

A photograph of a possum climbing a tree trunk, positioned on the left side of the cover. The possum is grey with a white stripe on its face and is reaching up with its front paws. The tree bark is rough and textured.

Travers

bushfire & ecology

Biodiversity Development Assessment Report

(Wyong Hospital Redevelopment
State Significant Development
Application No. 9536)

664 Pacific Highway
HAMLYN TERRACE

May 2019
(REF: 18COLL02F)



Biodiversity Development Assessment Report

(State Significant Development Assessment)

**664 Pacific Highway
Hamlyn Terrace**

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Executive Summary

Travers bushfire & ecology has been engaged to undertake a biodiversity development assessment for the proposed asset protection zone (APZ) surrounding a proposed new emergency department, and associated hospital facilities, at Wyong Hospital, located at Lot 1 DP1147734 664 Pacific Highway, Hamlyn Terrace.

Development proposal

The proposal is a listed State Significant Development Application (SSDA) No. 9536 and therefore, in accordance with the *BC Act*, a Biodiversity Development Assessment Report (BDAR) is required.

Approval is sought for the redevelopment of Wyong Hospital comprising the construction of a new CSB, and associated works as follows:

- A 6 storey Clinical Services building (1 storey undercroft parking, 1 storey podium, 4 storey tower), including:
 - o Undercroft parking and plant (Level 1)
 - o Podium;
 - Level 2 comprises Emergency Department (ED), ED drop off, ambulance parking, medical imaging, Psychiatric Emergency Centre (PECC), and a public link to existing building (Block A);
 - o Tower;
 - Level 3 comprises Intensive Care Unit (ICU), Paediatrics, and a clinical link to existing building (Block A);
 - Level 4 comprises of In Patient Units (IPU);
 - Level 5 comprises of shell Inpatient Unit and Acute Medical Unit;
 - Level 6 is plant;
- Minor alterations and additions to existing Block A;
- Formalisation of east-west road connection to Louisiana Road; and
- Associated works including landscaping, earthworks, and servicing upgrades.

Recorded biodiversity

The south-western portion of this lot has been subject to detailed survey effort and will hereafter be referred to as the 'study area'. In some circumstances survey has however extended slightly beyond this boundary.

The proposed development is restricted to the proposed new building plus the associated asset protect zones (APZ's) and will hereafter be referred to as the 'subject site'.

Ecological survey and assessment has been undertaken in accordance with relevant legislation including the *Environmental Planning and Assessment Act 1979 (EP&A Act)*, the *Biodiversity Conservation Act 2016 (BC Act)*, the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* and the *Fisheries Management Act 1994 (FM Act)*.

In respect of matters required to be considered under the *EP&A Act* and relating to the species / provisions of the *BC Act*, four (4) state listed threatened fauna species including East-coast freetail Bat (*Micronomus norfolkensis*), Eastern Bentwing-bat (*Miniopterus orianae oceanensis*), Little Bentwing-bat (*Miniopterus australis*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*), two (2) threatened flora species including *Eucalyptus camfieldii*

and *Tetratheca juncea*, and one (1) threatened ecological community (TEC) Swamp Oak Floodplain Forest were recorded within the study area.

An additional five (5) state listed threatened fauna species were recorded by *Abel Ecology* in 2017 over the Wyong Hospital site including White-bellied Sea Eagle (*Haliaeetus leucogaster*), Powerful Owl (*Ninox strenua*), Scarlet Robin (*Petroica multicolor*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and Large-footed Myotis (*Myotis macropus*). Scarlet Robin may have been confused with a non-threatened species as it was not recognised as threatened and was not assessed.

In respect of matters required to be considered under the EPBC Act, no threatened fauna species, no protected migratory bird species, one (1) threatened flora species and no TECs listed under this Act were recorded within the study area.

One (1) additional nationally threatened fauna species Grey-headed Flying-fox (*Pteropus poliocephalus*) was recorded by *Abel Ecology* in 2017.

In respect of matters relative to the FM Act, no suitable habitat for threatened marine or aquatic species was observed within the subject site.

Impact assessment

The direct, indirect and cumulative impacts of the proposal have been carefully considered in Section 5.1 of this report. Measures proposed to avoid/minimise/offset the impacts are outlined in Section 5.2.

The assessment of significance test in accordance with Section 7.3 of the *BC Act* does not need to be applied for state significant projects. State listed threatened species recorded during surveys are however considered in Appendix 3.

The principles for determining serious and irreversible impacts are set out under Section 6.7.2 of the *BC Reg 2017*. These principles have been reviewed and it is considered that the proposal will not cause any serious and irreversible impacts on threatened biodiversity.

There will be no significant impact on matters listed under the *FM Act*.

The proposed development was not considered to have a significant impact on matters of national environmental significance. As such a referral to Department of Environment and Energy should not be required.

Biodiversity Offsets Scheme (BOS) – Threshold Assessment

Section 7.14 (State significant development or infrastructure), clause 4, of the *BC Act* states:

“A condition to retire biodiversity credits is required to be complied with before any development is carried out that would impact on biodiversity values.”

The proposed development is a state significant development that impacts on biodiversity values. Under Section 7.14 of the *BC Act*, state significant developments are required to enter the Biodiversity Offsets Scheme (BOS). Therefore biodiversity offsets are required under the BOS.

Biodiversity impacts

The potential direct biodiversity impacts of the proposed development include:

- Removal/modification 0.106 ha of PCT 1728 / TEC vegetation (SOFF)
- Removal/modification 0.686 ha of PCT 1636 / quality non-TEC vegetation
- Up to 0.793 ha loss of vegetated habitat for threatened species
- Subsequent removal of threatened fauna species foraging habitat

The following actions and designing of works have been undertaken to either avoid or minimise impacts on biodiversity values:

- APZs have been designed to the minimum standard for a special fire protection purpose development
- Proposed buildings has been sited to take advantage of the existing disturbed zones of the carpark
- Fencing to exclude general access to quality areas of native vegetation
- Limit vegetation removal in APZ and selective vegetation retention (eg. Hollows & foraging trees)
- Integrated weed management and control of high threat exotics
- Monitoring for evidence of disease
- Adaptive management

BAM Calculator results

The BAM Calculator provides a means of objectively determining the loss of biodiversity values as a result of a proposed development. The 'credits' generated (Table A & B) are the amount of credits required to be 'transferred' (purchased and retired) to allow the proposed subdivision to proceed.

The estimated cost of the credits (Table C and D) are estimated by the BAM - Calculator.

Table A – Requirement for ecosystem credits

Zone	Veg. zone name	Veg. integrity loss	Area (ha)	Candidate SAI	Ecosystem credits
1	1636_Mod-Good	37.5	0.7	False	11
2	1728_Mod-Good	17.6	0.1	True	1
					Total: 12

Table B – Requirement for species credits

Veg. zone name	Veg. integrity loss	Area (ha)	Candidate SAI	Ecosystem credits
<i>Cryptostylis hunteriana</i>				
1636_Mod-Good	37.5	0.7	False	13
				Subtotal: 13
<i>Eucalyptus camfieldii</i>				
1636_Mod-Good	37.5	0.7	False	13
				Subtotal: 13
<i>Persicaria elatior</i>				
1728_Mod-good	17.6	0.1	False	1

				Subtotal: 1
Large-eared Pied Bat				
1636_Mod-Good	37.5	0.7	False	19
1728_Mod-Good	17.6	0.1	False	1
				Subtotal: 20
Southern Myotis				
1636_Mod-Good	37.5	0.7	False	13
1728_Mod-Good	17.6	0.1	False	1
				Subtotal: 14

Table C – Ecosystem credit costs

PCT common name	Price per credit	No. of ecosystem credits	Final credits price
1636 - Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast Note: This PCT has trades recorded	\$4,123.72	11	\$45,360.96
1728 - Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast Note: This PCT has no trades recorded	\$12,396.33	1	\$12,396.33
Subtotal (excl. GST)			\$57,757.29
GST			\$5,775.73
Total ecosystem credits (incl. GST)			\$63,533.02

Table D – Species credit costs

Species	Threat status	Price per credit	No. of species credits	Final credits price
<i>Cryptostylis hunteriana</i>	Vulnerable	\$150.00	13	\$2,599.80
<i>Eucalyptus camfieldii</i>	Vulnerable	\$173.02	13	\$2,958.89
<i>Persicaria elatior</i>	Vulnerable	\$150.00	1	\$199.98
Large-eared Pied Bat	Vulnerable	\$725.00	20	\$17,798.55
Southern Myotis	Vulnerable	\$725.00	14	\$12,458.98
Subtotal (excl. GST)				\$36,016.20
GST				\$3,601.62
Total species credits (incl. GST)				\$39,617.82

The above prices generated by the BAM-C calculator should be used as a guide only and confirmation will be required when purchasing potential credits.

List of abbreviations

APZ	asset protection zone
BAM	Biodiversity Assessment Method
BAR	Biodiversity Assessment Report
BC Act	<i>Biodiversity Conservation Act (2016)</i>
BC Reg	<i>Biodiversity Conservation Regulation (2017)</i>
BCAR	Biodiversity Certification Assessment Report
BDAR	Biodiversity Development Assessment Report
BOS	Biodiversity Offset Scheme
BPA	bushfire protection assessment
BSSAR	Biodiversity Stewardship Site Assessment Report
CEEC	Critically endangered ecological community
DCP	development control plan
DEC	NSW Department of Environment and Conservation (superseded by DECC from April 2007)
DECC	NSW Department of Environment and Climate Change (superseded by DECCW from October 2009)
DECCW	NSW Department of Environment, Climate Change and Water (superseded by OEH from April 2011)
DEWHA	Commonwealth Department of Environment, Water, Heritage & the Arts (superseded by SEWPAC)
DOEE	Commonwealth Department of Environment & Energy
EEC	endangered ecological community
EPA	Environmental Protection Agency
EP&A Act	<i>Environmental Planning and Assessment Act (1979)</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act (1999)</i>
FM Act	<i>Fisheries Management Act</i>
IBRA	Interim Biogeographic Regionalisation for Australia
LEP	local environmental plan
LGA	local government area
LLS Act	<i>Local Land Services Act (2013)</i>
NES	national environmental significance
NPW Act	<i>National Parks and Wildlife Act (1974)</i>
NSW DPI	NSW Department of Industry and Investment
OEH	Office of Environment and Heritage
PCT	plant community type
RFS	NSW Rural Fire Service
SAII	Serious And Irreversible Impacts
SEPP	State Environmental Planning Policy
SEWPAC	Commonwealth Dept. of Sustainability, Environment, Water, Population & Communities (superseded by DOEE)
SIS	species impact statement
TEC	threatened ecological community
TSC Act	<i>Threatened Species Conservation Act (1995) – Superseded by the Biodiversity Conservation Act (2016)</i>
VMP	vegetation management plan

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Introduction

1

Travers bushfire & ecology has been engaged to undertake a biodiversity development assessment for the proposed state significant development at Wyong Hospital. The proposal includes the construction of a new Clinical Services Building, including emergency department, intensive care unit, medical imaging, acute medical unit and paediatric assessment unit. A bridge link to connect the new building to the existing hospital and refurbishment of parts of the existing hospital building and areas to realign services roles is also proposed. The construction works will occur on Lot 1 DP1147734 664 Pacific Highway, Hamlyn Terrace.

The APZ area over existing vegetation is the area causing direct impacts on biodiversity and will hereafter be referred to as the 'subject site'. The south-western portion of this lot beyond the subject site has been subject to detailed survey effort and will hereafter be referred to as the 'study area'. In some circumstances survey has however extended slightly beyond this boundary (see Figures 1.1 & 1.2).

Previous surveys have been undertaken for other recent developments within the hospital grounds of Lot 1 by *RPS* (2014) and *Abel Ecology* (2017). These results have been incorporated and considered in this report.

1.1 Purpose

The purpose of this Biodiversity Development Assessment Report (BDAR) are to:

- Carry out a botanical survey in accordance with the Biodiversity Assessment Method (2017) to describe the vegetation communities and their conditions
- Carry out a fauna habitat survey for the detection and assessment of fauna and their potential habitats
- Carry out targeted surveys for threatened species, populations and ecological communities
- Prepare a Biodiversity Development Assessment Report (BDAR) in accordance with the Biodiversity Assessment Methodology (BAM) for a state significant project.
- Prepare a biodiversity impact assessment in accordance with the requirements of the:
 - a) *Biodiversity Conservation Act 2016 (BC Act)*,
 - b) *Biodiversity Conservation Regulation 2017 (BCR)*,
 - c) *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, and
 - d) *Fisheries Management Act 1994 (FM Act)*.

1.1.1 Certification of BAM compliance

Section 6.15 of the *BC Act* regarding the currency of a BDAR requires:

- (1) A biodiversity assessment report cannot be submitted in connection with a relevant application unless the accredited person certifies in the report that the report has been prepared on the basis of the requirements of (and information provided under) the biodiversity assessment method as at a specified date and that date is within 14 days of the date the report is so submitted.*
- (2) A relevant application is an application for planning approval, for vegetation clearing approval, for biodiversity certification or in respect of a biodiversity stewardship agreement.*

The accredited person for this BDAR, Mr. Lindsay Holmes (BAAS 17032), certifies here that the report has been prepared on the basis of the requirements of (and information provided under) the BAM as at 7 May 2019, and that date is within 14 days of the date the report is so submitted.

1.1.2 Terminology

Throughout this report the terms subject site and study area are used. It is important to have a thorough understanding of these terms as they apply to the assessment.

Subject site means the area directly affected by the proposal.

Study area means the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area should extend as far as is necessary to take all potential impacts into account.

Direct impacts are those that directly affect the habitat and individuals. They include, but are not limited to, death through predation, trampling, poisoning of the animal/plant itself and the removal of suitable habitat. When applying each factor, consideration must be given to all of the likely direct impacts of the proposed activity or development.

Indirect impacts occur when project-related activities affect species, populations or ecological communities in a manner other than direct loss. Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas. As with direct impacts, consideration must be given, when applying each factor, to all of the likely indirect impacts of the proposed activity or development.

1.2 Site description

1.2.1 Site overview

Table 1.1 provides an overview the planning, cadastral and topographical details of the study area and an overview of the site and surrounds is shown on Figure 1.3.

Table 1.1 – Site features

Location	664 Pacific Highway, Hamlyn Terrace
Location description	The site is situated between the Pacific Hwy and Louisiana Road with a main access of the Pacific Hwy and current construction access of Louisiana Road. Entry off the Pacific Hwy is just over 7km drive north-east of Wyong.
Area	Approx. 20.09ha
Local government area	Central Coast
Zoning	SP2 Infrastructure
Grid reference MGA-56	358216E 6318715N
Elevation	Approx. 11–17m AHD
Topography	Situated on a lower slope of 0–4% with a SSW aspect.
Catchment and drainage	Catchment – Tuggerah Lake Overland flow into unnamed stream flowing north-west, then ultimately into Wyong River and Tuggerah Lake.
Existing land use	Hospital

1.2.2 Landscape features

Table 1.2 examines the landscape features of the proposed development site in accordance with the BAM.

Table 1.2 – Landscape features

Operational footprint	As shown in Figure 1.2
Construction footprint	As shown in Figure 1.2
IBRA bioregions and subregions	Sydney Basin bioregion – Wyong subregion (Figures 1.5 and 1.6).
NSW landscape region and area (ha)	Wyong; Gosford - Cooranbong Coastal Slopes.
Native vegetation extent in the buffer area	241.16ha approx. and 23%.
Cleared areas	The majority of the study area has been previously cleared for indicated land uses, but there are areas of remnant vegetation in the south east of the study area.
Evidence to support differences between mapped vegetation extent and aerial imagery	Ground-truthed vegetation closely matches aerial imagery. Interpretation of ‘native vegetation’ as per the <i>Local Land Services Act 2013 (LS Act)</i> and <i>Biodiversity Conservation Act 2016 (BC Act)</i> definition.
Rivers and streams classified according to stream order	The site map (Figure 3) shows the study area relative to streams, and stream order.
Wetlands within, adjacent to and downstream of the site	There are several dams and detention basins across the site, shown on the site map (Figure 3).
Connectivity features	There is very good connectivity to the south and west of the subject site to a larger area of vegetation of approx. 7ha. This larger patch, however, isolated by Louisiana Rd to the west, and by the Pacific Highway and urban / cleared land to the south. The site map (Figure 3) shows an overview of the extent of native vegetation in the locality.

Areas of geological significance and soil hazard features	Geology; Narrabeen group, Tuggerah Formation, grey to green–grey laminate, red–brown claystone and siltstone, interbedded with fine- to medium-grained green–grey sandstone; Quaternary quartz sand, muddy sand, silt and mud. Soils; - Gorokan and Wyong soil landscapes.
Identification of method applied (i.e. linear or site-based)	Site based assessment.

1.3 Proposed development

Approval is sought for the redevelopment of Wyong Hospital comprising the construction of a new CSB, and associated works as follows:

- A 6 storey Clinical Services building (1 storey undercroft parking, 1 storey podium, 4 storey tower), including:
 - o Undercroft parking and plant (Level 1)
 - o Podium;
 - Level 2 comprises Emergency Department (ED), ED drop off, ambulance parking, medical imaging, Psychiatric Emergency Centre (PECC), and a public link to existing building (Block A);
 - o Tower;
 - Level 3 comprises Intensive Care Unit (ICU), Paediatrics, and a clinical link to existing building (Block A);
 - Level 4 comprises of In Patient Units (IPU);
 - Level 5 comprises of shell Inpatient Unit and Acute Medical Unit;
 - Level 6 is plant;
- Minor alterations and additions to existing Block A;
- Formalisation of east-west road connection to Louisiana Road; and
- Associated works including landscaping, earthworks, and servicing upgrades.

Clearing of the building footprint has been undertaken as approved for an open carpark. As the proposed facility is an occupied dwelling for special purposes, with remnant bushland generally to the south, APZs are required. The APZ's will impact on existing vegetated areas to the south and west which will require additional clearing and maintenance in accordance with a separate Bushfire Protection Assessment Report (*Travers bushfire & ecology* 2018). A fire trail is proposed within the APZ.

The proposed development is considered critical state significant infrastructure (CSSI). As a result the NSW Department of Planning and Environment (DPE) is responsible for assessing the development application with the Minister for Planning being the consent authority.

1.4 Secretary's Environmental Assessment Requirements (SEARs)

Item 16 of the SEARs identifies the requirements of the biodiversity assessment. Item 16 specifically states the following requirements for SSD 9536):

- Biodiversity impacts related to the proposed development (SSD 9536) are to be assessed in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method.

- The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method.
- The BDAR must include details of the measures proposed to address the offset obligation as follows;
 - o the total number and classes of biodiversity credits required to be retired for the development/project.
 - o the number and classes of like-for-like biodiversity credits proposed to be retired.
 - o the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules.
 - o any proposal to fund a biodiversity conservation action.
 - o any proposal to conduct ecological rehabilitation.
 - o any proposal to make a payment to the Biodiversity Conservation Fund.
- If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.
- The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the *Biodiversity Conservation Act 2016*.
- Where a Biodiversity Assessment Report is not required, engage a suitably qualified person to assess and document the flora and fauna impacts related to the proposal.

Note: Notwithstanding these requirements, the Biodiversity Conservation Act 2016 requires that State Significant Development Applications be accompanied by a Biodiversity Development Assessment Report unless otherwise specified under the Act.

1.5 Statutory assessment requirements

1.5.1 Environmental Planning and Assessment Act 1979 (EP&A Act)

Prior to any development taking place in New South Wales a formal assessment needs to be made of the proposed work to ensure it complies with relevant planning controls and, according to its nature and scale, confirm that it is environmentally and socially sustainable. State, regional and local planning legislation indicates the level of assessment required, and outlines who is responsible for assessing the development. The development assessment and consent system is outlined in Part 4 and the infrastructure and environmental impact assessment system is outlined in Part 5 of the *EP&A Act*.

Section 7.14 (BC Act) state significant development or infrastructure states:

- (1) This section applies to an application for development consent for State significant development under Part 4, or an application for approval for State significant infrastructure under Part 5.1, that is required under Division 2 to be accompanied by a biodiversity development assessment report.
- (2) The Minister for Planning, when determining in accordance with the EPA Act any such application, is to take into consideration under that Act the likely impact of the proposed development on biodiversity values as assessed in the biodiversity development assessment report. The Minister for Planning may (but is not required to) further consider under that Act the likely impact of the proposed development on biodiversity values.
- (3) If the Minister for Planning decides to grant consent or approval and the biodiversity offsets scheme applies to the proposed development, the conditions of the consent or approval may require the applicant to retire biodiversity credits to offset the

residual impact on biodiversity values (whether of the number and class specified in the report or other number and class). The residual impact is the impact after the measures that are required to be carried out by the terms or conditions of the consent or approval to avoid or minimise the impact on biodiversity values of the proposed development.

