Boambee Road (99 m length x 23 m width). Target species: koala, spotted-tail quoll
6	12400	Combined waterway bridge incorporated fauna underpass	Bridge crossing across unnamed tributary of Newports Creek (Class 2 waterway) (66 m length x 24 m width). Target species: koala, spotted-tail quoll, giant barred frog, pale-vented bush hen, fish
7	12800	Dedicated fauna underpass	Vegetation corridor identified for terrestrial fauna movement (1 x 3000 W x 3000 H RCBC approx 89 m long). Target species: koala, spotted-tail quoll, pale-vented bush hen
8	13750	Retained ridgeline over tunnel overpass	Roberts Hill ridgeline, 190 m ridgeline retained Target species: koala, spotted-tail quoll, pale-vented bush hen
9	14600	Combined waterway bridge incorporated fauna underpass	Bridge crossing across Coffs Creek (Class 2) (64 m length x 25.5 m width). Target species: koala, spotted-tail quoll, pale-vented bush hen, fish
10	16600	Combined rail bridge incorporating fauna underpass	Bridge crossing over North Coast Rail Line. Vegetated corridor along rail verge (180 m length x 28.5 m width). Target species: koala, spotted-tail quoll
11	17200	Retained ridgeline over tunnel overpass	Shephards Lane tunnel, 360 m ridgeline retained Target species: No proposed target as this location would only provide opportunities for fauna connectivity due to existing land use.
12	17800	Combined road bridge incorporating fauna underpass	Fauna passage included with access road underpass (30 m length x 24.5 m width). Target species: koala, spotted-tail quoll
13	19000	Retained ridgeline over tunnel overpass	Gatelys Road tunnel, 450 m ridgeline retained

Site No.	Design chainage	Connectivity structure type	Description, indicative dimensions and target species
			Target species: koala, spotted-tail quoll, pale-vented bush hen.
14	19750	Combined road bridge incorporating fauna underpass	Bridge underpass under West Korora Road (34 m length x 27 m width). Target species: koala, spotted-tail quoll, pale-vented bush hen
15	20150	Combined fauna and drainage underpass	Culvert crossing across tributary of Jordans Creek (Class 2) (1 x 3000 W x 3000 H, approx 60 m long). Target species: koala, spotted-tail quoll, pale-vented bush hen, fish
16	22450	Combined waterway bridge incorporated fauna underpass	Bridge underpass under Pine Brush Creek (Class 1) (60 m length x 27 m width). Target species: koala, spotted-tail quoll, pale-vented bush hen, giant barred frog, green-thighed frog.

Table 7: Retained ridgelines over tunnel overpasses

Design principles
The existing vegetation communities on the ridges will be retained where feasible (there may be need for some minor clearing associated with utilities/associated tunnel infrastructure).
Fauna exclusion fencing, with appropriate mechanisms to prevent climbing and burrowing animals, is to be installed on both sides of the tunnel approaches, extending above both portals and tying into the fauna fencing along the road corridor. The design of any barriers must not cause a barrier to the movement of any of the target fauna species.
Clearing of native vegetation is to be minimised as much as practicable on either side of the approaches to the tunnels. Areas where existing native vegetation has been removed during the construction of the project and is located within the fauna exclusion fencing area shall be revegetated with native vegetation.

Table 8: Waterway bridges incorporating fauna underpass

Design Principles
Clearance of vegetation adjacent to bridges across waterways is to be minimised. Design and construction methodology is to retain as much vegetation within the riparian zone of the waterway as is practicable.
Bridges are the preferred crossing structure for identified Class 1 waterways (major fish habitat), preferably being single- span or multi-span bridges with the pylons/piers located outside the main channel.
Where feasible and reasonable, the design is to avoid placing piers in permanent water channels and on-stream banks, to minimise alteration to water flow and/or damage to stream bank vegetation. This is important for the identified Class 1 waterways.
Bridges should be designed with a natural substrate at the abutment, such as soil or vegetation, where feasible and reasonable. Scattered rocks could be included.
Bridges should be designed to allow unimpeded water flow, stream bank and riparian vegetation, preferably on both sides of the water course

Design Principles
Any scour protection associated with the entries and exits to waterway bridges should accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks.
A minimum width of 3 m is to be retained between the toe of the scour protection and the top of bank to maintain fauna passage below the bridge on both sides. For effective connectivity, the 3m passage should consist of a natural substrate or other surface type that will not hinder fauna movement. Note: location of piers should not restrict the designated fauna passage area or the width of the passage should be widened to accommodate the pier.
Bridges should be designed (height, carriageway separation) to allow sufficient light and moisture to encourage growth of vegetation between twin bridge structures. A minimum height of 1.5 m should be allowed for in areas proposed for terrestrial fauna passage.
The design of bridges (and culverts) is to ensure physical, hydraulic and behavioural barriers are minimised for aquatic fauna movements. Impacts should be minimised by ensuring that: • The natural system flow and velocity is maintained or mimicked as closely as possible • Habitat within a culvert is to be as natural as possible (eg allow rocks and bed materials to infill the culvert base)
Revegetation works should be completed as soon as practicable following bridge construction and include restoration of a natural, riparian zone vegetation community underneath the bridge structure. Revegetation works on the entry/exit side of the structure are to provide for a continuous strip of native vegetation and habitat from each side of the bridge. Where possible, the vegetation community created as part of the revegetation works is to match the PCT of the retained vegetation communities. Planting underneath the bridge structures should include the use of groundcovers, with shrubs to be used when the height and light penetration allow for larger species to establish. All plant species are to be known to occur in the relevant PCT retained on either side of the bridge.
Where the bridges cross areas of habitat identified for threatened frog species the creek channels are to be reinstated to include habitat elements to support these species, including consideration for fringing riparian vegetation, emergent aquatic vegetation, suitable instream habitats to support species-specific life cycles.
The approaches to the fauna passage on each side of the bridge is to include fauna fencing that ties into the abutments to funnel fauna towards the crossing and to exclude fauna from the road infrastructure.

Table 9: Road bridges incorporating fauna underpasses

Design Principles
Bridges should be designed with a natural substrate at the abutment, such as soil or vegetation, where feasible and reasonable.
A minimum width of 3m is to be retained between the toe of the bridge and the edge of the road to maintain fauna passage below the bridge on one side.
Bridges should be designed (height, carriageway separation) to allow sufficient light and moisture to encourage growth of vegetation between the structures. A minimum height of 1.5m should be allowed for in areas proposed for terrestrial fauna passage
Revegetation works should be completed as soon as practicable following bridge construction and include restoration of a natural, vegetation community underneath the bridge structure. Revegetation works on the entry/exit side of the structure are to provide for a continuous strip of native vegetation and habitat from each side of the bridge. Where possible, the vegetation community created as part of the

Design Principles
revegetation works is to match the PCT of the retained vegetation communities. Planting underneath the bridge structures should include the use of groundcovers, with shrubs to be used when the height and light penetration allow for larger species to establish. All plant species are to be known to occur in the relevant PCT retained on either side of the bridge.
The approaches to the fauna passage on each side of the bridge is to include fauna fencing that ties into the abutments to funnel fauna towards the crossing and to exclude fauna from the road infrastructure.

Table 10: Rail bridges incorporating fauna underpasses

Design Principles
Bridges should be designed with a natural substrate at the abutment, such as soil or vegetation, where feasible and reasonable. Scattered rocks could be included.
Any scour protection associated with the entries and exits to bridges should accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks.
A minimum width of 3m is to be retained between the toe of the scour protection or the abutment and the edge of the road to maintain fauna passage below the bridge on both sides. For effective connectivity, the 3m passage should consist of a natural substrate with refuge areas (scattered rocks, logs) and landscaping of the habitat corridor approach, not consisting of all rock and not consisting of scour protection.
Bridges should be designed (height, carriageway separation) to allow sufficient light and moisture to encourage growth of vegetation under the structures. A minimum height of 1.5m should be allowed for in areas proposed for terrestrial fauna passage
Revegetation works should be completed as soon as practicable following bridge construction and include restoration of a natural, vegetation community underneath the bridge structure. Revegetation works on the entry/exit side of the structure are to provide for a continuous strip of native vegetation and habitat from each side of the bridge. Where possible, the vegetation community created as part of the revegetation works is to match the PCT of the retained vegetation communities. Planting underneath the bridge structures should include the use of groundcovers, with shrubs to be used when the height and light penetration allow for larger species to establish. All plant species are to be known to occur in the relevant PCT retained on either side of the bridge.
The approaches to the fauna passage on each side of the bridge is to include fauna fencing that ties into the abutments to funnel fauna towards the crossing and to exclude fauna from the road infrastructure.

Table 11: Dedicated fauna underpasses (culverts)

Design Principles
Crossings should provide an unobstructed view, for fauna using the underpass, of the horizon or habitat on either side of the structure. The location of underpasses on embankment fills should be optimized to provide these views
Culvert underpass structures that exceed 50m in length shall be a minimum 3x3m (height x width) box culvert. Culvert structures that are less than 50m length shall be a minimum 2.4mx2.4m box culvert should fill embankments heights not permit 3x3m box culvert. Approach grades to the underpass structures would be no steeper than 3H:1V.

Design Principles
Dedicated underpasses to have a natural substrate, such as soil or mulch. Sandy loam is preferable to prevent the generation of a mud substrate
In order to achieve dry passage in dedicated underpasses, the following design principles apply: • Dedicated underpasses are to be located above flow lines, gullies and depressions • Basin outlets should not lead to or run to dedicated underpasses • Basins should not be located in front of underpass structures • Locations are to be ground-truthed to ensure the correct conditions • Underpasses are to be designed with a longitudinal grade and to be free draining to reduce frequency and levels of any ponding water within the culverts
• Fauna furniture is to be incorporated into dedicated structure design and around the entrance • Place horizontal logs for passage as high above the base of the opening as practical, allowing 0.6 m ceiling clearance for fauna passage • Outside and within the culvert provide refuge poles (3m tall and 200mm diameter, with a forked top) are effective where introduced (feral) predators are likely to attack koalas. It is important to ensure that the poles are located at least three metres away from koala exclusion fencing.
Minimise clearing of existing native vegetation at the entry/exit points of the underpasses.
The approaches to the underpasses on either side of the road should be subject to revegetation works to connect the entry/exit points to areas of retained native vegetation and corridors.

Table 12: Combined fauna and drainage underpasses (culverts)

Design Principles
The underpass combines drainage or property access requirements with fauna passage requirements, in some cases including fish passage.
Combined crossings must be located and installed so that entrance slopes are not steeper than 3H:1V nor rocky and must provide suitable fauna passage.
Combined underpass floors and exit / entry points that are designed to cater for terrestrial fauna passage must provide dry fauna passage during a one in 1-year ARI three day storm event or must not have wet sections that retain water for longer than three days. A dry ledge or similar within combined underpasses to maintain dry passage maybe used. Minimum ledge width of 1.2m.
For aquatic species, the natural width, depth and gradient of the watercourse is to be maintained within the culvert, with no vertical drops created at the entrance or exit. All designs should be in accordance with NSW Fisheries Guideline “Why do Fish Need to Cross the Road” (now incorporated into DPI 2013).
Ensure that pathways to fauna underpasses are not affected by noise mounds or ancillary sites or rest areas.
Any scour protection associated with the entries and exits to combined drainage / fauna crossings must accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks.
Where feasible and not affecting the hydrological performance of the drainage structure, fauna furniture is to be installed in combined structures that have been designed to provide for terrestrial fauna movement, with consideration for raised ledges, shelter rocks and resting poles. Furniture is to be designed and located so to obstruct movement of the target fauna species through the underpass.

5.3.2 Permanent fauna exclusion fencing

During detailed design, opportunities are to be fully explored to install permanent fauna exclusion fencing along the alignment to funnel ground and arboreal fauna movements to safe crossing opportunities at the fauna crossing structures. Much of the 14 km alignment is likely to be subject to dedicated fauna exclusion fencing deemed appropriate for the habitat type adjacent to the project area. Sections to remain unfenced are likely to include larger interchange areas, agricultural areas or urban fringes. Fauna fencing should be installed on the outside edge of the on-load and off-load ramps where interchanges are located, as outlined in Table 13.

Detailed specifications to inform the design of permanent fauna fencing is provided in Table 14.

Temporary fauna exclusion fencing will be required if existing fauna fence at the southern end of the project on the Pacific Highway is removed during construction period.

Table 13: Proposed indicative fencing locations

Approximate chainage (northbound and southbound)	Fencing type	Comment
9750-13750	General fauna fencing where specific species fencing not proposed. Combine general fauna fence and frog fence at known threatened frog habitat	Mapped koala habitat Known giant barred frog habitat at Chainage 11500-11700 and Chainage 12000-12150
14300-14500	General fauna fencing where specific species fencing not proposed.	Mapped koala habitat
14750-15500	General fauna fencing where specific species fencing not proposed.	Mapped koala habitat
15750-16250	General fauna fencing where specific species fencing not proposed.	Mapped koala habitat
16600-20700	General fauna fencing where specific species fencing not proposed.	Mapped koala habitat
21000-22500	General fauna fencing where specific species fencing not proposed. Combine general fauna fence and frog fence at known threatened frog habitat	Mapped koala habitat Known giant barred frog habitat at Chainage 22250-22500