- (4) A condition to retire biodiversity credits is required to be complied with before any development is carried out that would impact on biodiversity values. If the retirement of particular biodiversity credits applies to a stage of the development, compliance with the condition for their retirement is postponed until it is proposed to carry out that stage of the development.
- (5) This section does not operate to limit the matters that the Minister for Planning may take into consideration in relation to the impact of proposed development on biodiversity values, the measures that the Minister may require to avoid or minimise those impacts or the power of the Minister to refuse to grant consent or approval because of those impacts.

1.5.2 Biodiversity Conservation Act 2016 (BC Act)

The *BC Act* repeals the *Threatened Species Conservation Act 1995*, the *Nature Conservation Trust Act 2001* and the animal and plant provisions of the *National Parks and Wildlife Act 1974*.

The *BC Act* and the *Biodiversity Conservation Regulation 2017* establishes a regulatory framework for assessing and offsetting impacts on biodiversity values due to proposed developments and clearing. It establishes a framework to avoid, minimise and offset impacts on biodiversity from development through the Biodiversity Offsets Scheme. Where development consent is granted, the authority may impose as a condition of consent an obligation to retire a number and type of biodiversity credits determined under the new Biodiversity Assessment Method (BAM).

Section 7.14 (State significant development or infrastructure), Point 4, of the *BC Act* states:

“A condition to retire biodiversity credits is required to be complied with before any development is carried out that would impact on biodiversity values.”

Under Section 7.14 of the *BC Act*, state significant developments are required to enter the Biodiversity Offsets Scheme (BOS). The BOS includes two (2) elements to the threshold test – an area trigger and a Sensitive Biodiversity Values Land Map trigger. If clearing exceeds either trigger, the Biodiversity Offset Scheme applies to the proposed clearing.

Development that is subject to the BAM includes development requiring consent under Part 4 of the *Environmental Planning and Assessment Act 1979 (EP&A Act)* (excluding complying development) and State Significant Development and State Significant Infrastructure. Some types of development are deemed to have State significance due to the size, economic value or potential impacts. A proposal for any of the identified development types is SSD if it is either 1) is over a certain size, 2) is located in a sensitive environmental area, and/or 3) will exceed a specific capital investment. Major Projects that are State Significant Development (SSD) or State Significant Infrastructure (SSI) will usually need to assess impacts and to offset these. SSD applications are assessed by the Department of Planning and Environment.

1.5.3 Fisheries Management Act 1994 (FM Act)

The *FM Act* provides a list of threatened aquatic species that require consideration when addressing the potential impacts of a proposed development. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, an SIS is required to be prepared.

1.5.4 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The *EPBC Act* requires that Commonwealth approval be obtained for certain actions. It provides an assessment and approvals system for actions that have a significant impact on matters of *national environmental significance* (NES). These may include:

- World Heritage Properties and National Heritage Places
- Wetlands of International Importance protected by international treaty
- Nationally listed threatened species and ecological communities
- Nationally listed migratory species
- Commonwealth marine environment

Actions are projects, developments, undertakings, activities, and series of activities or alteration of any of these. An action that needs Commonwealth approval is known as a controlled action. A controlled action needs approval where the Commonwealth decides the action would have a significant effect on an NES matter.

Where a proposed activity is located in an area identified to be of NES, or such that it is likely to significantly affect threatened species, ecological communities, migratory species or their habitats, then the matter needs to be referred to the Commonwealth Department of Environment and Energy (DOEE) for assessment. In the case where no listed federal species are located on site then no referral is required. The onus is on the proponent to make the application and not the Council to make any referral.

A threshold criterion apply to specific NES matters which may determine whether a referral is or is not required, such as for the *EPBC Act* listed ecological communities Cumberland Plain Woodland and Shale-Gravel transition Forest. Consultation with DOEE may be required to determine whether a referral is or is not required. If there is any doubt as to the significance of impact or whether a referral is required, a referral is generally recommended to provide a definite decision under the *EPBC Act* 1999 thereby removing any further obligations in the case of 'not controlled' actions.

A significant impact is regarded as being:

important, notable, or of consequence, having regard to its context or intensity and depends upon the sensitivity, value, and quality of the environment which is impacted and upon the duration, magnitude, and geographical extent of the impacts. A significant impact is likely when it is a real or not a remote chance or possibility.

Source: EPBC Policy Statement

Guidelines on the correct interpretation of the actions and assessment of significance are located on the department's web site <http://www.environment.gov.au/epbc/publications>.

1.5.5 Coastal Management Act 2016 (CM Act)

The *Coastal Management Act* (CM Act, 2016) establishes the framework and overarching objects for coastal management in New South Wales. The Act commenced on 29 June 2018 and replaces the previous *Coastal Protection Act* (1979).

The purpose of the CM Act is to manage the use and development of the coastal environment in an ecologically sustainable way, for the social, cultural and economic well-being of the people of New South Wales.

The CM Act also supports the aims of the *Marine Estate Management Act 2014*, as the coastal zone forms part of the marine estate.

The CM Act defines the coastal zone, comprising four (4) coastal management areas:

1. coastal wetlands and littoral rainforests area; areas which display the characteristics of coastal wetlands or littoral rainforests that were previously protected by SEPP 14 and SEPP 26
2. coastal vulnerability area; areas subject to coastal hazards such as coastal erosion and tidal inundation
3. coastal environment area; areas that are characterised by natural coastal features such as beaches, rock platforms, coastal lakes and lagoons and undeveloped headlands. Marine and estuarine waters are also included
4. coastal use area; land adjacent to coastal waters, estuaries and coastal lakes and lagoons.

The CM Act establishes management objectives specific to each of these management areas, reflecting their different values to coastal communities.

1.5.6 Licences

Individual staff members of *Travers bushfire & ecology* are licensed under Clause 20 of the *National Parks and Wildlife (Land Management) Regulation 1995* and Sections 120 & 131 of the *National Parks and Wildlife Act 1974* to conduct flora and fauna surveys within service and non-service areas. NPWS Scientific Licence Numbers: SL100848.

Travers bushfire & ecology staff are licensed under an Animal Research Authority issued by the NSW Department of Primary Industries. This authority allows *Travers bushfire & ecology* staff to conduct various fauna surveys of native and introduced fauna for the purposes of environmental consulting throughout New South Wales.

1.5.7 Local government planning instruments (LEP's & DCP's)

The land is currently zoned SP2 Special Protection in the Wyong Local Environmental Plan 2013 - see Figure 1.13.



Figure 1.1 – Site boundary (red) study area (blue)



Figure 1.2 – Proposed development footprint - Building (Grey) and APZ (Green)

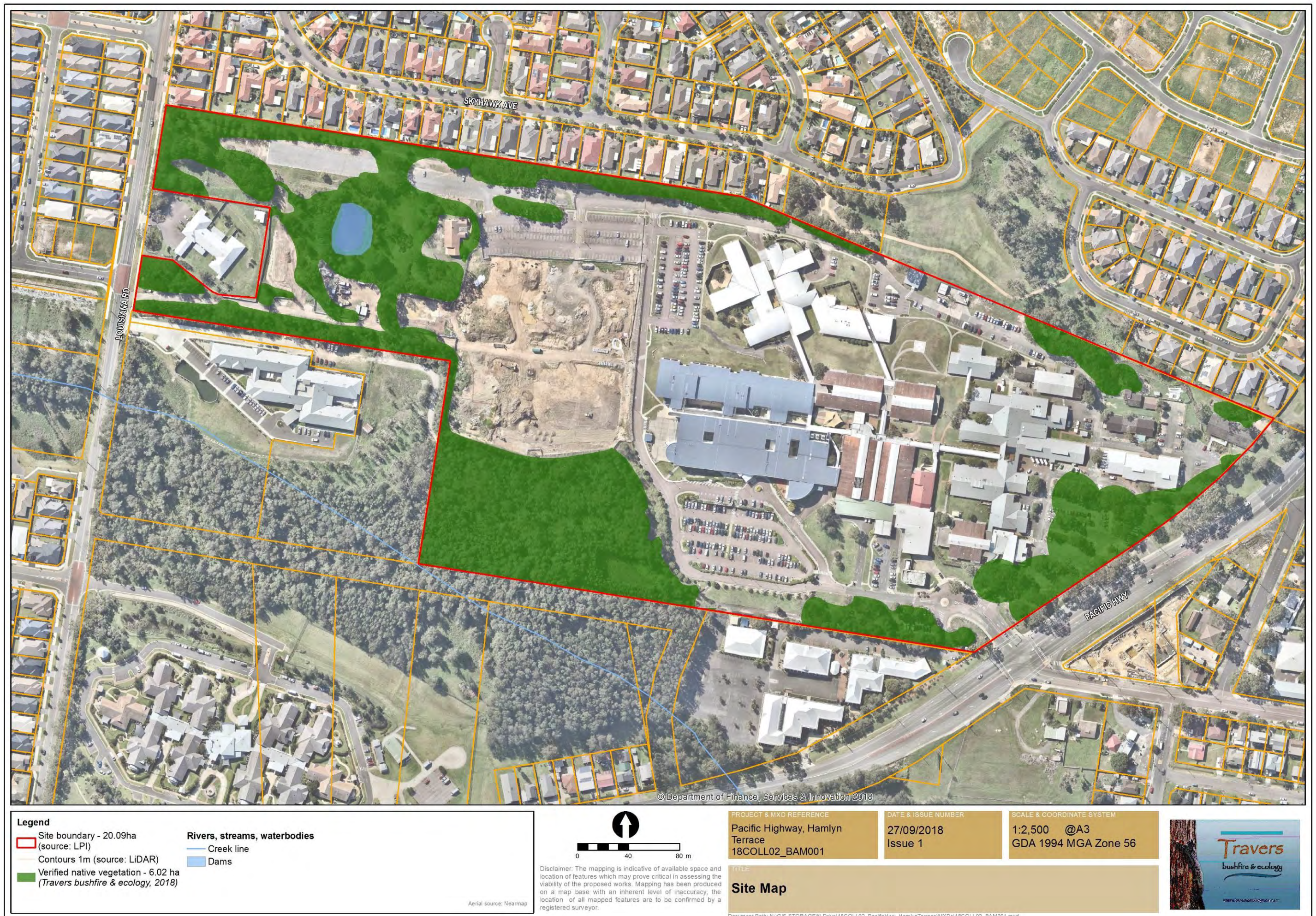
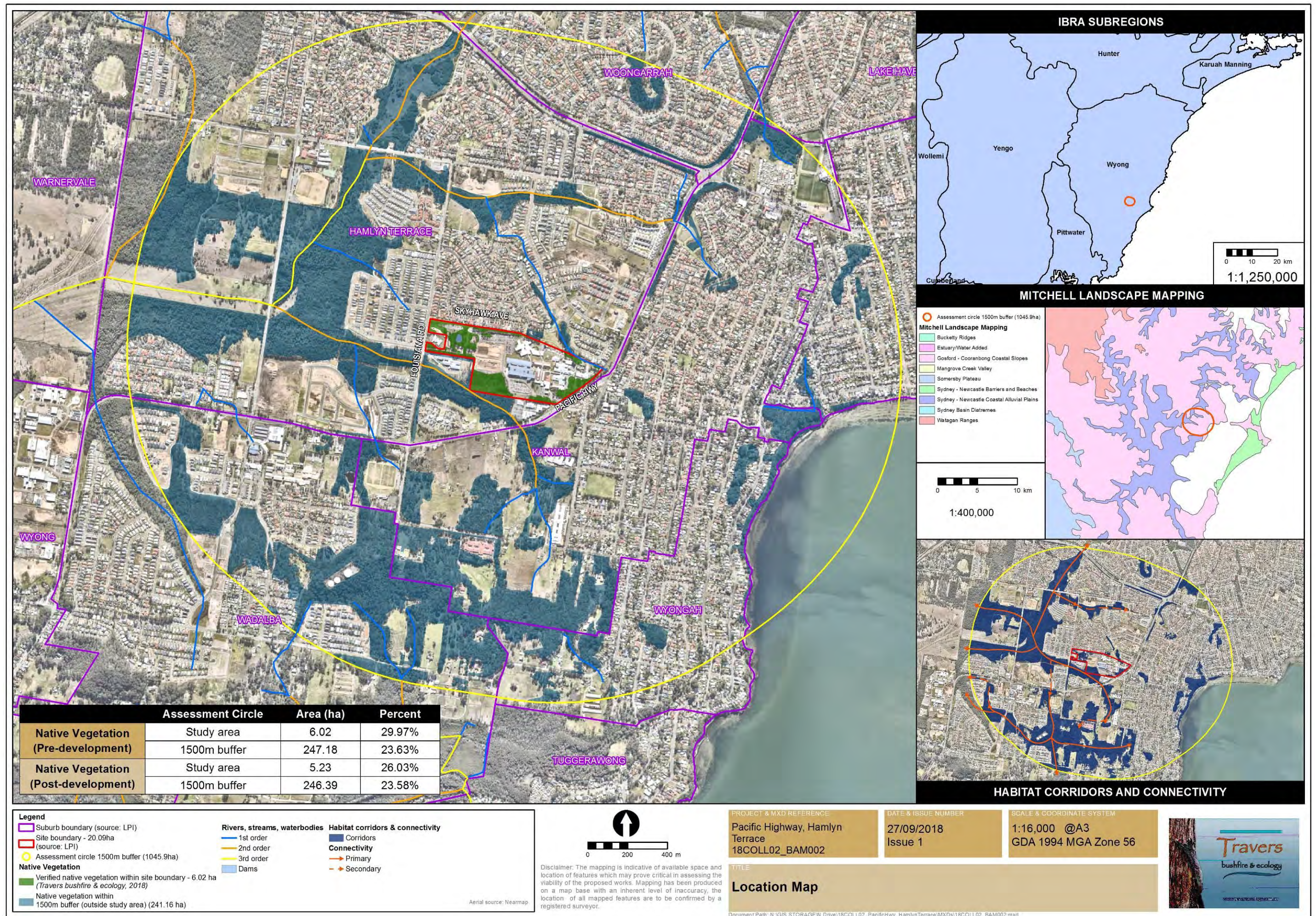


Figure 1.3 – Site map



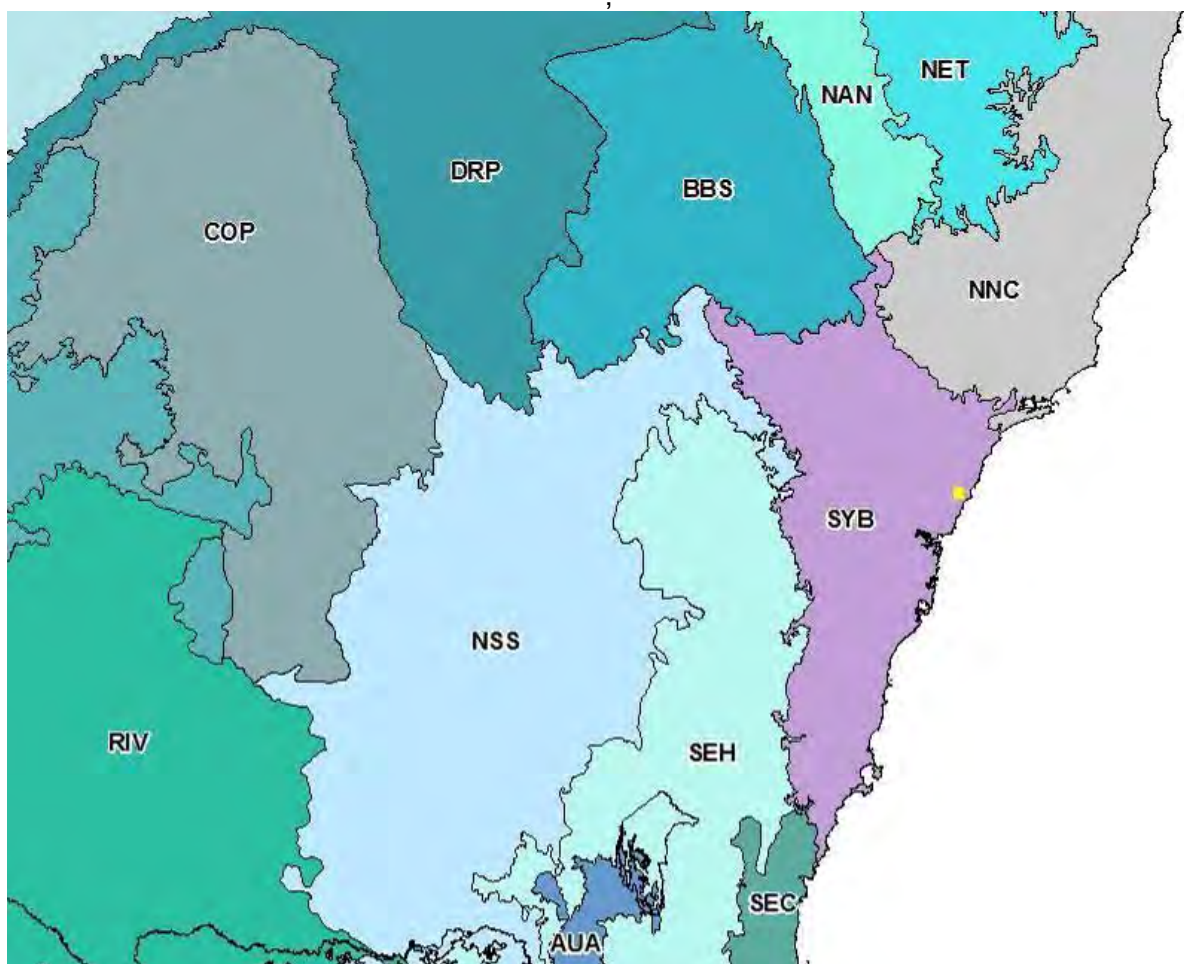


Figure 1.5 – IBRA bioregions

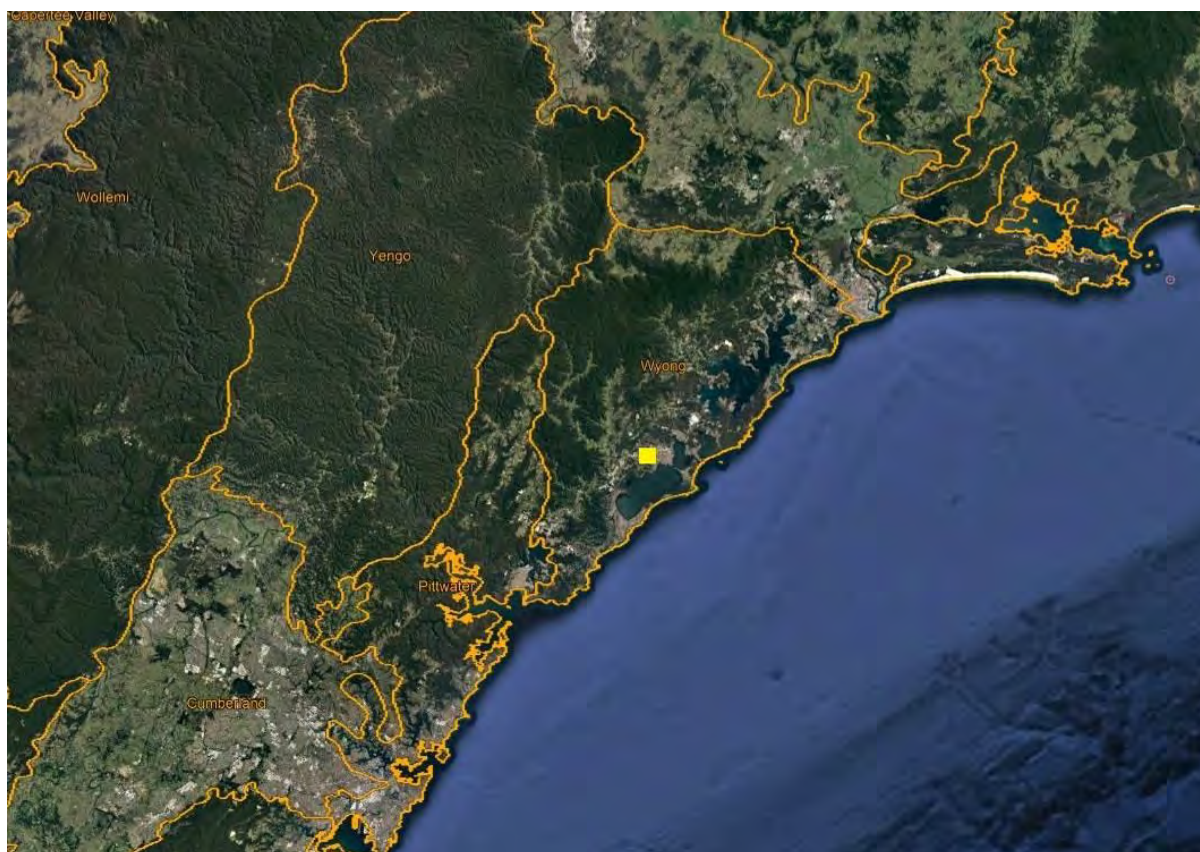


Figure 1.6 – IBRA subregions



Figure 1.7 – Mitchell Landscapes

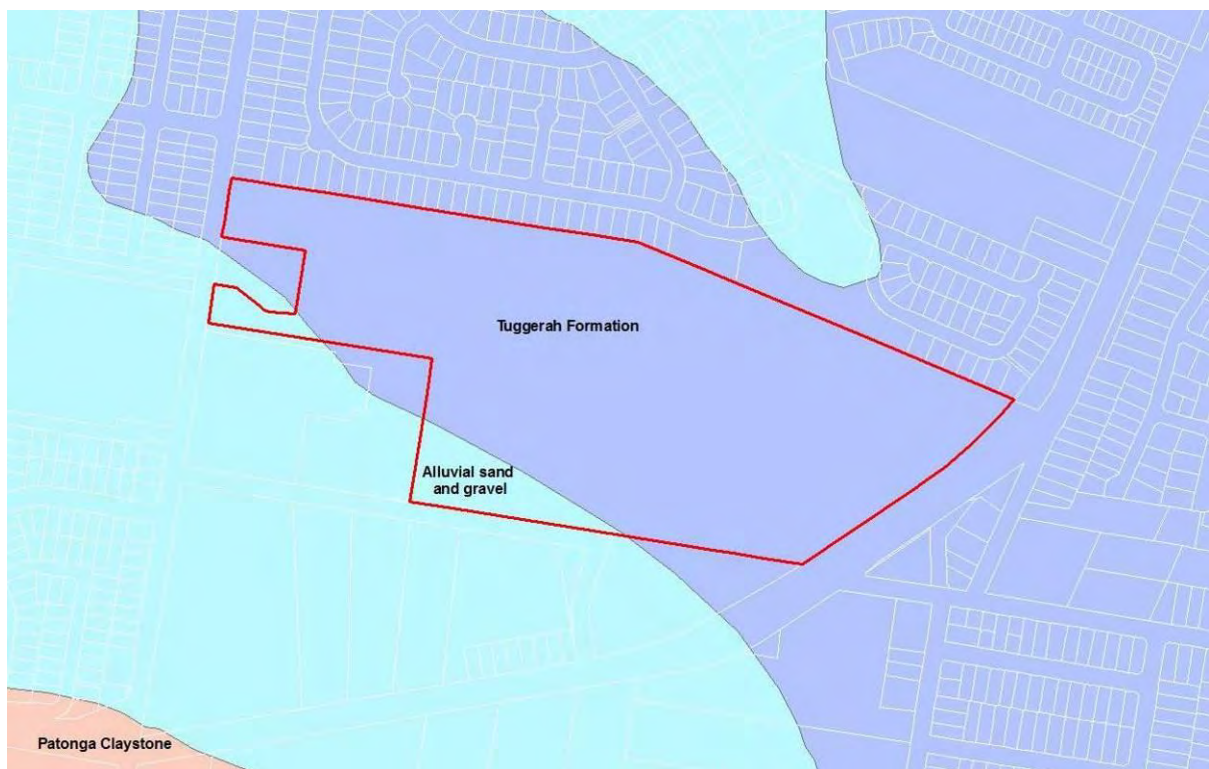


Figure 1.8 – Local geology



Figure 1.9 – Local soil landscapes

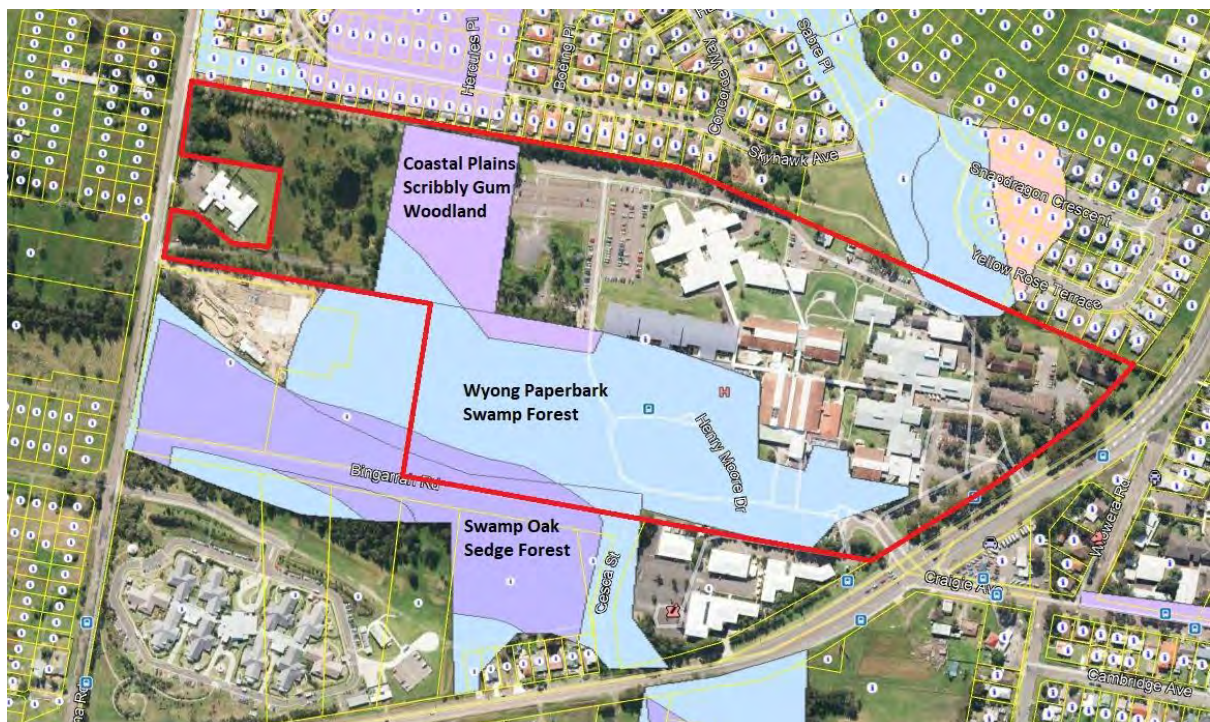


Figure 1.10 – LHCCREMS vegetation mapping (NPWS 2003)

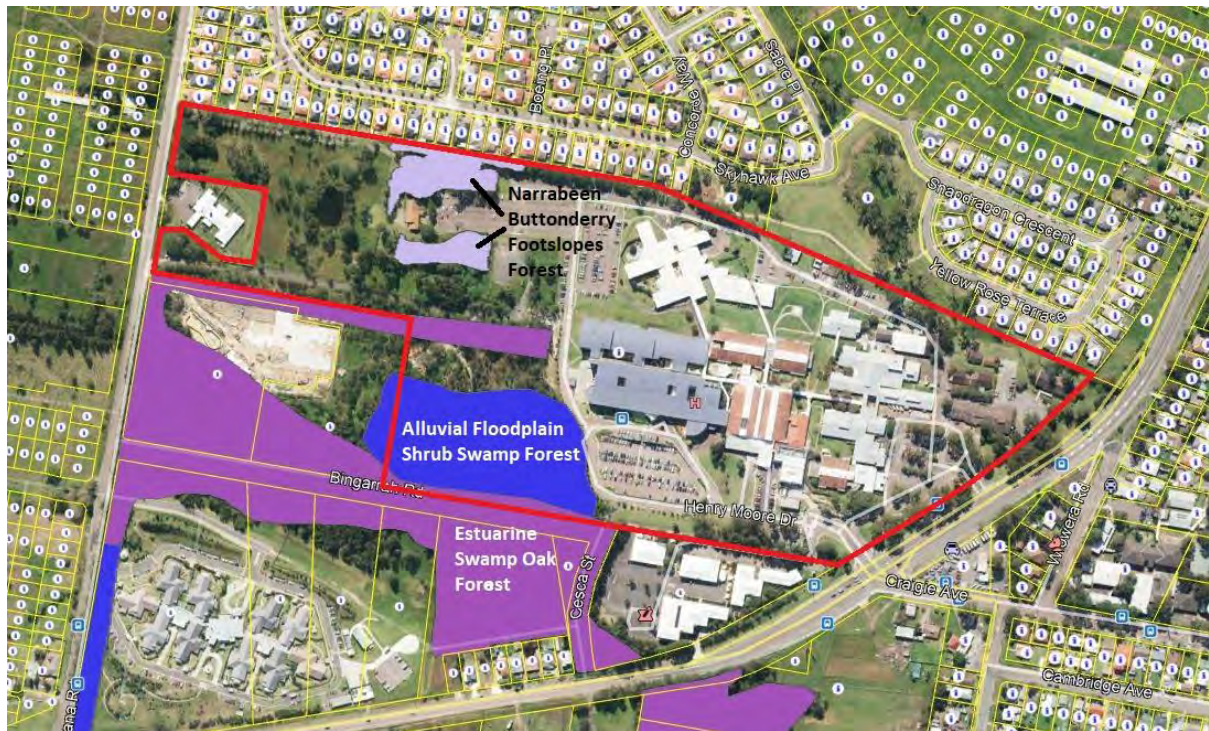


Figure 1.11 – Wyong LGA vegetation mapping (Bell & Driscoll 2008)

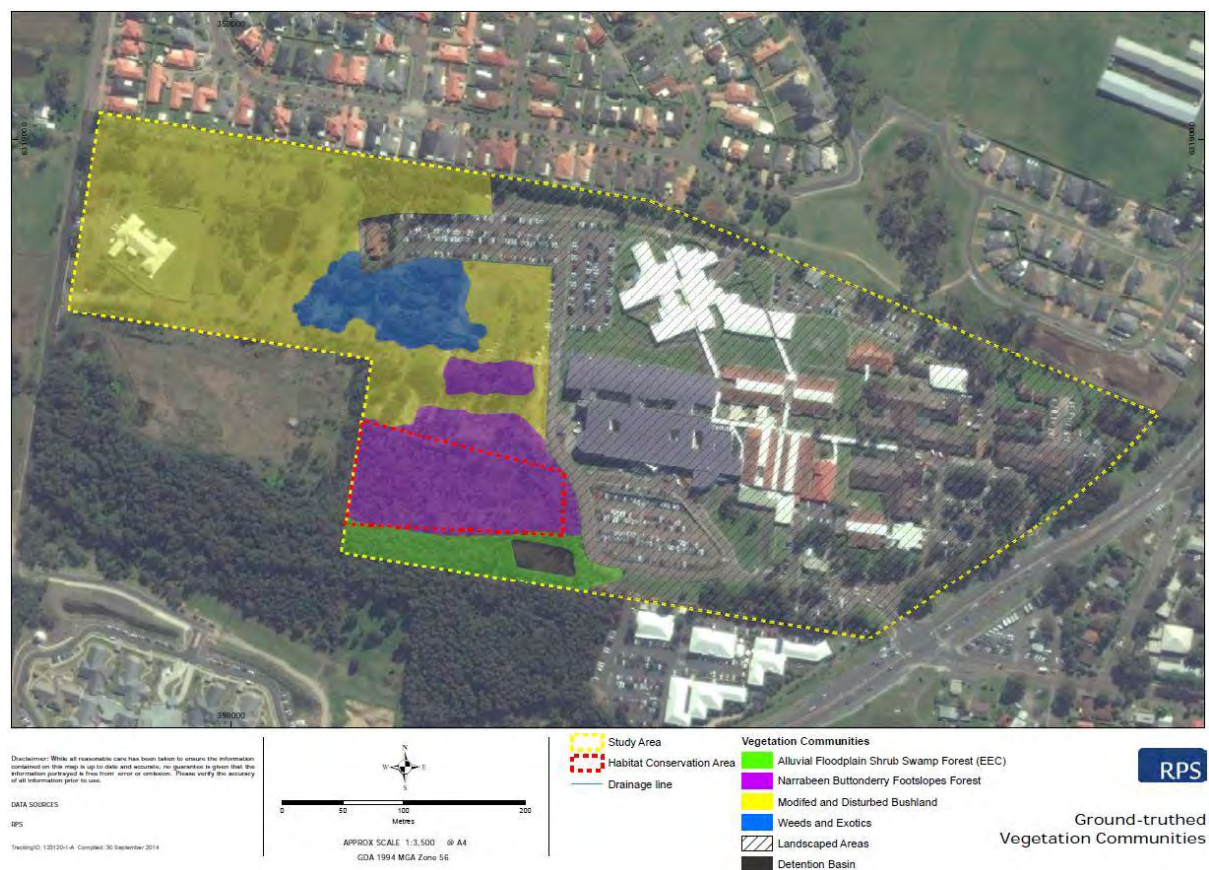


Figure 1.12 – Previous vegetation mapping by RPS (RPS 2014)

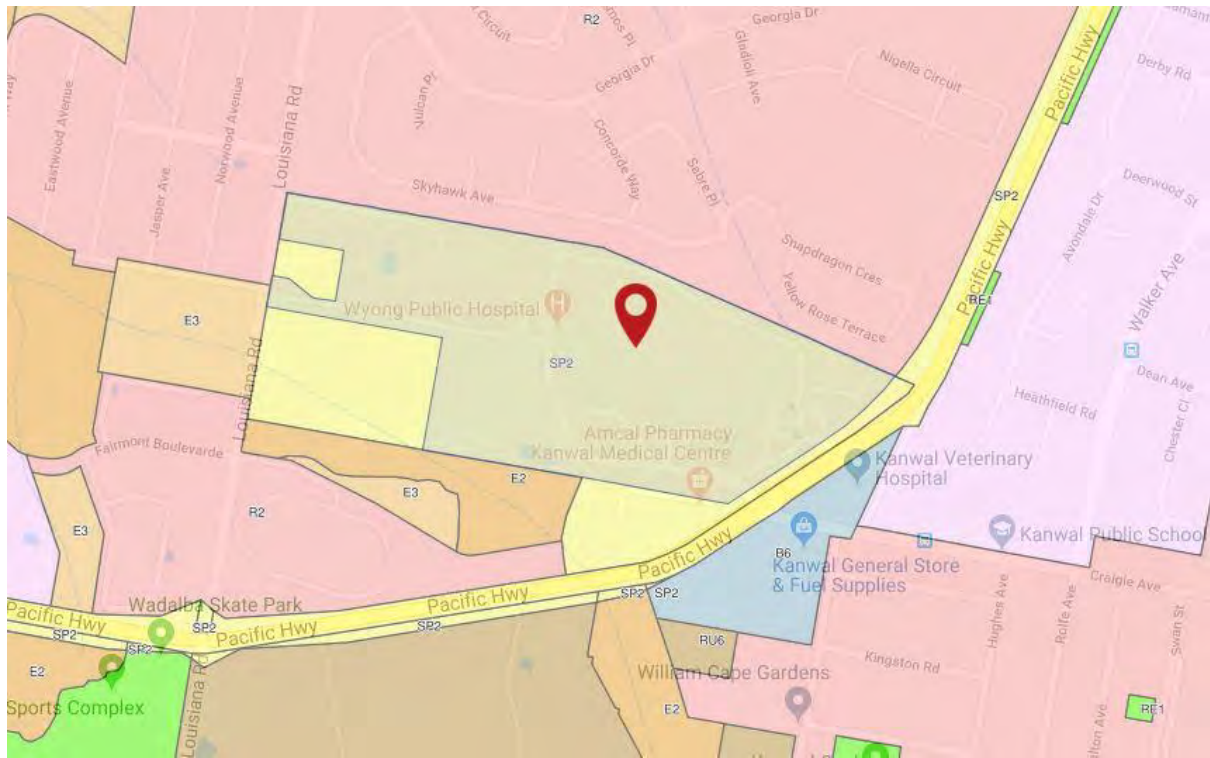


Figure 1.13 – Zoning



Survey Methodology

2

2.1 Pre-survey information collation & resources

A review of the relevant information pertinent to the subject site was undertaken.

Client documents reviewed include:

- Design Plan prepared by *HDR Architects*
- Bushfire Protection Assessment prepared by *Travers bushfire & ecology*

Standard technical resources utilised:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities 2004* (working draft), Department of Environment and Conservation (DEC)
- *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians* (DECC – April 2009a)
- <http://www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm>
- *Flora and Fauna Survey Guidelines - Version 2.0* (Wyang Shire Council 2014)
- Aerial photographs (Google Earth Pro / Spatial Information Exchange / NearMap)
- Topographical maps (scale 1:25,000)
- LiDAR data for contours (Land and Property Information, est. 2015 estimated)
- *Biodiversity Conservation Act 2016* (BC Act)
- *Biodiversity Conservation Regulation 2017* (BCR)
- *Fisheries Management Act 1994* (FM Act)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- NSW Office of Environment and Heritage's BioNet - Atlas of NSW Wildlife, which holds data from a number of custodians. Data obtained 05 Sep 2018
- EPBC Protected Matters Search Tool - *DOEE* (2018)
- Royal Botanic Gardens flora database (2018)
- BioNet Vegetation Classification System
- Lower Hunter Central Coast Regional Environmental Mapping System (LHCCREMS), 2003
- Revised Vegetation mapping of Wyong LGA: Stage 1 - West of F3 Freeway. Report to Wyong Shire Council (Bell & Driscoll 2008)
- Previous reports and surveys within the site (refer to Section 4.2)
- Australian Virtual Herbarium (accessed September 2018).

Desktop assessment:

To determine the likely and actual occurrence of flora species, fauna species and plant communities on the subject site, desktop assessments were undertaken including:

- ***A literature review*** – A review of readily available literature for the area was undertaken to obtain reference material and background information for this survey.

- **A data search** – A search of the *Atlas of NSW Wildlife* (OEH 2018) was undertaken to identify records of threatened flora and fauna species located within a 10km radius of the site. Searches were also undertaken on the DOEE – ‘protected matters search tool’ website to generate a report that will help determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in the area of interest. The search was broadened to a 10km radius like the Atlas search. These two searches combined, enabled the preparation of a list of threatened flora and fauna species that could potentially occur within the habitats found on the site (Tables A2.1, A2.2 and A2.3).

2.2 Flora survey methodology

Flora survey was undertaken on 10 September 2018. Parallel field transects were undertaken in accordance with Cropper (1993) to create a broad species list. Three (3) BAM plots were undertaken within vegetation portions of the study area.

A review of the Atlas of NSW Wildlife, Bionet (OEH September 2018) was undertaken prior to the botanical survey to identify threatened species previously recorded within 10km of the subject site and determine whether target searches were needed to be undertaken. Target searches for relevant threatened species were undertaken where applicable during the parallel field transect and stratified surveys.

All observed plant species are listed in Section 3.1.2 – Table 3.1.

The following information was collected at each of the three (3) 20m x 20m full floristic plots:

- Native overstorey, mid-storey and ground cover recorded for all observed species and an estimate of stems.
- Stratum (and layer): stratum and layer in which each species occurs
- Growth form: growth form for each recorded species
- Species name: scientific name and common name
- Percent projected foliage cover of the understorey strata and exotic vegetation

The following information was collected at each of the three (3) 20m x 50m transect plot sites:

- Number of trees with hollows visible from the ground within the 20m x 50m plot
- The total length of fallen logs >10 cm in diameter within the 20m x 50m plot
- The proportion of regenerating overstorey species within the vegetation zone
- Number of large trees
- Estimates of leaf litter cover, bare ground, cryptograms and rocks in 1x1m subplots at five (5) locations along the 50m central transect

All plot sheets utilised for the BAM calculator are in Appendix 7.

2.3 Fauna survey methodology

Site survey effort accounting for techniques deployed, duration, and weather conditions are outlined in Table 3.1 and are depicted on Figure 2.

Current standard fauna survey techniques employed by *Travers bushfire & ecology* in line with relevant survey guidelines as well as current survey knowledge are provided in Appendix 1. Site specific fauna survey techniques that have been tailored to the study area are described below.

Diurnal birds

Six (6) diurnal bird census points were undertaken within the study area. A minimum of 15 minutes of survey was undertaken at each census point in an area radiating out to between 30-50m. Bird census points were selected to give an even spread and representation across the site and its communities (see Figure 2). Census points were also commenced in locations where bird activity was apparent, as often different small bird species are found foraging together. Opportunistic diurnal bird survey was conducted between census points and whilst undertaking other diurnal surveys.