Table 14: Fauna fencing design specifications

Type	Design principles
Integration with crossing structures	Fencing must be integrated with crossing structures by guiding animals towards the crossing structure and preventing access to the road. Fencing is typically constructed on both sites of the road; otherwise animals are easily trapped on the road.
Returns	Fencing should be continuous and at their ends have a 'return area' to guide animals back into habitat rather than onto the road.
Integration with noise walls	Fauna fencing can be tied into noise walls where required.
Vertical access prevention	• Fence design should prevent animals from jumping over fences where possible. Target fence types should be designed depending on the threatened fauna in the area. • The fence must prevent animals from digging underneath. Construct metal flaps at the base of fencing where the fence crosses drainage lines to ensure fauna cannot burrow under the fence at these points.
Mesh size	The size of the mesh must prevent the target species from climbing through. A fence with large mesh for large animals can include a fine mesh at the base to prevent small species from climbing through.
Fencing tops for koalas	Fauna fencing where koalas are the target species will require either floppy-top or smooth metal sheeting on the top portion of the fence to prevent animals from climbing over.
Frog fencing	• Where frog fencing is required, it would extend a minimum of 50m either side of crossing structure • Frog fencing is to consist of a galvanised grid mesh fence <4mm, 400-500 mm high with a 150 mm wide sloped roof to discourage amphibian access. This can be attached to other fauna fencing. • Fencing in areas of giant barred frog and green-thighed frog habitat should be a minimum of 1000 mm in height. • Frog fences must be buried at least 10 cm or alternatively pegged down to prevent frogs crawling underneath.
Maintenance	• Fencing would require regular inspection and maintenance. A vehicle access track adjacent to the fence would facilitate rapid inspection and repair. Where overgrown vegetation that breaches the fence is likely, the vehicle track would also permit slashing vegetation. • Maintenance of fencing is critical to identify and repair breaches, periodic inspections are likely to be required.

5.3.3 Identify habitat exclusion zones

An exclusion zone is a designated 'no go' area that is clearly identified and appropriately delineated on site to prevent damage to ecological features that require protection. The location of any features such as native vegetation, threatened species and fauna habitat will be ground-truthed and used to inform the locations of exclusion zones. Exclusion zones will be identified in the project documentation and clearly marked on the ground with appropriate fencing or tape prior to construction by the project ecologist.

Exclusion zones will be identified on site in accordance with the Roads and Maritime Biodiversity Guidelines (RTA 2011).

5.3.4 Salvage/re-establish threatened flora

Threatened flora directly impacted by the project are to be salvaged and re-established in adjacent suitable habitat areas prior to construction or during the commencement of early site works. Baseline surveys suggest, up to 57 rusty plum and one southern swamp orchid could be salvaged and re-established. A salvage and re-establishment plan is to be prepared during project design outlining detailed procedures for the preparation of the re-establishment and receiving sites, plant movement, pre- and post- care of target individuals as well as detailing the objectives, monitoring procedures and contingency measures. The plan is to form a subplan of this TSMP.

Methods might include the following where appropriate:

- Direct transplanting of salvageable rusty plum saplings and southern swamp orchid
- Either direct transplanting of salvageable rusty plum trees where possible or replacement plantings, eg seed or tubestock
- Establish additional individuals by direct seeding using seed collected from the local population prior to establishment period.

5.3.5 Pre-clearing survey for threatened flora

During the pre-construction phase, targeted pre-clearing surveys are to be undertaken for rusty plum and southern swamp orchid within the project area including locations of access tracks, particularly where the species have been identified to occur or in identified habitat areas. The GPS coordinates of identified threatened flora that may be impacted by the project are to be mapped as part of the salvage and re-establishment plan discussed in Section 5.3.4 above, and salvage/re-establishment of those plants to receiving sites are to be addressed in the salvage and re-establishment plan.

5.4 Mitigation goals and corrective actions

The mitigation goals and associated corrective actions for threatened flora and fauna species to be implemented during the pre-construction phase are summarised in **Table 15**.

Table 15: Mitigation goals and corrective actions - Pre-construction

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
Placement of infrastructure to avoid threatened flora and fauna habitats where possible	Implementation of multi-disciplinary design review processes involving an ecologist to review placement of infrastructure in relation to habitat for threatened flora and fauna.	At each design iteration	Infrastructure intersects, overlaps or fragments habitat for threatened flora and fauna. Uncertainty regarding potential risks to threatened flora and fauna habitat (ie insufficient set-backs to vegetation/ sensitive habitat features, potential for significant disturbance, etc)	Conflicts and concerns to be flagged with design lead and appropriate strategies or alternative design / engineering solutions to be discussed and implemented.	Environment Manager
	Identify habitat exclusion zones prior to clearing to guide the placement of infrastructure and ancillary facilities outside of threatened flora and fauna habitat areas, where possible	Prior to commencement of site works	Exclusion zones have not been clearly identified in site plans. Exclusion zones have not been flagged and identified on site.	Sites works must not commence until exclusion zones have been decided and are clearly identified on site by the project ecologist. The site foreman/contractor will be required to implement these during the construction phase.	Project Ecologist

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
Project design is to include solutions for maintaining the connectivity of adjacent threatened flora and fauna habitats	Project design to incorporate the implementation of fauna connectivity structures and suitable engineering solutions to facilitate fauna movement within the vicinity of threatened flora and fauna habitat.	Prior to construction at detailed design stage	Detailed design drawings indicate changes to the location or design specifications for fauna structures that have the potential to impact suitability to facilitate fauna movement.	Amend design to meet design standards outlined in Section 5.3.1 of this Plan Additional fauna connectivity structures maybe required if design solution cannot feasibly achieve design principles for the identified fauna crossing locations	Structures and drainage design lead / Environment Manager
A Nest Box Management Plan would be prepared and implemented as part of the FFMP in accordance with Guide 8: Nest Boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011). The Plan would include requirements for monitoring and maintenance.	Opportunities for providing roosting habitat for microbats in new bridge structures adjacent areas of known microbat habitat would be investigated where future maintenance would not be compromised.	Prior to construction at detailed design stage	Detailed design drawings indicate changes to the locations of and design specifications for artificial microbat roosting sites and nest boxes	Amend design to meet the *Guide 8: Nest Boxes of the Roads and Maritime Biodiversity Guidelines*. Additional artificial microbat roosting sites and nest boxes may be required if design solution cannot feasibly achieve design principles in the guide above for the identified artificial microbat roosting sites and nest boxes locations.	Environment Manager

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
Project design is to minimise changes in hydrology within areas of adjacent threatened flora and fauna habitat	Engineering / design solutions to incorporate measures to maintain the background hydrology.	Confirm drainage design using hydrological modelling during detailed design. Baseline monthly ground and surface water level monitoring to inform natural variation within project area.	Water diverted to or from threatened flora or fauna habitat.	Drainage design reviewed and altered if necessary.	Civil design lead / Environment Manager
Salvage and re-establish threatened flora species impacted by the project	Prepare a salvage and establishment plan outlining procedures for the re-establishment of Southern Swamp Orchid and Rusty Plum species impacted by the project. Identify suitable receiving sites for the species and apply any necessary protection/ stewardship arrangements. Commission contractor with suitable experience in the re-establishment of the target flora species to undertake the works including pre- and post-management of species.	Prior to construction	Unavailability of suitable receiving sites within proximity to the project area	Search of available registers for broader IBRA sub-region.	Roads and Maritime

6. Construction management measures

6.1 Potential impacts during construction phase

- Direct loss of threatened flora as a result of vegetation clearing
- Fauna injury or mortality as a result of vegetation clearing
- Loss of habitat for threatened flora and fauna including hollow-bearing trees and potential roosting sites
- Loss of habitat connectivity and barriers to fauna movement
- Fauna entrapment in excavations
- Indirect impacts include disturbance and degradation of remaining habitats, such as erosion and changes to surface water quality and flows.