Seeding *Allocasuarina* trees within the subject site were searched for chewed cones indicating foraging activity by Glossy Black-Cockatoo.

A song-meter was deployed to record for the morning and afternoon bird chorus.

Nocturnal birds

A song-meter was deployed to record for owls calling after the dusk period for two hours as well as for owls calling when going to roost one hour before dawn.

Arboreal and terrestrial mammals

Elliott type B traps were used for trapping arboreal and terrestrial mammals. Trapping consisted of 60 arboreal trap nights and 60 terrestrial trap nights over four consecutive nights. Trap-lines consisting of five trap stations were deployed. An arboreal B trap and terrestrial B trap was placed at each station. A bait mix of rolled oats, peanut butter and honey was used and honey water sprayed onto trees as a lure.

A surveillance camera was deployed for 7 days nights at the southern edge of the subject site. The standard bait mix was placed in a canister in front of the camera as an attractant.

Bats

Passive microbat recording was deployed for 7 full nights from the southern edge of the subject site.

Habitat trees

Hollow-bearing trees were identified and recorded within the subject site on a *Trimble* handheld GPS unit during surveys. All data such as hollow types, hollow size, tree species, diameter at breast height, canopy spread and overall height were collected and a metal tag with the tree number placed on the trunk for field relocation purposes. Other habitat features such as nests and significant sized mistletoe for foraging were also noted.

A summary of hollow-bearing tree results is provided in Table 4.6.

2.4 Field survey effort

Tables 2.1 and 2.2 below detail the flora and fauna survey effort undertaken for the subject site, including previous survey by *Abel Ecology* in 2017 and *RPS* in 2014.

Table 2.1 – Fauna survey effort

Fauna group	Date	Weather conditions	Survey technique(s)	Time effort (24hr)
Travers bushfire & ecology				
Diurnal birds	10/9/2018	3/8 cloud, no wind, no rain, temp 19-13°C	Diurnal opportunistic & census	3hrs 45min 1330 - 1715
	11/9/2018	0/8 cloud, no wind, no rain, temp 14-21°C	Diurnal opportunistic & census	4hrs 15min 0815 - 1230
	12/9/2018	2/8 cloud, light NE wind, no rain, temp 19-23°C	Diurnal opportunistic	4hrs 15min 0815 - 1230
	13/9/2018	0/8 cloud, no wind, no rain, temp 3-22°C	Diurnal opportunistic	3hrs 0700 - 1000
	14/9/2018	7/8 cloud, no wind, no rain, temp 18-28°C	Diurnal opportunistic	4hrs 0700 - 1100
	20/9/2018	0/8 cloud, light S wind, no rain, temp 17-14°C	Diurnal opportunistic & census	2hrs 30min 1500 - 1730
Nocturnal birds	20/9/2018	0/8 cloud, no wind, no rain, temp 13-8°C	Spotlighting	2hrs 1730 - 1930
Arboreal mammals	10-13/9/2018	mostly fine, no rain, >8°C	Elliott trapping x15B	x60B trap nights
	20/9/2018	0/8 cloud, no wind, no rain, temp 13-8°C	Spotlighting	2hrs 1730 - 1930
Terrestrial mammals	10-13/9/2018	mostly fine, no rain, >8°C	Elliott trapping x15B	x60B trap nights
	12-20/9/2018	0 mostly fine, no rain, >8°C	Surveillance camera	x7 camera day/nights
	20/9/2018	0/8 cloud, no wind, no rain, temp 13-8°C	Spotlighting	2hrs 1730 - 1930
Bats	12-20/9/2018	0 mostly fine, no rain, >8°C	Ultrasonic microbat recording (Passive monitoring)	x7 over nights
	20/9/2018	0/8 cloud, no wind, no rain, temp 13-8°C	Spotlighting	2hrs 1730 - 1930
Reptiles	10/9/2018	3/8 cloud, no wind, no rain, temp 19-13°C	Diurnal opportunistic	3hrs 45min 1330 - 1715
	11/9/2018	0/8 cloud, no wind, no rain, temp 14-21°C	Diurnal opportunistic	4hrs 15min 0815 - 1230
	12/9/2018	2/8 cloud, light NE wind, no rain, temp 19-23°C	Diurnal opportunistic	4hrs 15min 0815 - 1230
	13/9/2018	0/8 cloud, no wind, no rain, temp 3-22°C	Diurnal opportunistic	3hrs 0700 - 1000
	14/9/2018	7/8 cloud, no wind, no rain, temp 18-28°C	Diurnal opportunistic	4hrs 0700 - 1100
	20/9/2018	0/8 cloud, light S wind, no rain, temp 17-14°C	Diurnal opportunistic	2hrs 30min 1500 - 1730

Fauna group	Date	Weather conditions	Survey technique(s)	Time effort (24hr)
Travers bushfire & ecology				
Amphibians	20/9/2018	0/8 cloud, no wind, no rain, temp 13-8°C	Spotlighting & call identification	2hrs 1730 - 1930
Abel Ecology				
Diurnal birds	16–18/08/2017	8.8–24.6°C	Bird survey	
Nocturnal birds	16–17/08/2017	8–24.6°C	Spotlighting Stag watching	9hrs
Arboreal mammals	16–17/08/2017	-	Hair tubes / wildlife cameras	2x days, 2x nights
	16–17/08/2017	8–24.6°C	Spotlighting Stag watching	9hrs
Terrestrial mammals	16–18/08/2017	8.8–24.6°C	Diurnal survey	
	16–17/08/2017	8–24.6°C	Spotlighting Stag watching	9hrs
Bats	16–18/08/2018		Ultrasonic microbat recording (Passive monitoring)	over 2 nights
	16–17/08/2017	8–24.6°C	Spotlighting Stag watching	9hrs
Reptiles	16–18/08/2017	8.8–24.6°C	Diurnal survey	
Amphibians	16–18/08/2017	8.8–24.6°C	Diurnal survey	
	16–17/08/2017	8–24.6°C	Spotlighting	9hrs
RPS				
Diurnal birds	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Diurnal survey	2x days
Nocturnal birds	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Spotlighting, call playback	2x nights
Arboreal mammals	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Spotlighting, call playback	2x days & nights
	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Baited infrared cameras	2x days & nights
Terrestrial mammals	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Diurnal survey	2x days
	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Baited infrared cameras	2x days & nights

Fauna group	Date	Weather conditions	Survey technique(s)	Time effort (24hr)
Travers bushfire & ecology				
Bats	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Spotlighting, Ultrasonic bat recording (passive)	2x nights
	15–16/08/2014	26/0.6mm rain, 13.6–22.8°C, wind NNW to 39km/h / NNE to 46km/h	Ultrasonic bat recording (passive)	2x nights
Reptiles	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Diurnal survey	2x days
Amphibians	11–12/08/2014	0/7.8mm rain, 8.1–14.2°C, wind SSW to 39km/h	Diurnal survey	2x days
	15/09/2014	26mm rain, 13.6°C, wind NNW to 39km/h	Targeted Wallum Froglet survey inc. call playback	1x day

Table 2.2 – Flora survey effort

Flora survey	Survey technique(s)	Dates
Travers bushfire & ecology		
Vegetation communities	Survey of the boundaries of all communities – field verification and aerial photographic interpretation	10/09/2018
Stratified sampling	20x20m / 20x50m BAM quadrats within existing vegetation	10/09/2018
	Parallel field traverse	10/09/2018
Threatened species searches	Parallel field traverse in potential habitats (all threatened flora with potential to occur)	10/09/2018
	Opportunistic searches in potential habitats and during all on-foot traverses across the site (all threatened flora with potential to occur)	10/09/2018
Abel ecology		
Vegetation communities	Survey of the boundaries of all communities – field verification and aerial photographic interpretation	16–18/08/2017
Stratified sampling	Random meander to compile vegetation descriptions and species lists	16–18/08/2017
Threatened species searches	Targeted parallel field traverse in potential habitats (<i>Tetratheca juncea</i>)	16–18/08/2017
	Opportunistic searches in potential habitats and during all on-foot traverses across the site (all threatened flora with potential to occur)	

RPS		
Vegetation communities	Survey of the boundaries of all communities – field verification and aerial photographic interpretation	11–12/08/2014
Stratified sampling	Full floristic plots (20x20m)	11–12/08/2014
	Random meander to compile vegetation descriptions and species lists, and undertake opportunistic searches for threatened species.	11–12/08/2014
Threatened species searches	Targeted parallel field traverse in potential habitats (<i>Tetratheca juncea</i> , <i>Thelymitra adorata</i> , <i>Caladenia tessellata</i> , <i>Microtis angusii</i>)	15/09/2014
	Opportunistic searches in potential habitats and during all on-foot traverses across the site (all threatened flora with potential to occur)	11–12/08/2014

Table 2.3 – Plot and transect survey effort – subject site

Veg zone no.	PCT	Condition	Area (Ha)	Minimum plots required	Plots sampled
1	1636	Moderate_good	0.686	1	2
2	1728	Moderate_good (weedy)	0.106	1	1

2.5 Survey limitations

It is important to note that field survey data collected during the survey period is representative of species occurring within the subject site for that occasion. Due to effects of fire, breeding cycles, migratory patterns, camouflage, weather conditions, time of day, visibility, predatory and / or feeding patterns, increased species frequency or richness may be observed within the subject site outside the nominated survey period. Habitat assessments based on the identification of micro-habitat features for various species of interest, including regionally significant and threatened species, have been used to minimise the implications of this survey limitation.

Flora survey limitations

The species list does not include all household or exotic garden / landscaping species and those species which could not be identified at the time of the survey past genus level. Cryptic species not flowering at the time of the survey may not be observed during survey outside of peak flowering periods. Likewise cryptic orchid species are generally only recognisable when flowering.

Threatened flora survey was limited to parallel field traverses in potential habitat over one day in September. This survey has been conducted in the appropriate period for all species with potential to occur, and those candidate species generated by the BAM calculator (see Sections 3.3 and 6.3), with the exception of *Persicaria elatior* and *Cryptostylis hunteriana*. For the purposes of the BAM credit assessment, these two species have been assumed present. Previous targeted survey for *Tetratheca juncea* by RPS in 2014 complies with OEH survey guidelines and is therefore valid and informative for this report (OEH 2016).

Fauna survey limitations

No nocturnal call-playback was undertaken. No hollows within or close to the subject site were considered suitable for use by threatened owls. Given also that survey was undertaken at the peak of the nesting season with a known local pair present, the prevention of disruption to nesting behaviour was considered priority. No evidence of owl activity within the subject site was found during survey. A song-meter was deployed for a week to somewhat overcome this limitation.

Arboreal trapping effort targeted presence of Squirrel Glider. This is found as the most reliable method of presence/absence given poor response from call-playback methods. There was no suitable habitat for any other threatened arboreal mammals targeted by call-playback methods, therefore no arboreal mammal call-playback was deployed.

Only one habitat tree was stag-watched on one night. Further stag-watching is not considered necessary given that the proposal will likely retain all recorded hollow-bearing trees.

Survey was not undertaken during or following any rainfall event to stimulate frog breeding activity. The study area is not expected to support habitat for threatened frog species, therefore such survey is not considered necessary.

2.6 Accuracy of identification

A putative specimen of *Eucalyptus camfieldii* was sent to Sydney Royal Botanic Gardens for identification. Structural descriptions of the vegetation were made according to Specht *et al* (1995).

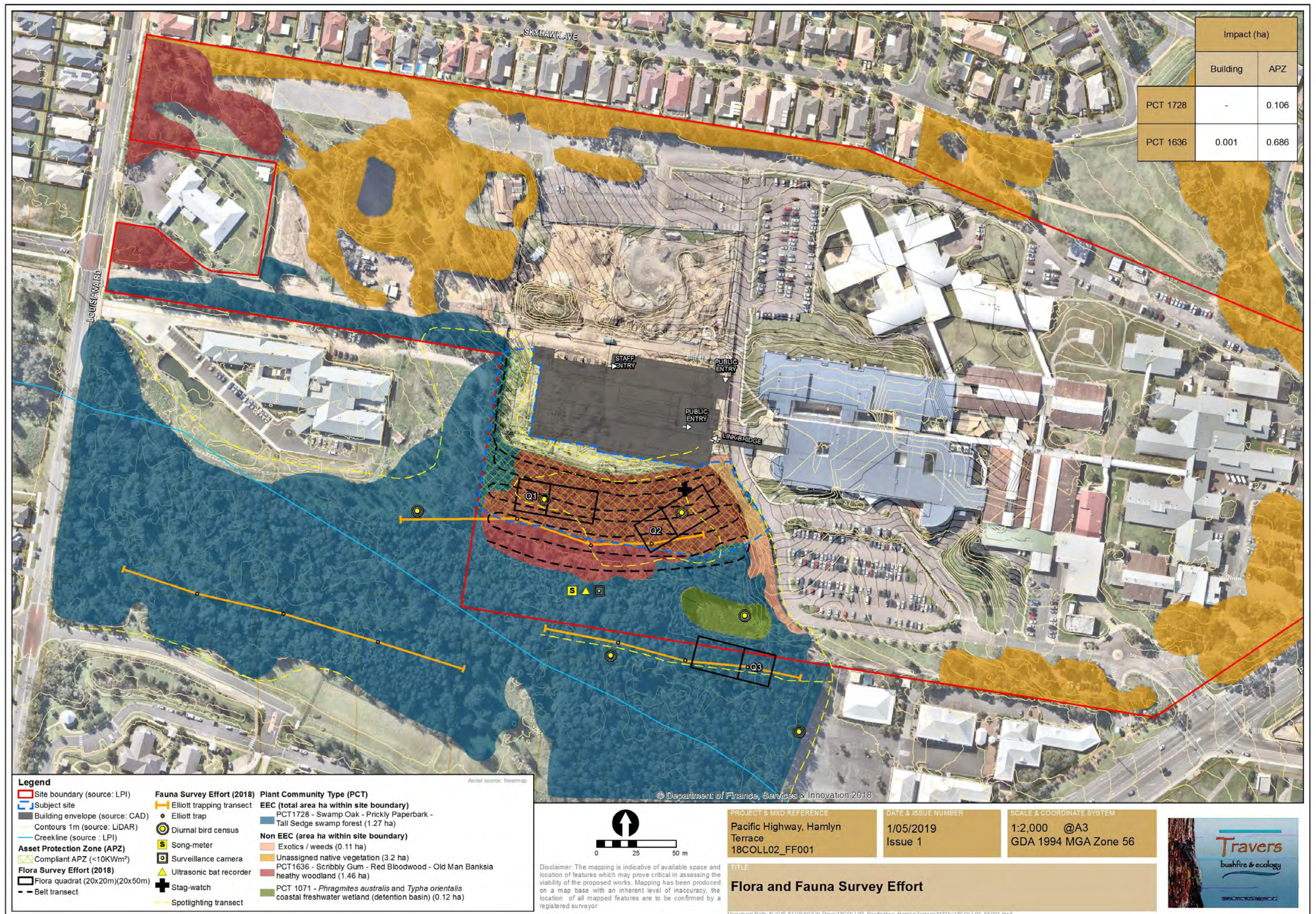


Figure 2 – Flora and fauna survey effort (plots and transects)



Survey Results

3

3.1 Flora results

3.1.1 Native vegetation extent

The native vegetation extent within the study area has been ground-truthed. The amount of native vegetation is 6.02ha. This value varies slightly from previous mapping due to recent approved clearing, and our interpretation of 'native vegetation' (as per the *LLS Act* and *BC Act* definition) to include planted or landscaped areas containing native species.

The native vegetation to be impacted measures 0.793ha. This is a combination of impacts from the APZ, building envelopes, and fire trails.

3.1.2 Flora species

The plants observed within the vegetation communities of the subject site are listed in the Table 3.1 below.

Table 3.1 – Flora observations for the subject site

Family	Scientific name	Common name
Trees		
Myrtaceae	<i>Angophora costata</i>	Smooth-barked Apple
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak
Myrtaceae	<i>Corymbia gummifera</i>	Red Bloodwood
Cyatheaceae	<i>Cyathea australis</i>	Rough Tree-fern
Myrtaceae	<i>Eucalyptus amplifolia</i>	Cabbage Gum
Myrtaceae	<i>Eucalyptus camfieldii</i> ^{TS} <-> <i>capitellata</i> (intergrade or hybrid)	Stringybark
Myrtaceae	<i>Eucalyptus haemastoma</i>	Broad-leaved Scribbly Gum
Santalaceae	<i>Exocarpos cupressiformis</i>	Native Cherry
Arecaceae	<i>Livistona australis</i>	Cabbage Tree Palm
Pittosporaceae	<i>Pittosporum undulatum</i>	Sweet Pittosporum
Shrubs		
Fabaceae	<i>Acacia longifolia</i>	
Fabaceae	<i>Acacia suaveolens</i>	Sweet Scented Wattle
Proteaceae	<i>Banksia marginata</i>	Silver Banksia
Proteaceae	<i>Banksia oblongifolia</i>	Fern-leaf Banksia
Rutaceae	<i>Boronia polygalifolia</i>	Dwarf Boronia
Fabaceae	<i>Bossiaea obcordata</i>	Spiny Bossiaea
Epacridaceae	<i>Epacris pulchella</i>	Wallum Heath

Family	Scientific name	Common name
Proteaceae	<i>Grevillea sericea</i>	Pink Spider Flower
Proteaceae	<i>Lambertia formosa</i>	Mountain Devil
Myrtaceae	<i>Leptospermum polygalifolium</i>	Tantoon
Myrtaceae	<i>Leptospermum trinervium</i>	Slender Tea-tree
Myrtaceae	<i>Melaleuca linearifolia</i>	Snow-in-summer
Myrtaceae	<i>Melaleuca nodosa</i>	Ball Honey Myrtle
Myrtaceae	<i>Melaleuca sieberi</i>	-
Fabaceae	<i>Mirbelia speciosa</i>	-
Proteaceae	<i>Persoonia levis</i>	Broad-leaved Geebung
Euphorbiaceae	<i>Phyllanthus hirtellus</i>	Thyme Spurge
Groundcovers		
Adiantaceae	<i>Adiantum aethiopicum</i>	Common Maidenhair
Anthericaceae	<i>Caesia parviflora</i>	Pale Grass Lily
Apiaceae	<i>Centella asiatica</i>	Swamp Pennywort
Asteraceae	<i>Conyza bonariensis</i> *	Flax-leaf Fleabane
Orchidaceae	<i>Cryptostylis subulata</i>	Large Tongue Orchid
Phormiaceae	<i>Dianella caerulea</i>	Blue Flax-lily
Droseraceae	<i>Drosera spathulata</i>	Common Sundew
Poaceae	<i>Entolasia marginata</i>	Bordered Panic
Poaceae	<i>Eragrostis brownii</i>	Brown's Lovegrass
Cyperaceae	<i>Gahnia clarkei</i>	Tall Saw-sedge
Gleicheniaceae	<i>Gleichenia dicarpa</i>	Pouched Coral Fern
Haloragaceae	<i>Gonocarpus micranthus</i>	-
Dilleniaceae	<i>Hibbertia aspera</i>	Rough Guinea Flower
Apiaceae	<i>Hydrocotyle</i> sp.*	-
Cyperaceae	<i>Lepidosperma laterale</i>	Variable Sword-sedge
Restionaceae	<i>Lepyrodia scariosa</i>	Scale Rush
Lindsaeaceae	<i>Lindsaea linearis</i>	Screw Fern
Xanthorrhoeaceae	<i>Lomandra longifolia</i>	Mat Rush
Poaceae	<i>Microlaena stipoides</i>	Weeping Grass
Poaceae	<i>Opismenus aemulus</i>	Basket Grass
Iridaceae	<i>Patersonia sericea</i>	Wild Iris
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken
Selaginallaceae	<i>Selaginella uliginosa</i>	Swamp Selaginella
Poaceae	<i>Themeda triandra</i>	Kangaroo Grass
Apiaceae	<i>Trachymene incisa</i>	Trachymene
Anthericaceae	<i>Tricoryne elatior</i>	Yellow Rush Lily
Menyanthaceae	<i>Villarsia exaltata</i>	Yellow Marsh Flower
Xanthorrhoeaceae	<i>Xanthorrhoea media</i>	Forest Grass Tree
Xyridaceae	<i>Xyris operculata</i>	Tall Yellow-eye
Vines		
Lauraceae	<i>Cassytha filiformis</i>	
Lauraceae	<i>Cassytha glabella</i>	
Apocynaceae	<i>Parsonsia straminea</i>	Common Silkpod

Family	Scientific name	Common name
Ephyphites		
Polypodiaceae	<i>Platyserium bifurcatum</i>	Elkhorn
* denotes exotic species		
TS denotes threatened species		

3.1.3 Vegetation descriptions of observed communities

The following vegetation communities were identified within the subject site through ground truthing:

PCT 1636 - Scribbly Gum - Red Bloodwood - *Angophora inopina* heathy woodland on lowlands of the Central Coast

This community occupies the majority of the subject site and is in good condition with few naturalised exotics.

Canopy – Dominated by *Eucalyptus haemastoma* and *Angophora costata*, with occasional *Corymbia gummifera* and *Casuarina glauca*. Canopy height ranges from 10m to 18m tall with a variable projected foliage cover (PFC) of approximately 16-40%.

Mid-storey – Common species are *Leptospermum polygalifolia*, *Leptospermum trinervium*, *Glochidion ferdinandi*, *Melaleuca nodosa*, *Lambertia formosa*, *Parsonsia straminea* and *Persoonia levis*. Exotics are present at less than 3% PFC, and include *Cinnamomum camphora*, *Lantana camara*, *Ligustrum sinense* and *Rubus fruticosus*.

Groundcovers – The groundcover is dominated by *Lepyrodia scariosa*, which provides approximately 50–60% PFC. Other species provide c. 20–25% PFC and include *Entolasia marginata*, *Gahnia clarkei*, *Hibbertia aspera*, *Dianella caerulea*, *Pratia purpurascens*, *Centella asiatica*, *Pteridium esculentum* and *Microlaena stipoides*. Exotic species are sparse but present at less than 1% PFC, and include *Andropogon virginicus* and *Axonopus fissifolius*.

PCT 1636 is recognised as the TEC Kincumber Scribbly Gum Forest under the BC Act. Travers bushfire & ecology believe this is erroneous considering *Angophora inopina* in the naming of this PCT is only recorded from Wyong heading north, some 23km from Kincumber.



Photo 1 - PCT 1636 - Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland within BAM plot 1.



Photo 2 - PCT 1636 - Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland within BAM plot 2.

PCT 1728 - Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast

This community occupies a small part of the subject site, and represents most of the vegetation outside of the subject site to the south and south-west. PCT 1728 is in moderate to poor condition with a relatively high abundance of exotic species in the mid-storey and ground layer.

Canopy – Dominated by *Casuarina glauca* with occasional eucalypts. Canopy height ranges from 12m to 20m tall with a projected foliage cover (PFC) of approximately 40%.

Mid-storey – The native mid-storey is represented by *Parsonsia straminea*, providing approximately 5% PFC, and an occasional *Platycerium bifurcatum* (Elkhorn fern). Exotic species such as *Lantana camara*, *Ligustrum lucidum*, *Senna pendula* and *Phoenix canariensis* dominate and provide approximately 22% PFC.

Groundcovers – Native species include *Entolasia marginata*, *Gahnia clarkei*, *Centella asiatica* and *Oplismenus aemulus* and provide approximately 26% PFC. Exotic species provide approximately 3% PFC and include *Asparagus* spp., *Solanum nigrum* and *Ipomoea indica*.

PCT 1728 is part of the endangered ecological community (EEC) "Swamp oak floodplain forest of the NSW North Coast | Sydney Basin and South East Corner bioregions" (SOFF) listed under the *BC Act*.



Photo 3 - PCT 1728 - Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest within BAM plot 3.

Exotics / weeds

This vegetation occupies a small area on an embankment along the eastern edge of the subject site and is comprised of naturalised exotic groundcovers and shrubs, particularly *Lantana camara*.

3.1.4 Plant community types (PCTs)

Evidence used to identify a PCT

Evidence used to identify the PCTs within the site: the entire list of PCTs was exported from the online BioNet Vegetation Classification Tool. Dominant canopy species, mid-stratum species, ground cover species, and Interim Biogeographic Regionalisation for Australia (IBRA) region and sub-region (Wyong) information were utilised to produce a short list of potential PCTs (Table 3.2). Final PCTs were then chosen based on species composition and presence, and similarity to descriptive attributes and distributional and landscape position (coastal lowlands) information provided in the BioNet Vegetation Classification Tool. Justification for inclusion or exclusion of each shortlisted PCT is provided in Table 3.2.

Table 3.3 provides a summary of the PCT occurring within the development site, including vegetation formation, percent cleared within and extent within the development site.

All plot sheets utilised for the BAM calculator are in Appendix 7.

Table 3.2 – PCT shortlist and justification

Zone	Shortlisted PCTs	PCT name	Match	Justification
1	1083	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	x	Wrong landscape position: Sandstone plateaux
	1134	Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	x	Wrong landscape position: hillslopes or flat rock outcrops.
	1636	Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast	✓	Correct landscape position: coastal lowlands. Presence of several diagnostic spp. in all strata.
	1642	Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast	x	Wrong landscape position: dissected sandstone hills.
	1643	Red Bloodwood - Smooth-barked Apple - Scribbly Gum - Old Man Banksia heathy woodland on sandstone ranges of the Central Coast	x	Wrong landscape position: sandstone ranges.
	1783	Red Bloodwood - Scribbly Gum / Old-man Banksia open forest on sandstone ridges of northern Sydney and the Central Coast	x	Wrong landscape position: crests, ridges and exposed gully slopes
	1786	Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region	x	Wrong landscape position: lower to upper escarpment slopes. Wrong geology: ironstone.

Zone	Shortlisted PCTs	PCT name	Match	Justification
	1824	Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin	x	Wrong landscape position: sandstone plateau
2	1717	Broad-leaved Paperbark - Swamp Mahogany - Swamp Oak - Saw Sedge swamp forest of the Central Coast and Lower North Coast	x	Lack of sclerophyllous spp. in canopy of Zone 2
	1728	Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	✓	Dominated by <i>Casuarina glauca</i> with <i>Entolasia marginata</i> . Lack of sclerophyllous spp. in canopy of Zone 2

Zone 1:

The identification of the most suitable PCT began by filtering for PCTs with *Eucalyptus haemastoma* and *Angophora costata* and as upper strata species within the Wyong IBRA sub-region. This provided three PCTs (1083, 1642 1643), none of which occur on the appropriate landscape position of coastal lowlands. PCT were filtered again, this time with *E. haemastoma* and *Corymbia gummifera* as upper strata species. This provided an additional five PCTs (1134, 1636, 1783, 1786, 1824). Only one of these PCTs occurs on the appropriate landscape position: PCT 1636. This PCT also contains several mid- and lower-strata diagnostic species present within Zone 1, such as *Leptospermum trinervium*, *Lambertia formosa*, *Epacris pulchella*, *Themeda triandra* and *Lepyrodia scariosa*. PCT 1636 was chosen as the closest match for Zone 1.

Zone 2:

The identification of the most suitable PCT was based upon filtering for PCTs within the Wyong IBRA sub-region with *Casuarina glauca* in the upper strata, and *Entolasia marginata* and *Gahnia clarkei* in the ground strata. This produced two PCTs: 1717 and 1728. Both PCTs are potentially representative, with similar landscape positions on poorly-drained coastal lowlands and floodplains. The vegetation description for PCT 1717 states that it is a myrtaceous swamp open forest, indicating a high prevalence of myrtaceous species (*Melaleuca*, *Eucalyptus*) in the canopy, whilst that for PCT 1728 states that it is dominated by *Casuarina*. Zone 2 is dominated by *Casuarina* with very few myrtaceous species in the canopy, therefore PCT 1728 is considered a closer match.

Table 3.3 provides a summary of the PCT occurring within the development site, including vegetation formation, percent cleared within and extent within the development site.

All plot sheets utilised for the BAM calculator are in Appendix 7.

Table 3.3 – PCTs within the site

PCT code	PCT name	Species relied upon	Vegetation formation	Vegetation class	% cleared	Area within development site (ha)	TEC status
1636	Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast	<i>E. haemastoma</i> <i>C. gummifera</i>	Dry Sclerophyll Forest (Shrubby sub-formation)	Sydney Coastal Dry Sclerophyll Forests	58	1.46 on site, 0.686 to be impacted	Kincumber Scribbly Gum Forest (only on Bouddi Peninsular)
1728	Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	<i>Casuarina glauca</i> , <i>Gahnia clarkei</i> , <i>Entolasia marginata</i>	Forested Wetlands	Coastal Floodplain Wetlands	81	1.27 on site, 0.106 to be impacted	Swamp Oak Floodplain Forest

PCT descriptions

PCT 1636

IBRA Subregion: Occurs within the Wyong IBRA subregion

Vegetation formation/class: Dry Sclerophyll Forest (Shrubby sub-formation) / Sydney Coastal Dry Sclerophyll Forests

Landscape position: This community occurs on coastal lowlands from northern Tuggerah Lake to the northern end of Lake Macquarie with a substrate of sandstone and moist sandy soils and an elevation under 100m. The altitude, soils and geology are correct for this vegetation type.

Plant Community Type ID (PCT ID):

1,636

PCT Classification Confidence Level: High

PCT Common Name: Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast

PCT Common Usage Name:

PCT Scientific Name: *Eucalyptus haemastoma*, *Corymbia gummifera* / *Banksia oblongifolia*, *Leptospermum trinervium*, *Lambertia formosa*, *Xanthorrhoea latifolia*, *Hakea dactyloides* / *Epacris pulchella*, *Ptilothrix deusta*, *Petrophile pulchella*, *Lomandra obliqua*, *Themeda australis*, *Lepyrodia scariosa*, *Aristida warburgii*

Data Entry Operator: SIVERTD

Data Entry Date: 04/07/2012

Last Modified By: MURPHYDY

Last Modified Date: 23/03/2016

Vegetation Description: Eucalypt dominated Woodlands with a shrubby mid-stratum and a graminoid ground cover. | This community occurs on coastal lowlands from northern Tuggerah Lake to the northern end of Lake Macquarie. The substrate is sandstone with moist sandy soils | elevation is usually under 100m.

Rain fall: Not Assessed

Elevation: Not Assessed

Emergent species: None

Upper Stratum Species: *Eucalyptus haemastoma*; *Corymbia gummifera*;

Mid Stratum Species: *Banksia oblongifolia*; *Leptospermum trinervium*; *Lambertia formosa*; *Xanthorrhoea latifolia*; *Hakea dactyloides*;

Ground Stratum Species: *Epacris pulchella*; *Ptilothrix deusta*; *Petrophile pulchella*; *Lomandra obliqua*; *Themeda australis*; *Lepyrodia scariosa*; *Aristida warburgii*;

Tree Growth Form Species:

Shrub Growth Form Species:

Grass and grasslike Growth Form Species:

Forb Growth Form Species:

Fern Growth Form Species:

Other Growth Form Species:

Diagnostic Species:

(Species Name:Group Score, Group Frequency,Non Group Score, Non Group Frequency; Fidelity Class)

Eucalyptus haemastoma: 3, 91%, 2, 3%; positive

Corymbia gummifera: 2, 88%, 2, 14%; positive

Banksia oblongifolia: 3, 92%, 2, 7%; positive

Leptospermum trinervium: 2, 92%, 2, 14%; positive

Lambertia formosa: 2, 88%, 2, 6%; positive

Xanthorrhoea latifolia: 3, 80%, 2, 4%; positive

Hakea dactyloides: 2, 73%, 1, 6%; positive

Epacris pulchella: 2, 96%, 2, 7%; positive

Ptilothrix deusta: 3, 67%, 3, 7%; positive

Petrophile pulchella: 2, 64%, 2, 4%; positive

Lomandra obliqua: 2, 63%, 2, 10%; positive

Themeda australis: 3, 63%, 2, 33%; positive

Lepyrodia scariosa: 3, 49%, 3, 6%; positive

Aristida warburgii: 2, 40%, 2, 2%; positive

Height Class (Walker & Hopkins 1990): 8 - Range:20.01-35.00m (Very tall),7 - Range:12.01-20.00m (Tall),6 -

Range:6.01-12.00m (Mid-high),5 - Range:3.01-6.00m (Low),4 - Range:1.01-3.00m (Dwarf)

Vegetation Formation: Dry Sclerophyll Forests (Shrubby sub-formation);

Vegetation Class: Sydney Coastal Dry Sclerophyll Forests;

NSW Landscape Name: Gosford - Cooranbong Coastal Slopes; Sydney - Newcastle Barriers and Beaches; Sydney - Newcastle Coastal Alluvial Plains;

Classification source: Somerville 2009

Authority: Hunter Project

Pre-European Mapped Or Modelled: Mapped or modelled

Current Extent Mapped Or Modelled: Mapped

Adequacy of plot sampling: Adequate

Number of Plots: 0

IBRA Bioregion: Sydney Basin (Not known);

IBRA Sub-Region: Hunter (Not known); Pittwater (Not known); Wyong (Not known);

LGA: Cessnock (Not known); Gosford (Not known); Lake Macquarie (Not known); Newcastle (Not known); Wyong (Not known);

Wednesday, 26 September 2018

Community Profile Report

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Lithology: Sandstone , Conglomerate
Landform Pattern: Not Assessed
Landform Element: Not Assessed
Pre-European Extent: Not Assessed
Pre-European Extent Accuracy: Not Assessed
Pre-European Comments:
Current Extent: Not Assessed
Current Extent Accuracy: Not Assessed
Current Extent Comments:
PCT Percent Cleared: 58.00 *% accuracy (of PCT % cleared estimate):* Not Assessed
Variation and Natural Disturbance:
Fire Regime:
PCT associated with TEC: Yes
Associated TEC Names: Listed TSC Act,CE: Kincumber Scribbly Gum Forest in the Sydney Basin Bioregion (Part) ;
Associated TEC Degree of Fit:
Associated TEC Comments:
Citations: (Sivertsen, D. et al., 2011 ; Somerville, M. (2009a))
Full Reference Details: (962; 862;). Sivertsen, D., Roff, A., Somerville, M., Thonell, J. and Denholm, B. 2011. Hunter Native Vegetation Mapping. Geodatabase Guide (Version 4.0), Internal Report for the Office of Environment and Heritage, Department of Premier and Cabinet, Sydney, Australia.; Somerville, M. (2009a) Hunter, Central & Lower North Coast Vegetation Classification & Mapping Project Volume 1: Vegetation Classification Technical Report. Hunter-Central Rivers Catchment Management Authority, Tocal, NSW.;
Profile source:
PCT Definition Status: Approved

PCT 1728

IBRA Subregion: Occurs within the Wyong IBRA subregion

Vegetation formation/class: Forested Wetlands / Coastal Floodplain Wetlands

Landscape position: Occurs on poorly drained sites from East Gosford north to Tuncurry. Substrates are unconsolidated sediments and elevations are below 20m. The altitude, soils and geology are correct for this vegetation type.

PCT 1728 forms part of the SOFF EEC. This PCT within the study area contained several species that are listed in the final determinations for SOFF.

3.1.5 Vegetation integrity assessment

A vegetation integrity assessment is an assessment on the site's condition. Vegetation patches are broken into zones of roughly equal quality and then surveyed by transect plots. The number of required transect plots is dependent upon the size of the zone.

Vegetation zone area (ha)	Minimum number of plots/transects
<2	1 plot/transect
>2–5	2 plots/transects
>5–20	3 plots /transects
>20–50	4 plots/transects
>50–100	5 plots/transects
>100–250	6 plots/transects
>250–1000	7 plots/transects; more plots may be needed if the condition of the vegetation is variable across the zone
>1000	8 plots/transects; more plots may be needed if the condition of the vegetation is variable across the zone

Once data from the transect plot has been collected, the composition of native plant species per growth form is assessed, along with numbers of stems, percentages of high threat exotic species present, size class of tree stems present, number of large trees, litter cover, hollows and fallen logs. Therefore the vegetation integrity assessment is a measure of composition, structure and function.

Figure 2 shows the location of the plots in relation to the impacted areas. The breakdown of PCTs and zones is shown on Figure 3. Impacted areas (the subject site) are shown cross-hatched.

The vegetation integrity score is obtained using equations and weightings based upon a number of entities to calculate scores for composition, structure and function, for an overall current vegetation integrity score.

PCT 1728_moderate_good, which is very weedy with low native species abundance and richness, scores poorly for composition and structure, but well for function due to high abundance of large trees, high litter cover and log presence. PCT 1636_moderate_good scores fairly well for all. Table 3.3 shows the current vegetation integrity (VI) score.

The BAM calculator assigns each vegetation zone to a patch size class, being <5ha, 5–24ha, 25–100ha or ≥100ha. Patch size, which is used to assess habitat suitability for threatened species in the Bam calculator, was determined as ≥100ha, and entered as 1,000ha for each vegetation zone (any number entered as 100 or greater will have no bearing on the outcome).

Table 3.3 – Current vegetation integrity (VI) score

Vegetation zone name	Area (ha)	Patch size (ha)	Composition condition score	Structure condition score	Function condition score	Current VI score
1636_moderate_good	0.686	1000	54.7	77.7	54.7	61.5
1728_moderate_good (weedy)	0.106	1000	23.3	37.6	98.8	44.3

The future VI score is measured assuming there will be limited vegetation retained in the APZ impact area. For PCT 1636, it is assumed that tree cover will be reduced to 10%, 15% shrub cover, grasses 36%, forbs 1%, ferns to 1%, and other to 4%. For PCT 1728, it is assumed that tree cover will be reduced to 10%, shrubs to 0%, grasses to 20%, forbs to 0.1%, ferns to 0.1% and other to 5%.

Given the above clarification, the future vegetation integrity score will be above 0 as indicated in Table 3.4.

Table 3.4 – Future vegetation integrity score

Vegetation zone name	Area (ha)	Patch size (ha)	Composition condition score	Structure condition score	Function condition score	Future vegetation integrity score	Change in integrity score
1636_moderate_good	0.686	1000	37.6	33.8	10.9	24	-37.5
1728_moderate_good (weedy)	0.106	1000	18.1	21.3	49.1	26.7	-17.6

3.2 Fauna results

Fauna species observed throughout the duration of fauna surveys are listed in Table 3.5 below.