6.2 Mitigation goals

- No damage to threatened flora and fauna habitat within marked exclusion zones
- No vehicle collision incidents with threatened fauna species within the construction area
- No threatened fauna injury or mortality due to vegetation clearing activities
- 80 per cent survival rate of re-established threatened flora species
- Minimise noise, light and dust during construction
- Reinstate habitat for threatened flora and fauna
- Minimise impacts to hydrology and water quality during construction including erosion and sediment control.

6.3 Management measures

6.3.1 Environmental work method statements

Environmental Work Method Statements (EWMS) are prepared to manage and control all activities that have the potential to negatively impact on the environment. EWMS will be prepared prior to the commencement relevant construction activities on site and will incorporate relevant mitigation measures and controls from management plans. They also identify key procedures to be used concurrently with the EWMS. EWMS are specifically designed to communicate requirements, actions, processes and controls to construction personnel using plans, diagrams and simply written instructions.

EWMS will be prepared progressively in the lead up to and throughout construction in consultation with relevant members from the Project team, and approved by the Environment Manager.

EWMS for activities identified as having high environmental risk will undergo a period of consultation with stakeholders and authorities prior to approval.

EWMS for activities likely to be considered high risk due to their proximity to environmentally sensitive areas which are relevant to the TSMP include:

- Working platforms in or adjacent to waterways.
- Temporary waterway crossings.

- Ancillary site establishment
- Stockpile management
- Clearing and grubbing
- Sediment basin, construction and management
- Dewatering activities
- Blasting.

Contractor to include any additional activities arising from risk review.

All construction personnel and sub-contractors undertaking a task governed by an EWMS must participate in training on the EWMS, and acknowledge that they have read and understood their obligations prior to commencing work.

Regular monitoring, inspections and auditing against compliance with the EWMS will be undertaken by Project management, quality, and environmental personnel to ensure that all controls are being followed and that any non-conformances are recorded and corrective actions implemented.

A register of EWMS will be maintained.

6.3.2 Construction induction and training

Induction and training will be conducted with all contractors and other staff that will be working in the area of known and potential threatened flora and fauna habitat. This training will highlight to staff the threatened species and their habitats to allow them to clearly identify them on site should they be located. Any personnel that will require site access will be informed of the importance of following the clearing, flora re-establishment and rehabilitation protocols.

6.3.3 Fauna rehabilitation protocol

The Project Ecologist will be present on site during all vegetation clearing and habitat removal activities to capture and relocate any fauna species that may be encountered. Identified habitat (including hollow-bearing trees) will be left for at least 48 hours after clearing the surrounding vegetation to allow fauna to relocate naturally. If necessary, fauna may need to be trapped or captured and relocated to nearby suitable habitat for release. The trapping and relocating of fauna will be undertaken in accordance with Guide 9: Fauna Handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) and the NSW code of Practice for Injured, Sick or Orphaned Protected Fauna (OEH 2011).

All adverse events or incidents involving fauna mortality that occur due to construction, will be recorded including details of the fauna, location of the incident and measures taken to address the issue. Injured fauna will be transported to the nearest veterinary surgery or wildlife carer for treatment and contact made with Wildlife Information Rescue Service (WIRES) Mid North Coast Branch, as necessary. The ecologist or wildlife carer will be responsible for the relocation and release of displaced fauna upon their recovery. Release sites for fauna are to be within close proximity to the site where the fauna were originally captured, if possible. The GPS location of release sites are to be recorded and provided to Roads and Maritime.

6.3.4 Pre-clearing surveys

Prior to the commencement of clearing operations, pre-clearing surveys will be undertaken in accordance with Guide 1: Pre-clearing Process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011). The surveys are to be undertaken by the Project Ecologist and are to involve a search of all habitat and animal breeding places within areas where vegetation clearing is to occur. The Project Ecologist is to confirm the location of exclusion zones and proposed clearing methods, such as

staged clearing, to ensure the protection of any threatened flora and fauna that may be encountered. Where necessary, the ecologist will record the location of any fauna to be relocated and identify suitable habitats within proximity for release.

Procedures for pre-clearing activities are detailed within this TSMP.

6.3.5 Clearing procedures

Clearing procedures are to be outlined in the TSMP and undertaken in accordance with the Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011). These will be finalised with the Project Ecologist during the pre-clearing surveys.

Clearing of vegetation and habitat features will be undertaken in a two stage process following the completion of the pre-clearing surveys. Under scrubbing and the removal of non-habitat trees would be undertaken first. Habitat trees (including hollow-bearing trees) are to be at least 48 hours after the removal of non-habitat trees, to enable resident hollow-dependent fauna to evacuate the tree prior to felling. The Project Ecologist must be present to supervise the removal of each tree.

Any habitat features including hollows, large woody debris and bushrock are to be salvaged and stockpiled during construction for later use for habitat restoration activities, in accordance with Guide 5: Re-use of woody debris and bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).

6.3.6 Temporary fencing and fauna management

Installation of temporary fauna fencing will be required if existing fauna fence at the southern end of the project on the Pacific Highway is removed during construction period. Permanent fauna fencing across the project is to be progressively installed as fauna connectivity structures become operational.

6.3.7 Koala specific management measures

Measures proposed to mitigate project impacts to koala habitat connectivity and to facilitate safe movement of the species throughout the project area include the management measures above, in particular permanent fauna connectivity structures with koala as a target species and fauna exclusion fencing with fencing tops suitable for koalas.

Additional measures to be implemented during the construction phase are:

- Induction training will be conducted for all contractors and project staff working in areas of known and potential koala habitat in the project area. This training will identify areas of koala habitat, crossing zones and key threats to the species. The importance of following the clearing and rehabilitation protocols will be made clear to all project personnel.
- During pre-clearing surveys, an ecologist will undertake daylight canopy search surveys of the scheduled clearing area prior to vegetation clearing (i.e. early in the morning prior to the commencement of vegetation clearing activities) to identify trees in which a koala is present and any adjacent trees with overlapping crowns.
- Suspension of clearing works if a koala is found during clearing operations to allow the animal to move out of the construction site on its own volition. In the event that a koala remains in the clearing site for more than 48 hours, it will be captured and relocated by the Project Ecologist to the nearest area of habitat identified as suitable for koala release and where the individual is at no risk of further harm.

- Each tree identified by the Project Ecologist as being a risk to a koala if felled, will not be felled, damaged or interfered with until the koala has moved from the clearing site. The Project Ecologist will physically move koalas if necessary in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA Projects (RTA 2011).
- If any koalas are observed showing signed of disease, WIRES must be contacted and direction taken from a wildlife carer on any actions to salvage the animal.