Table 3.5 – Fauna observations for the study area

Common name	Scientific name	Method observed		
Birds		RPS 2014	Abel 2017	TBE 2018
Australian King Parrot	<i>Alisterus scapularis</i>			W
Australian Magpie	<i>Cracticus tibicen</i>	✓	O	
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>		W	OW
Australian Pelican	<i>Pelecanus conspicillatus</i>		O	
Australian Raven	<i>Corvus coronoides</i>		O	OW
Australian White Ibis	<i>Threskiornis molucca</i>		O	
Australian Wood Duck	<i>Chenonetta jubata</i>		O	OW
Bell Miner	<i>Manorina melanophrys</i>		O	W
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>		O	OW
Brown Gerygone	<i>Gerygone mouki</i>			OW
Brown Goshawk	<i>Accipiter fasciatus</i>		O	O

Common name	Scientific name	Method observed		
Brown Thornbill	<i>Acanthiza pusilla</i>			OW
Common Blackbird *	<i>Turdus merula</i>			W
Common Myna *	<i>Sturnus tristis</i>	✓	O	OW
Crested Pigeon	<i>Ocyphaps lophotes</i>	✓	O	O
Crimson Rosella	<i>Platycercus elegans</i>	✓		
Eastern Rosella	<i>Platycercus eximius</i>	✓	O	
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	✓	O	OW
Eastern Whipbird	<i>Psophodes olivaceus</i>	✓	W	W
Eastern Yellow Robin	<i>Eopsaltria australis</i>	✓	O	W
Fairy Martin	<i>Hirundo ariel</i>		O	O
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>		W	
Figbird	<i>Sphecotheres viridis</i>		O	
Galah	<i>Eolophus roseicapillus</i>	✓	O	OW
Golden Whistler	<i>Pachycephala pectoralis</i>			OW
Grey Butcherbird	<i>Cracticus torquatus</i>	✓	O	OW
Grey Fantail	<i>Rhipidura albiscapa</i>	✓	O	OW
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	✓	O	
Hardhead	<i>Aythya australis</i>		O	
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>			W
House Sparrow *	<i>Passer domesticus</i>		O	
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	✓	O	
Lewin's Honeyeater	<i>Meliphaga lewinii</i>			W
Little Wattlebird	<i>Anthochaera chrysoptera</i>			W
Magpie-lark	<i>Grallina cyanoleuca</i>	✓	O	W
Masked Lapwing	<i>Vanellus miles</i>	✓	O	OW
Musk Lorikeet	<i>Glossopsitta concinna</i>		O	
Nankeen Kestrel	<i>Falco cenchroides</i>		O	O
Noisy Miner	<i>Manorina melanocephala</i>	✓	O	OW
Pacific Black Duck	<i>Anas superciliosa</i>		O	
Pied Butcherbird	<i>Cracticus nigrogularis</i>	✓		
Pied Currawong	<i>Strepera graculina</i>	✓		OW
Powerful Owl ^{TS}	<i>Ninox strenua</i>		O	
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	✓	O	OW
Red-browed Finch	<i>Neochmia temporalis</i>	✓	O	OW
Red Wattlebird	<i>Anthochaera carunculata</i>	✓	O	W
Red-whiskered Bulbul *	<i>Pycnonotus jocosus</i>			W
Rock Dove *	<i>Columba livia</i>		O	
Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>		O	W
Scarlet Robin ^{TS}	<i>Petroica multicolor</i>		W	
Silvereye	<i>Zosterops lateralis</i>	✓	O	OW
Spangled Drongo	<i>Dicrurus bracteatus</i>		O	
Spotted Pardalote	<i>Pardalotus punctatus</i>	✓		
Spotted Turtle-Dove *	<i>Streptopelia chinensis</i>		O	OW
Straw-necked Ibis	<i>Threskiornis spinicollis</i>		O	
Sulphur Crested Cockatoo	<i>Cacatua galerita</i>	✓		
Superb Fairy-wren	<i>Malurus cyaneus</i>	✓	O	OW
Variegated Fairy-wren	<i>Malurus lamberti</i>		O	
Welcome Swallow	<i>Hirundo neoxena</i>		O	O

Common name	Scientific name	Method observed		
White-bellied Sea-Eagle ^{TS}	<i>Haliaeetus leucogaster</i>		O	
White-browed Scrubwren	<i>Sericornis frontalis</i>	✓	O	OW
White-browed Treecreeper	<i>Climacteris affinis</i>	✓		
White-cheeked Honeyeater	<i>Phylidonyris niger</i>			W
White-faced Heron	<i>Egretta novaehollandiae</i>	✓		
Willie Wagtail	<i>Rhipidura leucophrys</i>	✓		
Yellow-faced Honeyeater	<i>Caligavis chrysops</i>	✓	O	W
Yellow-tailed Black-Cockatoo	<i>Calyptrorhynchus funereus</i>		O	
Mammals				
Black Rat *	<i>Rattus rattus</i>		Q	TQ
Brown Antechinus	<i>Antechinus stuartii</i>		Q	TQ
Bush Rat	<i>Rattus fuscipes</i>			TQ
Cat (feral)*	<i>Felis catus</i>	✓		
Chocolate Wattled Bat	<i>Chalinolobus morio</i>	✓		U ^{PO}
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	✓	O	OQ
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>	✓	O	O
East-coast Freetail Bat ^{TS}	<i>Micronomus norfolkensis</i>	✓	U	U
Eastern Bentwing-bat ^{TS}	<i>Miniopterus orianae oceanensis</i>	✓	U ^{PR}	U
Eastern Forest Bat	<i>Vespadelus pumilus</i>	✓ ^{PO}		U ^{PR}
Eastern Freetail-bat	<i>Mormopterus ridei</i>	✓ ^{PO}		U
European Red Fox *	<i>Vulpes vulpes</i>	✓		
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	✓	U	U
Greater Broad-nosed Bat ^{TS}	<i>Scoteanax rueppellii</i>	✓ ^{PO}	U ^{PR}	U
Grey-headed Flying-fox ^{TS}	<i>Pteropus poliocephalus</i>		W	
Large-footed Myotis ^{TS}	<i>Myotis macropus</i>	✓ ^{PO}	U ^{PO}	
Long-eared Bat	<i>Nyctophilus sp.</i>	✓ ^{PO}		
Little Bentwing-bat ^{TS}	<i>Miniopterus australis</i>	✓		U
Little Forest Bat	<i>Vespadelus vulturnus</i>	✓ ^{PO}	U ^{PR}	U ^{PR}
Northern Brown Bandicoot	<i>Isodon macrourus</i>			Q
Rabbit *	<i>Oryctolagus cuniculus</i>	✓	O	O
Southern Forest Bat	<i>Vespadelus regulus</i>	✓ ^{PO}	U ^{PR}	
Sugar Glider	<i>Petaurus breviceps</i>		Q	T
Swamp Rat	<i>Rattus lutreolus</i>	✓		Q
Swamp Wallaby	<i>Wallabia bicolor</i>			P ^{PR}
White-striped Mastiff-bat	<i>Austronomus australis</i>	✓	U ^{PR}	U
Reptiles				
Delicate Skink	<i>Lampropholis delicata</i>			O
Eastern Water Skink	<i>Eulamprus quoyii</i>			O
Amphibians				
Dwarf Tree Frog	<i>Litoria fallax</i>			W

Note: * indicates introduced species
^{TS} indicates threatened species

All species listed are identified to a high level of certainty unless otherwise noted as:

^{PR} indicates species identified to a 'probable' level of certainty – more likely than not

^{PO} indicates species identified to a 'possible' level of certainty – low-moderate level of confidence

Common name		Scientific name	Method observed
E - Nest/roost			W - Heard call
F -	H - Hair/feathers/skin	P - Scat	X - In scat
Tracks/scratchings	K - Dead	Q - Camera	Y - Bone/teeth/shell
FB - Burrow	O - Observed	T - Trapped/netted	Z - In raptor/owl pellet
G - Crushed cones	OW - Obs & heard call	U - Anabat/ultrasound	

3.3 BAM calculator species

The BAM calculator predicts the following ecosystem species:

- Australasian Bittern
- Gang-gang Cockatoo (Foraging)
- Glossy Black-Cockatoo (Foraging)
- Speckled Warbler
- Spotted Harrier
- Brown Treecreeper (eastern subspecies)
- Varied Sittella
- Spotted-tailed Quoll
- Little Lorikeet
- Painted Honeyeater
- White-bellied Sea-Eagle (Foraging)
- Little Eagle (Foraging)
- Black Bittern
- Swift Parrot (Foraging)
- Square-tailed Kite (Foraging)
- Black-chinned Honeyeater (eastern subspecies)
- Little Bentwing-bat (Foraging)
- Eastern Bentwing-bat (Foraging)
- Eastern Freetail-bat
- Turquoise Parrot
- Barking Owl (Foraging)
- Powerful Owl (Foraging)
- Eastern Osprey (Foraging)
- Scarlet Robin
- Koala (Foraging)
- Grey-crowned Babbler (eastern subspecies)
- Grey-headed Flying-fox (Foraging)
- Yellow-bellied Sheath-tail-bat
- Masked Owl (Foraging)

The BAM calculator predicts the following candidate species credit species:

- *Acacia bynoeana*
- *Angophora inopina*
- *Astrotricha crassifolia*
- Bush Stone-curlew
- *Callistemon linearifolius*
- Gang-gang Cockatoo (Breeding)
- Glossy Black-Cockatoo (Breeding)
- Eastern Pygmy-possum
- Large-eared Pied Bat
- Wallum Froglet
- *Cryptostylis hunteriana*
- *Diuris praecox*
- *Eucalyptus camfieldii*
- *Genoplesium insigne*
- *Grevillea parviflora subsp. parviflora*
- White-bellied Sea-Eagle (Breeding)
- Little Eagle (Breeding)
- Pale-headed Snake
- Swift Parrot (Breeding)
- Green and Golden Bell Frog
- Green-thighed Frog
- Square-tailed Kite (Breeding)
- *Melaleuca groveana*
- Little Bentwing-bat (Breeding)
- Eastern Bentwing-bat (Breeding)
- Southern Myotis
- Barking Owl (Breeding)
- Powerful Owl (Breeding)
- Eastern Osprey (Breeding)
- *Persicaria elatior*
- Giant Dragonfly
- Squirrel Glider
- Brush-tailed Rock-wallaby
- Brush-tailed Phascogale
- Koala (Breeding)
- Common Planigale
- *Prostanthera askania*
- Grey-headed Flying-fox (Breeding)
- *Rutidosis heterogama*
- *Tetratheca glandulosa*
- *Tetratheca juncea*
- Masked Owl (Breeding)
- Mahony's Toadlet

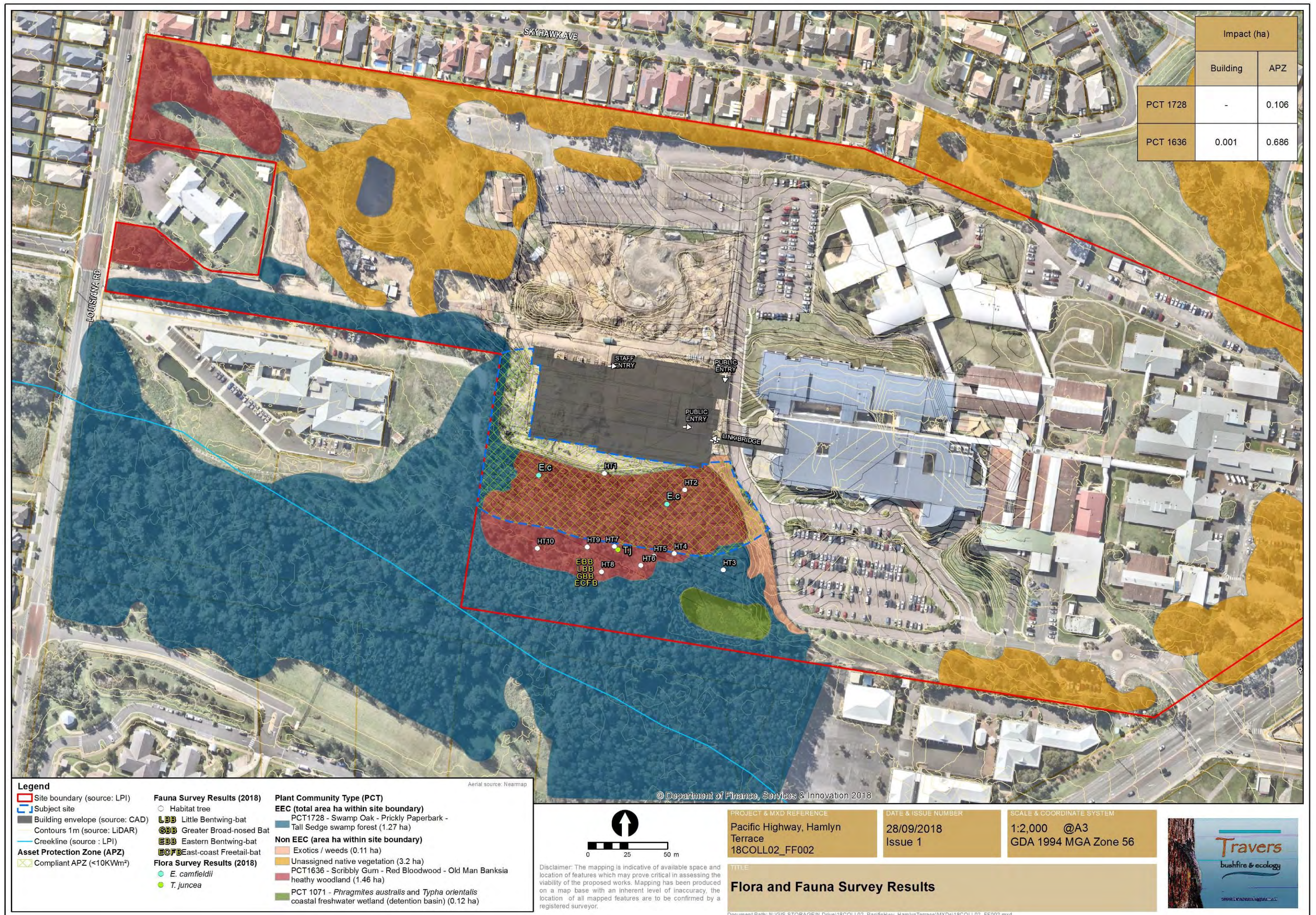


Figure 3 – Flora and fauna survey results (PCTs and vegetation zones)



Biodiversity Assessment

4

4.1 BOS thresholds

The BOS includes two (2) elements to the threshold test – an area trigger and a Sensitive Biodiversity Values Land Map trigger. If clearing exceeds either trigger, the Biodiversity Offset Scheme applies to the proposed clearing.

Section 7.14 (State significant development or infrastructure), clause 4, of the *BC Act* states:

“A condition to retire biodiversity credits is required to be complied with before any development is carried out that would impact on biodiversity values.”

As this project is a state significant development that impacts on biodiversity values, the above condition requires entry into the BOS, and therefore threshold criteria do not need consideration.

4.1.1 Sensitive Biodiversity Values Land

As this project is a state significant development that already enters into the BOS, this threshold criteria does not need consideration.

Nonetheless the study area is located on lands mapped as Sensitive Biodiversity Values Land (Figure 3).



Figure 4 – Sensitive Biodiversity Land Map (Orange) – study area shown in Red
(source: <https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=BVMap>)

4.1.2 Area clearing threshold

As this project is a state significant development that is to be assessed under the BOS, this threshold criteria does not need consideration.

The area threshold varies depending on the minimum lot size (shown in the Lot Size Maps made under the relevant Local Environmental Plan (LEP), or actual lot size (where there is no minimum lot size provided for the relevant land under the LEP).

The area threshold applies to all proposed native vegetation clearing associated with a development proposal. Thresholds outlined under the BOS are outlined in the table below.

Results Summary		
Date of Calculation	12/09/2018 4:16 PM	BAM Required*
Total Digitised Area	2.12 ha	
Minimum Lot Size Method	Lot size	
Minimum Lot Size	20.15 ha	
Area Threshold	0.5 ha	
Area of native vegetation cleared	Unknown #	Unknown #
Impact on biodiversity values land map	yes	yes

No minimum lot size is provided by the Wyong LEP (2013) so the actual lot size of 20.09ha is used. This means that a clearing threshold 0.5ha applies.

4.1.3 Serious and Irreversible Impacts

An impact is to be regarded as serious and irreversible if it is likely to contribute significantly to the risk of a threatened species or ecological community most at risk of extinction. Threatened species and communities that are potential for serious and irreversible impacts are outlined in Appendix 2 of *Guidance to assist a decision-maker to determine a serious and irreversible impact* (OEH 2017). The principles for determining serious and irreversible impacts are set out under Section 6.7.2 of the *Biodiversity Conservation Regulation 2017*.

Candidate species recorded or with potential to occur within the study area include:

Table 4.1 – Candidate SAIL species

Species (Scientific name)	Species (Common name)	BC Act	Potential to occur
<i>Miniopterus schreibersii</i> subsp. <i>oceanensis</i>	Eastern bentwing-bat	E	recorded
<i>Vespadelus troughtoni</i>	Eastern cave bat	V	unlikely
<i>Miniopterus australis</i>	Little bentwing-bat	E	recorded
Swamp Oak Floodplain Forest	-	EEC	recorded

The additional impact assessment provisions for threatened species are outlined under Section 10.2.3 of the BAM (2017) and have been applied to the recorded Eastern Bentwing-bat and Little Bentwing-bat within Appendix 5. Swamp Oak Floodplain Forest

has been additionally assessed in Appendix 6. As a result of this assessment it is concluded that the proposal will not likely cause a serious or irreversible impact on the Eastern Bentwing Bat, Little Bentwing-bat or Swamp Oak Floodplain Forest.

4.2 Previous surveys reviewed

The following regional vegetation mapping and ecological assessments were examined to identify the potential vegetation communities and threatened species onsite.

Lower Hunter and Central Coast Regional Environment Management Strategy Vegetation Survey, Classification and Mapping; Lower Hunter and Central Coast Region (LHCCREMS) (NPWS 2003):

- Wyong Paperbark Swamp Forest (MU43)
- Swamp Oak Sedge Forest (MU41)
- Coastal Plains Scribbly Gum Woodland (MU31)

Revised Vegetation mapping of Wyong LGA: Stage 1 - West of F3 Freeway. Report to Wyong Shire Council (Bell & Driscoll 2008):

- Alluvial Floodplain Shrub Swamp Forest (MU 20)
- Estuarine Swamp Oak Forest (MU 03)
- Narrabeen Buttonderry Footslopes Forest (MU28)

Wyong Hospital Redevelopment: Ecological Assessment (RPS 2014):

- Alluvial Floodplain Shrub Swamp Forest (MU 20)
- Narrabeen Buttonderry Footslopes Forest (MU28)
- East-coast Freetail Bat (*Micronomus norfolkensis*)
- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – possible recording
- Large-footed Myotis (*Myotis macropus*) – possible recording
- Little Bentwing-bat (*Miniopterus australis*)
- Modified and Disturbed Bushland
- Weeds and Exotics
- Landscaped Areas

Note: the Eastern Falsistrelle (*Falsistrellus tasmaniensis*) was also a possible recording within this report alongside several other non-threatened microbats which have not been included in the species list for this assessment as they were not further recorded by *Abel Ecology* (2017) or *Travers bushfire & ecology* (2018).

Wyong Hospital – Enabling Works: Flora & Fauna Assessment (Abel Ecology 2017):

- Coastal Foothills Spotted Gum – Ironbark Forest (LHCCREMS MU15)
- Swamp Mahogany – Paperbark Swamp Forest (LHCCREMS MU37)
- Wyong Paperbark Swamp Forest (LHCCREMS MU43)
- Narrabeen Doyalson Coastal Woodland (Wyong MU31)
- Powerful Owl (*Ninox strenua*)
- Scarlet Robin (*Petroica multicolor*)
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- East-coast Freetail Bat (*Micronomus norfolkensis*)

- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*) – probable recording
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – probable recording
- Large-footed Myotis (*Myotis macropus*) – possible recording

Note: Scarlet Robin may have been confused with a non-threatened species as it was not recognised as vulnerable in the recorded fauna list and was not assessed as threatened within the document.

4.3 Flora

All species are listed in Table 3.1.

Two (2) threatened flora species were observed: *Eucalyptus camfieldii* and *Tetratheca juncea*. *Eucalyptus camfieldii* was recorded at two locations within the subject site and *Tetratheca juncea* is located just beyond the subject site and is therefore not impacted.

4.3.1 Local / Regional flora matters

The following species, listed as Keystone Tree Species in the Wyong Council Flora and Fauna Survey Guidelines Appendix 8.4 – Species Having Conservation Significance – were observed within the study area:

Common name	Botanical name	Potential Schedule 1 or 2 fauna
Wattle	<i>Acacia longifolia</i>	Squirrel Glider
Sydney Red Gum	<i>Angophora costata</i>	Squirrel Glider
Banksia	<i>Banksia oblongifolia</i>	Squirrel Glider
Red Bloodwood	<i>Corymbia gummifera</i>	Squirrel Glider
Scribbly Gum	<i>Eucalyptus haemastoma</i>	Marked Owl / Squirrel Glider
Forest Red Gum	<i>Eucalyptus tereticornis</i>	Yellow-bellied Glider / Koala
Paperbarks	local <i>Melaleuca</i> species	Ringtail Possum
Grass Tree	<i>Xanthorrhoea</i> spp.	Squirrel Glider

4.3.2 State legislative flora matters

BC Act – A search of the *Atlas of NSW Wildlife* (OEH 2018) indicated a list of species that have been recorded within a 10 km radius of the study area. Those species are considered for suitable habitat and potential to occur in Table A2.1 (Appendix 2).

Based on the habitat assessment within Appendix 2, it is considered that the subject site provides varying levels of potential habitat for the following state listed threatened flora species:

Table 4.2 – State listed threatened flora species with suitable habitat present

Scientific name	BC Act	Potential to occur
<i>Eucalyptus camfieldii</i>	V	recorded (probable)
<i>Tetratheca juncea</i>	V	recorded outside subject site
<i>Angophora inopina</i>	V	low
<i>Cryptostylis hunteriana</i>	V	low
<i>Genoplesium insigne</i>	E1	low

Scientific name	BC Act	Potential to occur
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V	low
<i>Callistemon linearifolius</i>	V	unlikely
<i>Melaleuca biconvexa</i>	V	unlikely
<i>Rutidosia heterogama</i>	V	unlikely
<i>Thelymitra adorata</i>	E4a	unlikely

Note: Full habitat descriptions for these species are provided in Appendix 2.

One (1) state listed threatened flora species, *Eucalyptus camfieldii*, was observed during surveys undertaken with a 'probable' level of certainty. A specimen sent to the NSW Herbarium prompted the following determination:

"Eucalyptus camfieldii <-> *capitellata* (intergrade or hybrid), juvenile material required for more detailed diagnosis det. A.E. Orme 14 Sep 2018"

In the absence of better material for diagnosis, we take a conservative approach regarding the identification of this species, and treat it as *E. camfieldii* for the purposes of this assessment.

One (1) further state listed threatened flora species, *Tetratheca juncea*, was also observed during surveys undertaken just outside the subject site.