6.3.8 Habitat restoration and landscape design

Procedures for the reinstatement of native vegetation and habitats within the project area will be detailed in the Urban Design Landscape Management Plan, for the project. This would include the provision of replacement foraging resources for target threatened fauna, including plants that provide copious nectar and fruits, where appropriate and targeting areas that are located within:

- Regional and local Biodiversity links / fauna corridors
- Areas adjacent to existing threatened flora and fauna habitats and riparian zones
- Coastal Management SEPP, SEPP44 Koala habitat and environmental protection zones.

Any salvaged hollows, large woody debris and bushrock are to be re-used as a part of the restoration works in accordance with Guide 5: Re-use of woody debris and bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).

6.3.9 Hydrology and water quality

To manage potential impacts associated with water quality, erosion and sedimentation, management considerations have been incorporated into the project design. These designs have taken into account the guidelines, principles and design standards as defined in Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Management Urban Stormwater: Soils and Construction – Main Road Construction (DECC, 2008). These documents outline target parameters and measures for water quality and soil management during road construction and ongoing operation to prevent environmental pollution.

Water quality objectives for the project relate to the protection of sensitive downstream receiving environments during and post-construction; particularly those environments that provide important habitat for threatened frog species. The key mitigation measures to be implemented during construction will include sediment basins and additional erosion and sediment controls to intercept run-off and retain the associated sediments and pollutants. Procedures for the maintenance and monitoring of these measures during construction are to be incorporated into the Construction Erosion and Sediment Control Plan.

During operation, permanent water quality management and protection measures will be installed to protect adjacent waterways and wetland areas from pollutants generated by the project. These will include grassed swales. Water quality objectives for the project should be consistent with the NSW Water Quality and River Flow Objectives for the Bellinger River Catchment (OEH, 2018).

Water quality monitoring will be conducted prior to, during and post construction comparing upstream and downstream results to monitor sediment and pollutant levels and to trigger the need for corrective actions.

6.3.10 Disease-causing pathogens

Pathogens are agents that cause disease in flora and fauna and are usually living microorganisms such as a bacterium, virus, or fungus. Such pathogens in NSW include:

- Phytophthora (*Phytophthora cinnamomi*) which is a soil-borne fungus that causing tree death;
- Chytrid fungus (*Batrachochytrium dendrobatidis*) which affects amphibians;
- Myrtle rust which is a plant disease caused by the fungus *Uredo rangelli*;
- Fusarium wilt/Panama disease which is a plant disease caused by the fungus *Fusarium oxysporum*.

Pathogens can be spread on footwear, vehicles and machinery, particularly during wet weather or in wet conditions.

Management requirements in Guide 7: Pathogen management (RTA 2011) must be applied wherever pathogens are known or suspected to occur on or adjacent to the bypass and during maintenance works. A Panama Disease Control Management Plan would be developed to manage risks associated with potentially infected plant material during and following clearing and grubbing, movement of the pathogen in soils and water due to erosion and sedimentation during construction and movement of the pathogen via contaminated construction equipment and vehicles entering and leaving the construction footprint (**Chapter 13, Agriculture**).

The Plan will be prepared in accordance with relevant Queensland's Department of Agriculture and Fisheries guidelines including Panama disease tropical race 4: Biosecurity standards and guidelines (2015) and Panama disease tropical race 4: Decontamination guide (2016).

Specific management measures and controls will address the following as a minimum for all existing and former banana plantations within the construction footprint:

- Cleaning and washdown procedures for construction plant, vehicles and equipment and personnel
- Clearing and grubbing practices
- Stockpile management procedures for topsoil and other materials
- Procedures for the management and/ or disposal of contaminated and/ or potentially contaminated Panama disease soils including its identification as such to prevent accidental spread of the disease by others
- Erosion and sediment control requirements
- Dust management controls
- The movement of construction plant, vehicles and equipment and personnel both within the project and externally, including where construction plant and equipment may have previously worked in other affected areas such as north east Queensland Revegetation and rehabilitation practices.

6.4 Mitigation goals and corrective actions

The mitigation goals and associated corrective actions for threatened flora and fauna species to be implemented during the construction phase are summarised in Table 16.

Table 16: Mitigation goals and corrective actions - Construction

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
No damage to threatened flora and fauna habitat within marked exclusion zones	Exclusion zones kept clearly marked and visible on site. Site inductions mandatory for all new site workers.	Throughout construction	Exclusion zones do not correspond with approved drawings. Fencing moved or damaged. Damage to vegetation or habitat for fauna within exclusion zones.	Stop works until exclusion fencing has been reinstated in accordance with approved plans. Project Ecologist to be contacted and to assess impacts. Breech to be reported to Roads and Maritime. Suitable replanting works to be commissioned or biodiversity offsets to be purchased, as necessary.	Construction Manager
No vehicle collision incidents with threatened fauna species within the construction area	Temporary fauna exclusion fencing will be required if existing fauna fence at the southern end of the project on the Pacific Highway is removed during construction period. Construction speed limits applied for all construction vehicles and machinery.	Throughout construction	Fauna injury or mortality due to collision with construction vehicles. Fauna within the construction footprint.	Implementation of fauna rehabilitation protocols. Review placement of fauna fencing/ crossings, haulage routes, as needed.	Construction Manager / Project Ecologist

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
No threatened fauna injury or mortality due to vegetation clearing activities	Pre-clearing survey undertaken in accordance with approved procedures. Site clearing works to be undertaken in accordance with approved clearing procedures and supervised by Project Ecologist.	At all times during vegetation clearing works	Fauna injury or mortality	Immediate stop work procedures and fauna rehabilitation procedures implemented.	Construction Manager / Project Ecologist
80% survival rate of re-established flora species (rusty plum and southern swamp orchid)	Salvage and re-establishment plan (developed during pre-construction) to be implemented. Post-care and monitoring of re-established species.	Weekly for first 12 weeks Monthly 3- 12 months. Annually from 12 months	Plants fail to establish and grow Decline in health or failure	Soil and water sampling Inspect for pest or pathogens Apply appropriate controls/ soil improvement measures, where necessary Alter watering regime if needed.	Project Ecologist
Minimise impacts to hydrology and water quality during construction	Implementation of CEMP measures for erosion and sediment control. Ground and surface water monitoring during construction. Contain any spills	Monthly monitoring of groundwater levels. After rainfall and/or weekly inspection of control devices	Sediments/ pollutants introduced to local waterways and wetlands Groundwater levels outside of expected range	Incident reported to Roads and Maritime Control devices/ measures inspected for suitability and corrected/ reinstated where necessary. Spill containment procedures implemented where appropriate. Relevant agencies notified and environmental impacts assessed and rectification works commissioned if required	Construction Manager / Environment Manager

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
Minimise noise, light and dust during construction	Implementation of CEMP measures for erosion and sediment control and noise. Temporary site lighting will be installed and operated in accordance with AS4282:1997 Control of the Obtrusive Effect of Outdoor Lighting (Standards Australia 1997).	Monitoring as per CEMP, however will not include monitoring for light impacts	Excessive amounts of dust and/ or noise	Implement control measures as outlined in CEMP.	Construction Manager / Environment Manger
Reinstate habitat for threatened flora and fauna	Progressive habitat restoration and revegetation in accordance with landscape specifications	Monthly inspection of revegetation works	Low survival rates of restored habitat areas and/or high incidence of weed species in revegetation areas.	Habitat suitability assessed and corrective improvement works commissioned as necessary.	Project Ecologist/ Construction Manager
Avoid introduction or spread of disease-causing agents that have the potential to impact on the environment and biodiversity	Apply management requirements in Guide 7: Pathogen management (RTA 2011) wherever pathogens are known or suspected to occur on or adjacent to the bypass, throughout construction and	Consideration the potential for pathogens on site or in the area should be given at an early stage (eg initial site inspection prior to commencement of works). There should be periodic monitoring for pathogens by a suitably qualified person, every	Management activities not being undertaken. New introduction of a disease-causing agent on or adjacent to the project and during maintenance works (eg laboratory analysis to confirm suspected plant	Review management actions, eg inclusion of best practice hygiene protocols from Guide 7. Increase monitoring period.	Project Ecologist/ Construction Manager

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
	during maintenance works.	month and in particular of revegetation works and interface of retained or adjacent vegetation.	pathogens observed during monitoring).		

7. Operational Management Measures

7.1 Potential impacts

- Direct mortality of threatened fauna from vehicle collisions
- Modification or further disturbance to habitats due to weeds, pests, disease-causing agents, edged effects, increased accessibility to people
- Habitat degradation as a result of altered hydrology.

7.2 Mitigation goals

- Maintain habitat revegetation effort and monitor restoration or enhancement works, until revegetated habitat structure and floristics is representative of target communities
- Maintain fauna exclusion fencing and connectivity structures for the life of the project, including monitoring to ensure crossing structures facilitate natural daily movements and minimise road kill
- Minimise impacts from pest animals on threatened fauna and their usage of crossing structures and contribute to regional pest control where exotic predators are found using connectivity structures
- Avoid introduction or spread of disease-causing agents that have the potential to impact on the environment and biodiversity
- Monitor activity of threatened fauna species present on site and the success of mitigation measures to avoid or minimise project impacts.
- Maintain stormwater quality devices and ensure water quality outputs are below target pollutant thresholds.

The following section outlines the monitoring programs to be undertaken during the operational phase of the project to achieve the mitigation goals.

7.3 Mitigation goals and corrective actions

The mitigation goals and associated corrective actions for threatened flora and fauna species to be implemented during the operation phase are summarised in **Table 17**.

Table 17: Mitigation goals and corrective actions – operation phase

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
Maintain habitat revegetation effort and monitor restoration or enhancement works, until revegetated habitat structure and floristics is on trajectory to re-establish to target vegetation community	Inspection, monitoring and maintenance of revegetated areas will be specified within the Roads and Maritime specifications including R178 and R179. Native vegetation should be re-established if/where practicable in accordance with Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011). Habitat may be replaced or re-instated in accordance with Guide 5: Re-use of woody debris and bushrock (RTA 2011). Habitat removal will be undertaken in accordance with Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and	For the first twelve months monitoring of revegetation will be quarterly. It will then go to every 6 months for years two and three. Monitoring will occur in spring/summer to evaluate the success of revegetation against performance objectives. A written report to be submitted to Roads and Maritime by contractor after each maintenance inspection.	Monitoring and maintenance activities not being undertaken. Performance measures outlined in Roads and Maritime specifications R178 and/or R179 not met.	Review maintenance schedule for revegetated areas within one month of trigger being identified and plant more feed and habitat trees as required. Undertake additional weed control Increase monitoring period as advised by landscape designer.	Construction Manager

Mitigation goals	Proposed mitigation measure	Monitoring/ timing frequency	Triggers for corrective actions	Corrective actions	Responsibility
	managing biodiversity on RTA projects (RTA 2011).				
Maintain fauna exclusion fencing and connectivity structures for the life of the project, to enable target fauna usage and minimise road kill	Maintenance of fauna connectivity structures as part of routine highway maintenance to remove debris and replace damaged furniture etc. Monitoring details are provided in Section 8 of this plan below.	Regular inspections as part of the Roads and Maritime routine highway maintenance program. Annual inspection are required targeting inspection of koala underpass structures prior to start of breeding season (July).	A single reported road kill of a threatened species.	A maintenance check is to be performed within 5 days of any reported road kill incident. Any fence or structure found to be damaged during a maintenance check is to be repaired. Review need for additional fauna fencing.	Roads and Maritime
Minimise impacts from pest animals on threatened fauna and their usage of crossing structures and contribute to regional pest control where exotic predators are found using connectivity structures	Engage in consultation with regional pest control agencies. Implement pest control program focused at crossing structures where deemed appropriate.	Monitoring for presence of pest animals at crossing structures will form part of fauna connectivity monitoring program described in Section 9.	High usage of crossing structures (>25% increase) by exotic predators reported after the first monitoring period and each subsequent monitoring period as per Section 9.3.	Meet with regional pest control stakeholders as soon as practical and contribute to pest control program where reasonable and feasible. Implement pest control program around crossing structures to reduce pest animal predation.	Roads and Maritime
Sediment and pollutant levels are within acceptable parameter limits during construction and post-construction within a month of the completion of construction.	Procedures for the maintenance and monitoring of sediments and pollutants during construction are to be incorporated into the Construction Erosion and Sediment Control Plan.				Environment Manager / Construction Manager

8. Monitoring Program

The purpose of the monitoring programs is to provide robust information in order to draw sound conclusions around the effectiveness of mitigation measures and inform further actions for adaptive management. The success of mitigation measures will be evaluated against performance indicators and the corrective management actions or contingency plans would be applied where poor performance or failing measures are detected.

The monitoring program methodologies may be subject to modification and refinement during the course of the program and would be dependent on the on-going results, access to monitoring sites or outcomes of corrective management actions or contingency plans.

8.1 Predator control

Objectives:

- Low activity or absence of pest animals within or in the vicinity of fauna connectivity structures during operation of the project.

Should monitoring of fauna connectivity structures demonstrate feral predators such as wild dogs, cats or foxes to be predating on threatened mammals or inhibiting mammal movement through the structures, Roads and Maritime would engage with DPIE and adjacent landowners to identify and implement strategies to reduce this predation risk. Monitoring results will be reviewed after each subsequent monitoring period to address predator and pest densities and identify areas in which regional scale programs can be implemented by the aforementioned parties.

8.2 Road mortality

Roadside surveys would be undertaken along the alignment to identify and record road kill where safe to do so and will be undertaken twice a year by qualified ecologists during the first three years following project completion. Further, surveys for incidental road kill information will be collected from Roads and Maritime road maintenance crews as part of meeting ongoing operational requirements of the highway network. Incidental road kill observations will allow further analysis of areas which fall outside of fenced sections of the carriageway and allow a review of the need to install further fencing or connectivity structures to mitigate fauna vehicular strike. Further, collation of road kill reports from local government authorities, and wildlife care organisations (such as WIRES) where available will be utilised in the monitoring program to aid in identifying any further sections of the road regularly attributable to threatened mammal road mortalities.