As the proposed development is a state significant development, and the BOS already applies, a significance of impact assessment is not required.

Impacts upon *E. camfieldii* and *T. juncea* are not listed as potential SAILs (*Reference - Guidance to assist a decision-maker to determine a serious and irreversible impact* Office of Environment & Heritage 2017).

(b) Endangered flora populations (NSW)

There are two (2) known endangered populations within Wyong Shire. *Eucalyptus parramattensis* subsp. *parramattensis* in the Wyong and Lake Macquarie LGAs *Eucalyptus oblonga* at Bateau Bay.

They are not represented within the study area.

(c) Threatened ecological communities (NSW)

One (1) threatened ecological community (TEC) – *Swamp oak floodplain forest of the NSW North Coast / Sydney Basin and South East Corner bioregions* (SOFF) – was observed within the subject site. This community is listed as an EEC under the BC Act.

As the proposed development is considered a state significant development, and the BOS already applies, a significance of impact assessment is not required.

SOFF is listed in the BAM calculator as a candidate ecological community that meets the SAIL principles and criteria. This potential SAIL is dealt with in Appendix 6.

(d) Ecosystem credit species

Based upon the BAM calculator and field surveys to date, no predicted threatened flora species were considered as confirmed candidate species.

(e) Species credit species

Based upon the BAM calculator and field surveys to date, the following predicted threatened species were considered as confirmed candidate species and associated PCT (1638 moderate-good, 1728 moderate-good):

Table 4.3 – Species credit species (flora)

Common name	BC Act	Potential to occur (presence status) / Habitat	Associated PCTs	Survey sufficient to rule out presence	Presence		Final Candidate Species
					Assumed	Expert report	
<i>Acacia bynoeana</i>	E1	not likely		✓ also			
<i>Angophora inopina</i>	V	low	1636	✓			
<i>Astrotricha crassifolia</i>	V	x		✓			
<i>Callistemon linearifolius</i>	E1	x		✓ also			
<i>Cryptostylis hunteriana</i>	V	low	1636	x	✓		✓
<i>Diuris praecox</i>	V	not likely		✓ also			
<i>Eucalyptus camfieldii</i>	V	recorded - subject site	1636		✓		✓
<i>Genoplesium insigne</i>	E1	low	1636	✓			
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V	low	1636	✓			
<i>Melaleuca groveana</i>	V	x		✓ also			
<i>Persicaria elatior</i>	V	low	1728	x	✓		✓
<i>Prostanthera askania</i>	E1	x		✓ also			
<i>Rutidosia heterogama</i>	V	unlikely	1636	✓			
<i>Tetratheca glandulosa</i>	V	x		✓			
<i>Tetratheca juncea</i>	V	recorded in study area but outside impact area	1636	✓			

The species that have been excluded above are excluded based on the absence of any suitable habitat, not being detected in targeted survey, available extent of remaining habitat, geographic distribution, soil type, last known local record being decades old, distance to nearest record, isolation of particular habitats or degradation of habitats. Specific reasons for each excluded species are given below:

- *Acacia bynoeana*: marginal habitat and no records within 5km of site. Survey in September also sufficient to rule out presence.
- *Diuris praecox*: no records within 8km of site. Survey in September also sufficient to rule out presence.
- *Melaleuca groveana*: no records within 10km of site. Survey in September also sufficient to rule out presence.

- *Prostanthera askania*: OEH specie profile states “Occurs in moist sclerophyll forest and warm temperate rainforest communities” - there is no such habitat on site. Survey in September also sufficient to rule out presence.
- *Tetratheca glandulosa*: OEH species profile states “occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches” - there is no such habitat on site. No records within 10km. Survey in September also sufficient to rule out presence.

The impact area polygon for species credit species with potential habitat present is indicated on Figure 5.

(f) Local data

Local data has not been used in this case.

(g) Expert reports

Expert reports have not been utilised for flora on this project.

(h) Endangered wetland communities

A number of wetland communities have been listed as TECs under the NSW *BC Act*. We note that ‘wetlands’ are included in the definition of ‘waterfront lands’ in accordance with the *Water Management Act 2000 (WM Act)* due to their inclusion in the definition of a ‘lake’ under the same Act. TECs that are considered to be an endangered protected wetland are as follows:

- Artesian springs ecological community
- Castlereagh Swamp Woodland Community
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions
- Coastal Upland Swamp in the Sydney Basin bioregion
- Coolibah–Black Box woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands bioregions
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions
- Kurri sand swamp woodland in the Sydney Basin Bioregion
- Lagunaria swamp forest on Lord Howe Island
- Maroota Sands swamp forest
- Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion
- Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions
- Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions
- The shorebird community occurring on the relict tidal delta sands at Taren Point
- Upland wetlands of the drainage divide of the New England Tableland Bioregion
- Wingecarribee Swamp

SOFF present within the subject site is considered an endangered wetland community. The following impacts are to be considered:

- *Impact on the extent of wetland vegetation*

The proposed development will remove 0.106ha of SOFF. This SOFF is part of a larger patch of SOFF covering approximately 7ha.

- *Impact on acid sulfate soils*

Acid sulfate soils are not mapped within the study area on the Wyong Local Environment Plan 2013 acid sulfate soils map.

- *Indirect impacts*

Indirect impacts are identified in Section 5.1

- *Impacts due to stormwater quality or quantity*

The proposal is likely to increase the flow of runoff due to larger areas of impervious surfaces and reduced vegetation cover. Higher sediment and nutrient loads are also likely. Monitoring of water quality before, during and after development is to be undertaken. Standard sediment control practices are to be in place during construction.

- *Impacts on groundwater*

Clearing of vegetation, particularly trees, can raise the level of groundwater. Minimisation of tree clearing within the proposed APZ should reduce the amount of groundwater rise.

- *Proposed mitigation measures*

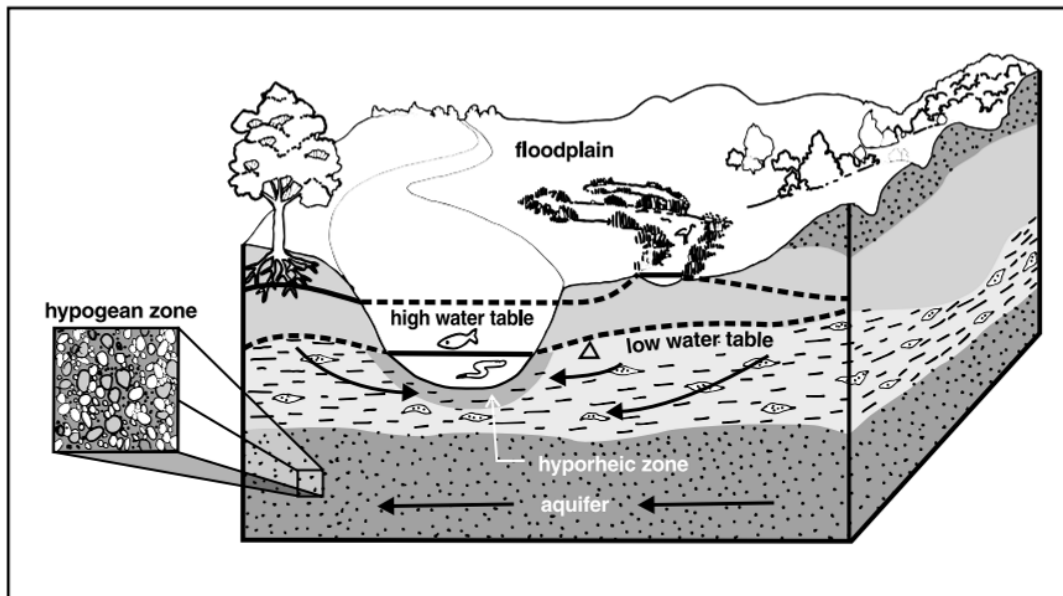
Actions and designing of works to avoid and minimise impacts are listed in Section 5.2.

In accordance with the *WM Act*, endangered wetland communities are through the definition of 'lakes' potentially classed as waterfront land. Referral to DPI WaterNSW may be required for determination under the *WM Act* as a controlled activity. As well as protection, a buffer may be applied to these communities as specified by DPI WaterNSW.

(i) Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater. Some examples of ecosystems which depend on groundwater are:

- wetlands;
- red gum forests, vegetation on coastal sand dunes and other terrestrial vegetation;
- ecosystems in streams fed by groundwater;
- limestone cave systems;
- springs; and
- hanging valleys and swamps.



Alluvial groundwater system discharging into a river

Groundwater dependent ecosystems are therefore ecosystems which have their species composition and their natural ecological processes determined by groundwater (NSW State Groundwater Dependent Ecosystems Policy April 2002).

The SOFF (PCT 1728) is a Groundwater Dependent Ecosystem (GDE) as it is likely fed from an alluvial aquifer. The proposed development is likely to remove or modify 0.106 ha of SOFF.

(j) Coastal wetlands

Wetlands on site or adjacent

The new interactive mapping tool provides updated mapping of the former SEPP 14 wetlands, and does not identify any such wetlands within, or adjacent to, the study area.

(k) State Environmental Planning Policy (Coastal Management) 2018

State Environmental Planning Policy (Coastal Management) 2018 updates and consolidates into one integrated policy SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection), including clause 5.5. of the Standard Instrument – Principal Local Environmental Plan. These policies are now repealed.

The Coastal Management SEPP gives effect to the objectives of the *CM Act* from a land use planning perspective, by specifying how development proposals are to be assessed if they fall within the coastal zone.

An integrated and coordinated approach to land use planning is promoted by the new SEPP. It defines the four coastal management areas in the Act through detailed mapping and specifies assessment criteria that are tailored for each coastal management area. Councils and other consent authorities must apply these criteria when assessing proposals for development that fall within one or more of the mapped areas. The Coastal Management SEPP identifies development controls for consent authorities to apply to each coastal management area to achieve the objectives of the *CM Act*.

The Coastal Management SEPP establishes the approval pathway for coastal protection works.

The Coastal Management SEPP does not apply to this site as it does not fall under any of the coastal management areas.

4.3.3 Matters of national environmental significance - flora

(a) Threatened flora species (national)

A review of the schedules of the *EPBC Act* indicated the potential for a list of threatened flora species to occur within a 10km radius of the site. These species have been considered for habitat presence and potential to occur within Appendix 2.1.

Based on the habitat assessment within Appendix 2.1, it is considered that the subject site provides varying levels of potential habitat for the following nationally listed threatened flora species:

Table 4.4 – Nationally listed threatened flora species with suitable habitat present

Scientific name	<i>EPBC Act</i>	Potential to occur
<i>Eucalyptus camfieldii</i>	V	recorded (probable)
<i>Tetratheca juncea</i>	V	recorded outside subject site
<i>Angophora inopina</i>	V	low
<i>Cryptostylis hunteriana</i>	V	low
<i>Genoplesium insigne</i>	CE	low
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V	low
<i>Melaleuca biconvexa</i>	V	unlikely
<i>Rutidosia heterogama</i>	V	unlikely
<i>Thelymitra adorata</i>	CE	unlikely

One (1) nationally listed threatened flora species, *Eucalyptus camfieldii*, was observed during surveys undertaken within the subject site at a 'probable' level of certainty. A specimen sent to the NSW Herbarium prompted the following determination:

"Eucalyptus camfieldii <-> *capitellata* (intergrade or hybrid), juvenile material required for more detailed diagnosis det. A.E. Orme 14 Sep 2018"

In the absence of better material for diagnosis, we take a conservative approach regarding the identification of this species, and treat it as *E. camfieldii* for the time being.

One (1) further nationally listed threatened flora species, *Tetratheca juncea*, was also observed during surveys undertaken. This species was recorded just outside of the subject site.

(b) Endangered ecological communities (national)

No *EPBC Act* listed TECs were observed within the study area.

4.4 Fauna

All fauna species recorded during combined survey(s) are listed in Table 3.5.

4.4.1 Fauna habitat

The fauna habitats present within the site are identified within the following table.

Table 4.5 – Observed fauna habitat

Topography					
Flat	✓	Gentle	✓	Moderate	Steep
Drop-offs					
Vegetation structure					
Closed forest		Open forest	✓	Woodland	Heath
Grassland					
✓					✓
Disturbance history					
Fire		Under-scrubbing	✓	Cut and fill works	✓
Tree clearing	✓	Grazing			
Soil landscape					
DEPTH:	Deep	✓	Moderate	✓	Shallow
TYPE:	Clay	✓	Loam	✓	Sand
VALUE:	Surface foraging	✓	Sub-surface foraging	✓	Denning/burrowing
WATER RETENTION:	Well Drained	✓	Damp / Moist	Water logged	Swamp / Soak
Rock habitat					
None present					
Feed resources					
FLOWERING TREES:	Eucalypts	✓	Corymbias	✓	Melaleucas
	Banksias		Acacias	✓	
SEEDING TREES:	Allocasuarinas	✓	Conifers		
WINTER FLOWERING EUCALYPTS:	C. maculata		E. crebra		E. globoidea
	E. squamosa		E. grandis		E. multicaulis
	E. robusta		E. tereticornis		E. agglomerata
FLOWERING PERIODS:	Autumn		Winter		Spring
OTHER:	Mistletoe		Figs / Fruit		Sap / Manna
Foliage protection					
UPPER STRATA:	Dense		Moderate	✓	Sparse
MID STRATA:	Dense	✓	Moderate	✓	Sparse
PLANT / SHRUB LAYER:	Dense	✓	Moderate	✓	Sparse
GROUNDCOVERS:	Dense	✓	Moderate	✓	Sparse
Hollows / logs					
TREE HOLLOW:	Large		Medium	✓	Small
TREE HOLLOW TYPES	Spouts / branch	✓	Trunk	✓	Broken Trunk
GROUND HOLLOW:	Large		Medium		Small
Vegetation debris					
FALLEN TREES:	Large		Medium		Small
FALLEN BRANCHES:	Large		Medium		Small
LITTER:	Deep		Moderate	✓	Shallow
HUMUS:	Deep		Moderate		Shallow
Drainage catchment					
WATER BODIES	Wetland(s)	Soak(s)	Dam(s)	✓	Drainage line(s)
RATE OF FLOW:	Still	✓	Slow		Rapid

CONSISTENCY:	Permanent	Perennial	✓	Ephemeral	✓
RUNOFF SOURCE:	Urban/ Industrial ✓	Parkland	Grazing	Natural	
RIPARIAN HABITAT:	High quality	Moderate quality	Low quality ✓	Poor quality	
Artificial habitat					
STRUCTURES:	Sheds	Infrastructure	Equipment		
SUB-SURFACE	Pipe / culvert(s) ✓	Tunnel(s)	Shaft(s)		
FOREIGN MATERIALS:	Sheet	Pile / refuse			

4.4.2 Habitat trees

A complete assessment of the location of habitat trees and the size of hollows within the subject site was undertaken as part of surveys. Table 4.6 below provides hollow-bearing tree data and other habitat features recorded. Figure 3 shows locations of habitat trees.

Table 4.6 – Habitat tree data

Tree no.	Common name	DBH (cm)	Height (m)	Spread (m)	Vigour (%)	Hollows & other habitat features recorded
HT1	Smooth-barked Apple	110	18	12	20	1x 20-30cm trunk, 1x 40-50cm trunk, feral bees / trunk scratch
HT2	Smooth-barked Apple	90	18	15	20	1x 5-10cm branch spout, 1x 20-30cm trunk, 3x 30-40cm trunk, nest box
HT3	Smooth-barked Apple	180	20	25	60	1x 10-15cm trunk, 1x 20-30cm trunk, 1x 30-40cm trunk, trunk scratch /feral bees
HT4	Smooth-barked Apple	120	30	12	35	1x 10-15cm trunk, 1x 40-50cm trunk, trunk scratch
HT5	Smooth-barked Apple	95	18	8	30	1x 10-15cm branch spout, 1x 30-40cm trunk, trunk scratch
HT6	Smooth-barked Apple	150	20	18	40	1x 5-10cm branch spout, 2x 15-20cm trunk
HT7	Smooth-barked Apple	120	18	9	20	1x 5-10cm branch spout, 2x 10-15cm trunk, 1x 15-20cm trunk, trunk scratch
HT8	Smooth-barked Apple	100	25	25	60	1x 15-20cm branch spout, 1x 30-40cm trunk, nest box
HT9	Red Bloodwood	90	25	25	70	nest box
HT10	Smooth-barked Apple	80	20	10	20	1x 5-10cm branch spout, nest boxes x2

Hollow-dependent threatened fauna species recorded during previous or recent surveys include the Powerful Owl, East-coast Freetail Bat, Greater Broad-nosed Bat and Large-footed Myotis. Of these the Greater Broad-nosed Bat and East-coast Freetail bat were

recorded as part of recent surveys within the subject site itself. Whilst some large sized hollows were recorded these were not considered suitable for Powerful Owl or other threatened large forest owls and no owl activity was detected within the subject site.

The hollows within the subject site itself may therefore support roosting/breeding habitat for the recorded hollow-dependent threatened microbats East-coast Freetail Bat, Large-footed Myotis and Greater Broad-nosed Bat.

Non-threatened hollow-dependent fauna species recorded during combined surveys include Australian King Parrot, Australian Owlet-nightjar, Australian Wood Duck, Crimson Rosella, Eastern Rosella, Galah, Musk Lorikeet, Pacific Black Duck, Rainbow Lorikeet, Spotted Pardalote, Sulphur Crested Cockatoo, Yellow-tailed Black-Cockatoo, Brown Antechinus, Chocolate Wattled Bat, Common Brushtail Possum, Common Ringtail Possum, Eastern Forest Bat, Eastern Freetail-bat, Gould's Wattled Bat, Long-eared Bat, Little Forest Bat, Southern Forest Bat, Sugar Glider and White-striped Mastiff-bat.

It is anticipated that all recorded hollows will be retainable as part of the proposal. Two hollow-bearing trees (HT1 & HT2) are located within the proposed APZ however these may be retained subject to a health and safety assessment. The other recorded hollows are located just beyond the proposed APZ extent. In this case it is expected that if any hollows are utilised by recorded microbats for roosting/breeding then such use may continue.

4.4.3 Local fauna matters

(a) Squirrel Glider habitat assessment

Squirrel Glider habitat on the subject site should be assessed according to Wyong Shire Council's (now Central Coast Council) *Interim Ecological Assessment Information Required to Assess Clearing Impacts within Squirrel Glider Habitat in Wyong Shire* (Wyong Shire Council, August 2000). A standardized field proforma providing consideration to this document is filled out during field surveys undertaken within the Wong LGA.

The assessment of Squirrel Glider habitat considers the following:

- (a) Habitat quality (vegetation type);
- (b) Remnant patch size;
- (c) Density of habitat trees;
- (d) Abundance of food plants;
- (e) Habitat vulnerability;
- (f) Disturbance factors.

Habitat quality

The subject site contains two native vegetation communities. These are listed below with their respective areas of impact.

Table 4.7 – Impacted habitat suitable for Squirrel Glider

Vegetation community	Study area		
	Study area	Subject site	% loss
Swamp Oak – Prickly Paperbark – Tall Sedge Swamp Forest	7.07	0.11	1.5%
Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland	1.46	0.69	47.1%
TOTAL	8.528117	0.791867	9.29%

The Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland vegetation community provides high quality habitat for Squirrel Glider on the optimum end of preference. All key dominant species are utilised for foraging as seasonal flowering permits. The Red Bloodwood may also be used for sap flows.

Whilst the majority of this community is indicated to be impacted in Table 5.4, it should be noted that all of this impacted area is within the proposed APZ and the trees most suitable for foraging and denning may therefore be selected and retained. Squirrel Glider will continue using such trees in a managed landscape provided connectivity permits and there is suitable habitat extent within the connective landscape. Nonetheless, the impacted patch of this community is the largest within the immediate locality bound by Central Coast Hwy and Louisiana Road.

A small patch of Swamp Oak – Prickly Paperbark – Tall Sedge Swamp Forest will also be impacted. This community is utilised by Squirrel Glider, particularly given its central proximity on the floodplain to more ideal communities. Swamp Oak itself is not of value for foraging however paperbark and Swamp Mahogany trees proximate to these are of high seasonal importance. The portion of this community that will be impacted by the proposal is dominated by Swamp Oak and therefore has very minor foraging capacity. With the absence of hollows also along this strip the remaining value of this patch is for connectivity across the fragmented landscape towards the north-west.

Remnant patch size

The remnant patch size of Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland is 0.95 ha. Of this 0.69 ha will be impacted by APZ. The total area of connective open forest habitat bound by Central Coast Hwy and Louisiana Road is just over 7 ha. This is closer to the less optimum patch size.