The GPS location of each road kill specimen would be recorded and assessed in relation to the closest fauna crossing structure to evaluate its effectiveness. The condition of the crossing structure and fauna exclusion fence in the vicinity of the road kill site would be investigated for any problems or breach and repairs, maintenance carried out as appropriate as described in Section 9.1 above.

8.2.1 Performance indicators and corrective actions

Performance indicators and corrective actions for road mortality are described in Table 18.

Performance of the connectivity structures in preventing threatened mammal road mortalities would be measured by achievement of a zero rate of vehicle strike for threatened species. Detection of small mammal road kill can sometimes be difficult, as most individual animals if struck are thrown far from the road by the collision, or damaged too extensively to be identified. Reliance on this method alone could result in an under-estimation of the number of individuals struck by vehicles.

Table 18: Performance indicators and corrective actions – road mortality

Triggers for corrective actions	Corrective actions	Responsibility
A single reported road kill of a target threatened mammal species.	• Check fauna exclusion fencing in proximity to road kill for any damage. Any fencing found to be damaged is to be repaired. Initiate repair works as soon as possible. • If road kill is found in an area with no fauna exclusion fencing evaluate the need for additional fencing. • If the road kill is found in proximity to a crossing structure check connectivity structure for damage. Any structure found to be damaged during a maintenance check is to be repaired. Initiate repair works as soon as possible. • Review habitat adjoining the structure. Consider improving habitat condition and connectivity. • Re-evaluate mitigation measures if target threatened mammals if road mortality to threatened mammal species is observed over three monitoring periods. • Consider additional mitigation measures. After a minimum of three consecutive monitoring periods Roads and Maritime will evaluate if there is a residual impact to connectivity.	Roads and Maritime

8.3 Artificial microbat roosting sites and nest boxes

Objective:

- Artificial habitats in good condition, free from pests and used by target species.

8.3.1 Timing and methods

Inspections should occur 18 months after installation of nest boxes or completion of structure allowing for microbat usage and checked again in the fourth year and review need for further monitoring as outlined in Guide 8: Nest Boxes of the Biodiversity Guidelines (RTA 2011). Monitoring will coincide with nesting seasons for target species. Nest box monitoring should ideally occur during late spring.

Maintenance inspections will be in conjunction with monitoring events.

The Project Ecologist would physically inspect the nest box or artificial roost site, and record the following as a minimum where possible:

- Identification code of the nest box or roosting site:
- Evidence of microbats (guano and/or staining)
- Number of microbats present
- Identification of species
- Indications of breeding activity

- Occurrence of any pest species such as common mynas, common starling and European bees
- Condition of the nest box (eg. any deterioration, holding of water, excess nesting material) if applicable
- Date and time of inspection
- Roost features present
- Record of rainfall during monitoring period.

Annual monitoring/inspection results of the information above would be provided to Roads and Maritime.

8.3.2 Performance indicators and corrective actions

Performance indicators and corrective actions for artificial habitat monitoring are described in **Table 19**.

Table 19: Performance indicators and corrective actions – artificial roost sites and nest boxes

Triggers for corrective actions	Corrective actions	Responsibility
• Monitoring surveys undertaken identify no evidence of use of nest boxes by target species after three consecutive monitoring periods • Monitoring surveys undertaken identify no evidence of use of artificial roost sites by target species within two years after installation • Fallen, damaged or degraded nest boxes and artificial roosting sites (including holding or leaking of water) • Excess nesting material which may impede access over time • High levels of structure usage (>25%) by exotic pest species such as common mynas, common starling and European bees.	• Upgrade maintenance schedule and/or box design if boxes are continually being found to be damaged. • Nest boxes and artificial roosting sites found to be fallen, degraded or damaged during a maintenance check is to be repaired. Initiate repair works within 5 days of identification. • Excess nesting material to be removed within 5 days of identification. • Re-evaluate nest box strategy if these structures are not used by target species or are used by pest species and identify adaptive management action, e.g. repositioning, relocation, replacement, assessment of whether the microclimatic conditions within the artificial roosting sites and nest boxes are suitable for inhabitation by the target species. • If a nest box needs to be removed from the site for repair, then an alternative nest box should be installed in the same location upon removal of the damaged nest box. Following fourth year monitoring period review the need for further monitoring as outlined in the Guide 8: Nest Boxes of the Biodiversity Guidelines (RTA 2011).	Environment Manager / Construction Manager – during construction Roads and Maritime – during operation

8.4 Water quality monitoring

Objective:

- Ground and surface water levels and quality within acceptable parameter limits during construction and post-construction.

8.4.1 Timing and methods

Surface and groundwater quality monitoring will be undertaken to evaluate the performance of water management measures and to determine, if any, corrective actions may be required should water levels/ target parameters vary beyond natural variation. Procedures for monitoring of identified locations are to be incorporated into the project's water quality monitoring program.

Environmental management measures to address surface and groundwater impacts are contained in the EIS - **Chapter 19, Surface water quality** and **Chapter 20, Groundwater** respectively.

There are also interactions between the mitigation measures in **Chapter 10, Biodiversity**, **Chapter 17, Flooding and hydrology** and **Chapter 18, Soils and contamination**. These measures have been developed so that appropriate management of surface and ground water would minimise the potential for impacts to the community and environment.

The environmental management measures will be supported by water quality monitoring pre-construction, during construction on a monthly basis with daily visual inspections, and a post-construction assessment within a month of the completion of construction.

Refer to Figure 6 for the indicative baseline water quality monitoring sites (to be reviewed prior to construction).

Locations for the pre-construction and during construction monthly monitoring should include upstream and downstream sites of the project boundary on:

- Pine Brush Creek
- Jordans Creek
- Treefern Creek
- Coffs Creek
- Newports Creek.

In addition to these main waterways, during construction phase, immediate disturbance to any waterway should be visually monitored with support of in situ measurements to monitor for major exceedances according to the Soil and Water Management Plan and site-specific Erosion and Sediment Control Plans (Table 20).

Table 20: Monthly surface water monitoring assessment data

Assessment Criteria	Parameter
Visual inspections	Water colour
	Clarity
	Surface film, slick, and/or scum
	Flow rate seconds/metre
Physical	Temperature (ºC)

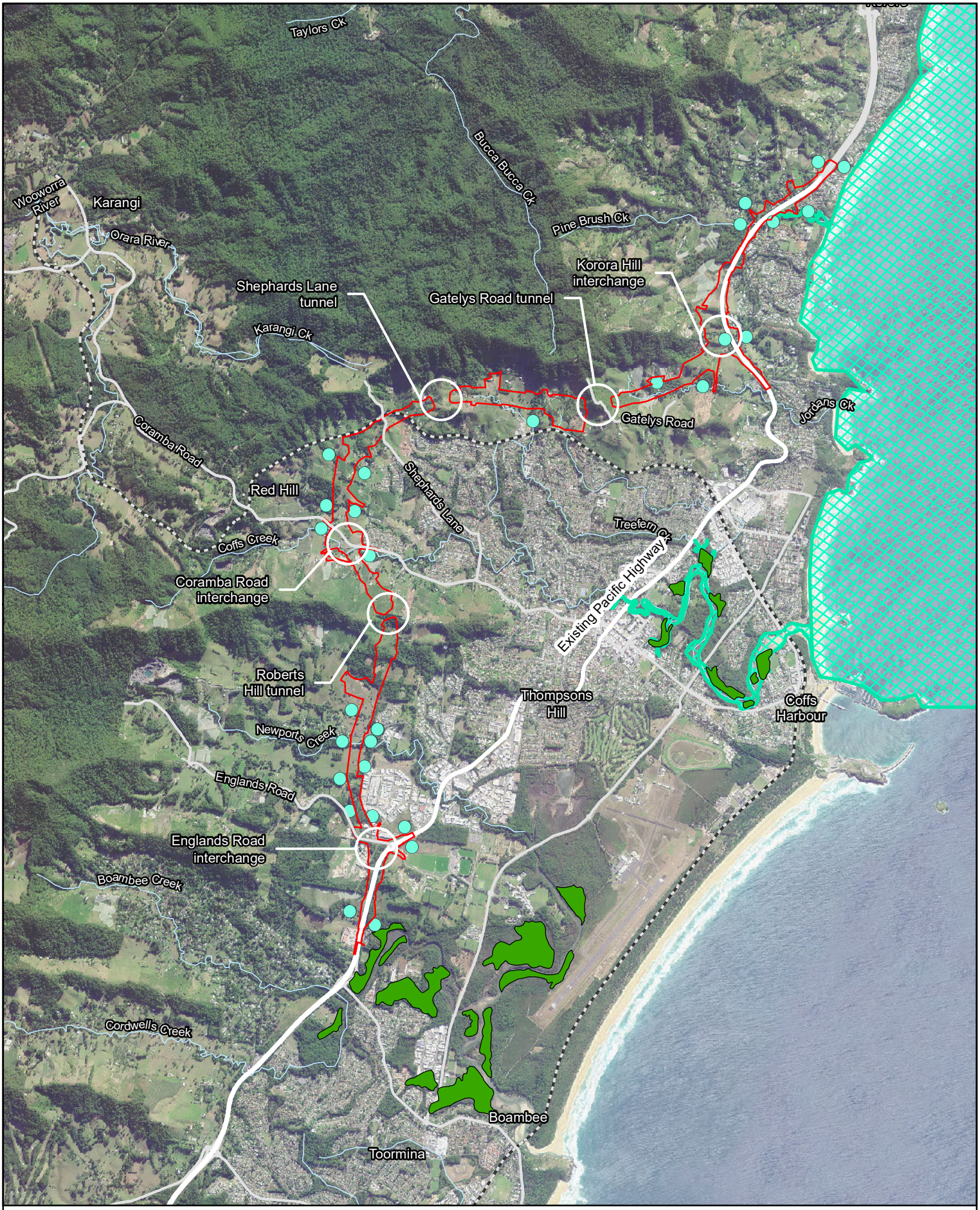
Assessment Criteria	Parameter
	pH
	Dissolved oxygen (% saturation and mg/L)
	Turbidity (NTU)
	Electro conductivity (uS/cm)
Laboratory analysis	Total Suspended Solids (mg/L)
	Total phosphorus
	Total nitrogen

8.4.2 Performance indicators and corrective actions

Performance indicators and corrective actions for ground and surface water monitoring are described in Table 21.

Table 21: Performance indicators and corrective actions – ground and surface water monitoring

Triggers for corrective actions	Corrective actions	Responsible party
• Sediment and pollutant levels are outside acceptable parameter limits • Ground and surface water levels outside of expected range • Control devices found to be unsuitable	• Review of rainfall data and inspection of erosion and sediment control measures within the vicinity. Correct measures where necessary. • Review and increase monitoring frequency. • Control devices/ measures inspected for suitability and corrected/ reinstated where necessary. • Incident, eg oil spill, reported to Roads and Maritime. • Relevant agencies notified and environmental impacts assessed. • Undertake remedial action on the machinery or process responsible, eg in response to oil or fuel spills full inspection and necessary repairs/corrective action to be undertaken on the machinery or process responsible prior to operation re-commencing.	Roads and Maritime / Construction Manager / Environment Manager



Legend

- Construction footprint
- North Coast Railway
- Watercourse
- Indicative Surface Water Quality Sampling Locations
- NSW Coastal Management SEPP wetlands
- Solitary Islands Marine Park (NSW)

Coffs Harbour Bypass
Recommended surface water quality sampling locations
Figure 6

0 0.5 1 1.5 km

Scale @A4: 1:60,000
GDA 1994 MGA Zone 56

N

8.5 Evaluation, project review and reporting

Detailed threatened species reports will be prepared outlining the results of any monitoring undertaken pertaining to the project.

Annual reports would be prepared outlining the results of the targeted surveys and monitoring undertaken pertaining to the project. This may include a separate monitoring report per target species or a combined report for one or more species. A brief annual report would be prepared by the contractor(s) for distribution to the Roads and Maritime and other relevant government agencies for threatened species.

The contractor(s) employed to undertake the monitoring would be responsible for the evaluation of the monitoring information collected against performance thresholds.

A final report would be prepared at the conclusion of the monitoring period. This report would incorporate all the results of the monitoring and recommend any additional measures (if deemed necessary) to facilitate the long-term survival of the target threatened mammal population in the locality.

An overall summary of the actions proposed in the above plan is provided in **Table 22**. It also identifies the person responsible for the actions and the estimated timing of the project.

Table 22: Summary table and implementation schedule of management plan

No.	Task.	Responsibility	Pre-Construction	During Construction	Post-Construction	Post-Construction (Seasonal)																			
						Year 1				Year 2				Year 3				Year 4				Year 5			
						Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
Pre-Construction Management																									
	Identify exclusion zones																								
	Finalise design of fauna fencing and connectivity structures																								
	Salvage and re-establish threatened flora																								
Construction Management																									
	Implement work method statements																								
	Induction and training																								
	Fauna rehabilitation protocol																								
	Pre-clearing surveys																								
	Finalise and implement clearing procedures																								
	Installation of permanent fauna fencing																								
	Installation of permanent fauna connectivity structures																								
	Habitat restoration and landscaping																								
	Hydrology and water quality measures				6 months																				
	Inspections for introduction or spread of disease-causing agents	Roads and Maritime																							
Operational Management																									
	Continued habitat revegetation effort and monitoring of revegetated habitat areas (until objective is achieved)	Contractor																							
	Road mortality monitoring	Roads and Maritime																							

No.	Task.	Responsibility	Pre-Construction	During Construction	Post-Construction	Post-Construction (Seasonal)																			
						Year 1				Year 2				Year 3				Year 4				Year 5			
						Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
	Predation control monitoring	Roads and Maritime																							
	Maintenance and monitoring of nest boxes installed	Roads and Maritime																							
	Water quality monitoring	Roads and Maritime																							
Evaluation and Reporting prepared annually for monitoring and correcting actions implemented																									
	Evaluation and reporting yearly	Roads and Maritime																							

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