Density habitat trees

The density of habitat trees within the Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland vegetation community is notably high at greater than 2 potential habitat trees per hectare, which is in the more important end of the scale. The density of habitat trees beyond this community in the immediate connective locality is low and at the less optimum end <2 trees with hollows / ha.

Abundance of food plants of Squirrel Glider

The abundance of Squirrel Glider food resources within the subject site for the open forest vegetation communities is provided in the following table.

Table 4.8 – Squirrel Glider food resource abundance

Food plants	Food item	Estimated average no. of plants / hectare in	
		Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland	Swamp Oak – Prickly Paperbark – Tall Sedge Swamp Forest
<i>Angophora costata</i>	Sap, nectar & pollen	30	0
<i>Eucalyptus haemastoma</i>	Sap, nectar & pollen	60	0
<i>Eucalyptus racemosa</i>	Sap, nectar & pollen	0	0

Food plants	Food item	Estimated average no. of plants / hectare in	
		Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland	Swamp Oak – Prickly Paperbark – Tall Sedge Swamp Forest
<i>Eucalyptus robusta</i>	Sap, nectar & pollen	0	0
<i>Eucalyptus siderophloia</i>	Sap, nectar & pollen	0	0
<i>Eucalyptus paniculata</i>	Sap, nectar & pollen	0	0
<i>Eucalyptus fibrosa</i>	Sap, nectar & pollen	0	0
<i>Corymbia gummifera</i>	Sap, nectar & pollen	10	0
<i>Corymbia maculata</i>	Nectar & pollen	0	0
<i>Melaleuca linariifolia</i>	Nectar & insects	6	5
<i>Melaleuca nodosa</i>	Nectar & insects	80	6
<i>Melaleuca quinquenervia</i>	Nectar & insects	0	0
<i>Melaleuca sieberi</i>	Nectar & insects	20	5
<i>Acacia</i> spp.	Seeds & gum	20	0
<i>Banksia spinulosa</i>	Nectar & pollen	0	0
<i>Banksia serrata</i>	Nectar & pollen	0	0
<i>Banksia integrifolia</i>	Nectar & pollen	0	0
<i>Banksia oblongifolia</i>	Nectar & pollen	6	0
<i>Xanthorrhoea</i> spp.	Nectar & gum	15	0

Edge to width ratio

The connective remnant patch size is most similar to the oval shape however combining the remaining connective fragments surrounding the hospital a high edge to width ratio of habitat remains.

Habitat disturbance

The *Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland vegetation community* is in relatively good condition. The remaining native vegetation communities within the study area including the Swamp Oak forest to the remaining south are heavily impacted by weeds, most notably Lantana and Privet. In this regard, the best quality area of remaining habitat in the immediate locality for Squirrel Glider will be impacted.

Proximity to existing or future residential development

Development within the study area for the hospital facilities have been progressive in recent years. There is no known future development plans following the current proposal. The recent developments have placed increasing pressures on the native vegetation remaining within the lot and surrounding study area. The zoning within the entire subject lot is SP2 Health Services Facility however most of the remaining open forest habitat within this lot to the south is flood affected. The remaining open forest in adjacent lots to the immediate south of this lot are also flood affected.

Conclusion of Squirrel Glider assessment

The impacted area of habitat covers most of the remaining *Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland vegetation community* in the immediate locality. This area appears to be the highest quality habitat remaining for the Squirrel Glider in the immediate

locality. This is given the vegetation community and constituent floristics for seasonal foraging diversity but also the density of hollows and the quality of habitat. Much of the valuable habitat features for Squirrel Glider within this area of affected habitat is retainable (hollows, key foraging tree species, gliding connectivity) and gliders are known to persist in such environments provided local connective habitat features can support viable populations. Therefore the key habitat features will be mostly retained for potential future or seasonal use and recolonization. Having said this it appears that there are increasing pressures on the local population of Squirrel Gliders with previously known locations not supporting the species any more in recent years target trapping and survey.

The non-threatened Sugar Glider is alternatively regularly recorded, which can co-exist with the Squirrel Glider however competition between the two for habitat resources is expected. The smaller and possibly more opportunistic Sugar Glider appears to be more resilient to reduced habitat loss and remaining smaller fragments. An up to date review of the local status of Squirrel Glider and predicted sub-populations may highlight local areas of greater conservation significance.

Squirrel Glider was not recorded during target trapping surveys, yet Sugar Glider was recorded by both *Travers bushfire & ecology* (2018) and *Abel Ecology* (2017).

There are one-hundred and sixty-nine (169) records of Squirrel Glider within 10km of the subject site, however there are only 5 records within Hamlyn Terrace with the most recent of these being in 2004. This is also the most recent record including the surrounding suburbs of Kanwal, Wyongah, Gorokan, Lake Haven and Woongarra. There are two records from Warnervale in 2016 and a couple of records from the Wadalba corridor from 2016/17, the closest of which is over 3km away.

Therefore there is no assurance that Squirrel Gliders persist in the immediate locality or may recolonise this habitat. Any updated review of presence within the region should ideally be accompanied with a review of available connectivity and this would predict usable habitat and highlight management priorities. The proposal will not impact on connectivity or isolate any potential habitat areas.

Habitat enhancement measures are specified within the recommendations of this report. This includes the placement of nest boxes within the connective habitats to the south. It should be noted here that twelve (12) nest boxes were counted within the subject site and only one of these appears to remain in a usable state. All others have perished which highlights the importance of quality nest box materials, construction and treatment standards. Landscaping should also consider foraging shrubs and trees. The proposal may also provide an opportunity to provide gliding poles to ensure connectivity to and from the study area across the Central Coast Hwy and Louisiana Road.

4.4.4 State legislative fauna matters

(a) Threatened fauna species (NSW)

BC Act – A search of the *Atlas of NSW Wildlife* (OEH, 2018) provided a list of threatened fauna species previously recorded within a 10km radius of the subject site. These species are listed in Table A2.2 (Appendix 2) and are considered for potential habitat within the subject site. Strictly estuarine and oceanic threatened species found within 10km have not been included as no marine / aquatic habitats occur within the subject site.

Based on the habitat assessment within Appendix 2, it is considered that the subject site provides varying levels of potential habitat for the following state listed threatened fauna species:

Table 4.9 – State listed threatened fauna species with suitable habitat present

Common name	BC Act	Potential to occur
East-coast Freetail Bat	V	recorded
Little Bentwing-bat	V	recorded
Eastern Bentwing-bat	V	recorded
Greater Broad-nosed Bat	V	recorded
White-bellied Sea Eagle	V	recorded (Abel Ecology)
Powerful Owl	V	recorded (Abel Ecology)
Scarlet Robin	V	recorded (Abel Ecology)
Grey-headed Flying-fox	V	recorded (Abel Ecology)
Large-footed Myotis	V	recorded (Abel Ecology)
Square-tailed Kite	V	✓
Glossy Black-Cockatoo	V	✓
Little Lorikeet	V	✓
Barking Owl	V	✓
Masked Owl	V	✓
Varied Sittella	V	✓
Squirrel Glider	V	✓
Yellow-bellied Sheath-tail-bat	V	✓
Eastern Falsistrelle	V	✓
Little Eagle	V	low
Dusky Woodswallow	V	low
Large-eared Pied Bat	V	low
Wallum Froglet	V	unlikely
Flame Robin	V	unlikely
Long-nosed Potoroo	V	unlikely
Eastern Cave Bat	V	unlikely
Eastern Chestnut Mouse	V	unlikely

Note: Full habitat descriptions for these species are provided in Appendix 2

Four (4) state listed threatened fauna species including East-coast freetail Bat (*Micronomus norfolkensis*), Eastern Bentwing-bat (*Miniopterus orianae oceanensis*), Little Bentwing-bat (*Miniopterus australis*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*) were recorded within the subject site during recent surveys. An additional five (5) state listed threatened fauna species were recorded by *Abel Ecology* in 2017 over the Wyong Hospital site including White-bellied Sea Eagle (*Haliaeetus leucogaster*), Powerful Owl (*Ninox strenua*), Scarlet Robin (*Petroica multicolor*), Grey-headed Flying-fox (*Pteropus policephalus*) and Large-footed Myotis (*Myotis macropus*). Scarlet Robin may have been confused with a non-threatened species as it was not recognised as vulnerable in the recorded fauna list and was not assessed as threatened within the document.

Given the proposal is a state significant project a significance of impact assessment is not needed to be applied in accordance with Section 7.2 of the *BC Act*. Nonetheless a summary of impacts on state listed threatened fauna and a detailed summary of the seven recorded threatened fauna species is provided in Appendix 3.

FM Act – No habitats suitable for threatened aquatic species were observed within the subject site and as such the provisions of this act do not require any further consideration.

(b) Endangered fauna populations (NSW)

There are no endangered fauna populations within the Central Coast LGA.

(c) SEPP 44 Koala Habitat Protection

SEPP 44 Koala Habitat Protection applies to land within Local Government Areas (LGAs) listed under Schedule 1 of the Policy. In addition, Part 2 of the Policy outlines a three (3) step process to assess the likelihood of the land in question being potential or core koala habitat. Part 2 applies to land which has an area of greater than 1 hectare or has, together with any adjoining land in the same ownership, an area of more than 1 hectare.

The subject site is required to be considered under SEPP 44 as it falls within the Central Coast (old Wyong) LGA, which is listed on Schedule 1 of this Policy. In addition, the total area of the subject site is greater than 1 hectare, hence Part 2 – Development Control of Koala Habitats, of the Policy applies.

Potential Koala Habitat (PKH) is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the policy.

Core Koala Habitat (CKH) is defined as an area of land with a resident population of koalas, evidenced by attributes such as breeding females (i.e. females with young) and recent sightings of and historical records of a population.

A Koala Plan of Management is required to be prepared where council is satisfied that the land is CKH.

Step 1 – Is the land PKH?

One Koala food tree species – Scribbly Gum (*Eucalyptus haemastoma*) as listed on Schedule 2 of SEPP 44 – was recorded within the study area.

These trees comprised greater than 15% of the total number of trees within the Scribbly Gum – Red Bloodwood – Old Man Banksia Heathy Woodland vegetation community and therefore is classified under SEPP 44 as PKH.

Step 2 – Is the land CKH?

Target searches were conducted within this community along with other opportunistic methodologies throughout the subject site. No Koalas were observed during combined fauna surveys and there was no evidence of previous Koala habitation.

A search of the Atlas of NSW Wildlife (OEH 2018) found sixteen (16) records of Koala habitation within 10 km of the subject site. The closest record is located in the eastern portions of the Hospital site but to a 1km accuracy. This record is from 1967. A record at 1.7km to the south at Tuggerawong from 2004 has a lower accuracy. Remaining records exist to the west between Wyong and Woongarra from 1916 to 2003. Koalas are not expected to persist in the locality.

As such the subject site is not considered to comprise 'core Koala habitat' as defined under SEPP 44.

Step 3 – Koala Plan of Management

As the land is not considered to comprise CKH a Koala Plan of Management is not considered to be required.

(d) Ecosystem credit species

Based upon the BAM calculator and field surveys to date, the following predicted threatened fauna species were considered as confirmed candidate species within the associated PCTs (1638 moderate-good, 1728 moderate-good):

Table 4.10 – Ecosystem credit species (fauna)

Common name	BC Act	Potential to occur (presence status)	Excluded (justified below)	Foraging habitat only
White-bellied Sea Eagle	V	Recorded		✓
Little Bentwing-bat	V	Recorded		✓
Eastern Bentwing-bat	V	Recorded		✓
Powerful Owl	V	Recorded		✓
Grey-headed Flying-fox	V	Recorded		✓
East-coast Freetail Bat	V	Recorded		
Scarlet Robin	V	Recorded		
Glossy Black-Cockatoo	V	✓		✓
Barking Owl	V	✓		✓
Varied Sittella	V	✓		
Little Lorikeet	V	✓		
Square-tailed Kite	V	✓		
Yellow-bellied Sheath-tail-bat	V	✓		
Masked Owl	V	✓		
Little Eagle	V	Low		
Australasian Bittern	E	Not likely	✓	
Gang-gang Cockatoo	V	Not likely	✓	
Speckled Warbler	V	Not likely	✓	
Spotted Harrier	V	Not likely	✓	
Brown Treecreeper	V	Not likely	✓	
Spotted-tailed Quoll	V	Not likely	✓	
Painted Honeyeater	V	Not likely	✓	
Black Bittern	V	Not likely	✓	
Swift Parrot	E	Not likely	✓	
Black-chinned Honeyeater	V	Not likely	✓	
Turquoise Parrot	V	Not likely	✓	
Eastern Osprey	V	Not likely	✓	
Koala	V	Not likely	✓	
Grey-crowned Babbler	V	Not likely	✓	

The species that have been excluded above are excluded based on the absence of any suitable habitat, available extent of remaining habitat, geographic distribution, and last known local record being decades old, lack of suitable geological features, isolation of particular habitats or degradation of habitats.

(e) Species credit species

Based upon the BAM calculator and field surveys to date, the following predicted threatened fauna species were considered as confirmed candidate species within the associated PCTs (1638 moderate-good, 1728 moderate-good):

Table 4.11 – Species credit species (fauna)

Common name	BC Act	Potential to occur (presence status) / Habitat	Associated PCTs	Survey sufficient to rule out presence	Presence of species		Breeding habitat absent	Final Candidate Species
					Assumed	Expert report		
Bush Stone-curlew	E	Not likely		✓ also				
Gang-gang Cockatoo (Breeding)	V	Not likely						
Glossy Black-Cockatoo (Breeding)	V	✓	1636		✓		✓	
Eastern Pygmy-possum	V	Not likely		✓ also				
Large-eared Pied Bat	V	low	1636, 1728		✓		✓	✓
Wallum Froglet	V	Not likely		✓ also				
White-bellied Sea-Eagle (Breeding)	V	recorded	1636, 1728		✓		✓	
Little Eagle (Breeding)	V	low	1636, 1728		✓		✓	
Pale-headed Snake	V	Not likely						
Swift Parrot (Breeding)	E	Not likely						
Green and Golden Bell Frog	E	Not likely						
Green-thighed Frog	V	Not likely						
Square-tailed Kite (Breeding)	V	✓	1636, 1728		✓		✓	
Little Bentwing-bat (Breeding)	V	recorded	1636, 1728		✓		✓	
Eastern Bentwing-bat (Breeding)	V	recorded	1636, 1728		✓		✓	
Southern Myotis	V	recorded	1636, 1728		✓			✓
Barking Owl (Breeding)	V	✓	1636, 1728	✓				
Powerful Owl (Breeding)	V	recorded	1636, 1728		✓		✓	
Eastern Osprey (Breeding)	V	Not likely						
Giant Dragonfly	E	Not likely						
Squirrel Glider	V	✓	1636, 1728	✓				
Brush-tailed Rock-wallaby	E	Not likely		✓ also				
Brush-tailed Phascogale	V	Not likely		✓ also				
Koala (Breeding)	V	Not likely		✓ also				
Common Planigale	V	Not likely		✓ also				
Grey-headed Flying-fox (Breeding)	V	recorded	1636, 1728		✓		✓	
Masked Owl (Breeding)	V	✓	1636, 1728		✓		✓	
Mahony's Toadlet	E	Not likely						

The species that have been excluded above are excluded based on the absence of any suitable habitat, available extent of remaining habitat, geographic distribution, and last known local record being decades old, lack of suitable geological features, isolation of

particular habitats or degradation of habitats. For example, the Pale-headed Snake is known from various dry forest and woodland types however the species has never been recorded in coastal areas east of the M1 Motorway between Sydney and Newcastle, hence the species is not likely to occur.

The impact area polygon for species credit species with potential habitat present is indicated on Figure 5.

(f) Local data

Local data has not been used in this case.

(g) Expert reports

Expert reports have not been utilised for fauna on this project.

4.4.5 National environmental significance - fauna

(a) Threatened fauna species (National)

EPBC Act – A review of the schedules of the *EPBC Act* identified a list of threatened fauna species or species habitat likely to occur within a 10km radius of the subject site. These species have been listed in Table A2.2 (Appendix 2), and those with potential habitat within the subject site are considered in the seven-part test within Appendix 3.

Based on the habitat assessment within Appendix 2, it is considered that the subject site provides varying levels of potential habitat for the following nationally listed threatened fauna species:

Table 4.12 – Nationally listed threatened fauna species with suitable habitat present

Common name	<i>EPBC Act</i>	Potential to occur
Grey-headed Flying-fox	V	recorded (Abel Ecology)
Large-eared Pied Bat	V	low
Long-nosed Potoroo	V	unlikely

No nationally listed threatened fauna species were recorded during recent survey. One (1) nationally listed threatened fauna species Grey-headed Flying-fox (*Pteropus poliocephalus*) was recorded by *Abel Ecology* (2017). This species was recorded by call whilst foraging within the study area. The location, foraging tree species and number was not mapped or indicated. This is also a state listed fauna species and a detailed assessment under state legislation (*EP&A Act 1979*) is undertaken within the state significance of impact test (Appendix 3).

The Significant Impact Criteria for a vulnerable species listed under the *EPBC Act 1999* (Appendix 4) was reviewed to assess the impacts on Grey-headed Flying-fox as a result of the proposed development within the subject site. As the subject site does not contain any likely roosting or subsequent breeding habitat and foraging habitat will remain well represented in the subject site and nearby locality, it is concluded that there will not be any significant impact on this species, or other nationally listed threatened fauna species with potential to occur, as a result of the subdivision proposal.

(b) Protected migratory species (National)

The *EPBC Act Protected Matters Report* provides additionally listed terrestrial, wetland and marine migratory species of national significance likely to occur, or with habitat for these species likely to occur, within a 10km radius of the subject site. The habitat potential of migratory species is considered in Table A2.3 (Appendix 2). The habitat potential of threatened migratory species is considered in Table A2.3 Table A2.2 (Appendix 2).

No nationally protected migratory bird species were recorded present during the combined surveys.

The impact assessment for nationally protected migratory species with potential to occur has concluded a not significant impact.

4.4 Vegetation connectivity and habitat corridors

The vegetation within the subject site is not mapped as part of any corridors identified on the Wyong Shire Council Corridors & Fragment Map (*Payne 2002*). No more recent document on corridors was sourced on the Central Coast Council website.

The contribution that the subject site provides to local connectivity is depicted on Figure 6. This demonstrates how the remaining connectivity in the locality is fragmented by roads and other diminished portions. Such a connective landscape may provide movement corridors for gliders (if fundamental habitat requirements are maintained within) and birds, however has limited potential for larger terrestrial species to persist and amphibians to disperse in the locality.

Furthermore the connectivity has poor strategic benefit to link major portions of habitat and also loops around areas prioritised for residential areas than for maintaining key local habitat features. As a result the capacity for the remaining connectivity to support native species diversity is becoming further limited.

The 0.79ha of vegetation to be impacted as part of the proposal is located on the northern edge of existing vegetation that extends out to a total area of approximately 8.16ha bound within local roads. This vegetation is predominantly PCT 1728 Swamp Oak Forest. The impacted vegetation however is predominantly on a 0.95ha patch of PCT 1636 Scribbly Gum / Red Bloodwood Woodland. Whilst approximately 12% of the total bushland remnant will be reduced this will include 0.69ha (72%) of the PCT 1636 patch.

This affected community provides a notably higher presence of:

- Flowering canopy tree species number and diversity for foraging by nectarivores
- Tree species providing sap flows for gliders (Red Bloodwood)
- Higher density of hollows supported by all size classes
- Greater presence of native groundcovers and shrubs for shelter in the understorey

Based on the above considerations, the proposal will not impact on a regional corridor however the vegetation does contribute to local connectivity. The removal/modification of habitat is at the outer edges of this vegetated patch and will not result in any bottleneck effect, fragmentation or isolation of habitat along the total connective area. As discussed however the impacted habitat does provide notable unique habitat benefits to contribute to this connectivity.

Ambrose (2007) advised that it is essential for a corridor to have the following characteristics in order to be effective:

- Vegetated corridors that comprise a mosaic of different habitats are considered more likely to contain the necessary food, shelter and nesting resources for fauna. Therefore, corridors that link patches over the entire ecological gradient from ridge to gully would conserve more species, especially those that have large home ranges and changing seasonal requirements (Lindenmayer et al. 1994).
- The quality of the habitat within the corridor is important. Some fauna would reluctantly utilise corridors of low quality, such as areas invaded by weeds or subject to frequent fires, or due to a reduction in the availability of essential resources (such as feeding, shelter, roosting and breeding sites).
- The size of the corridor is also important. For example, corridors with mature trees, but with little or no understorey may afford good habitat for birds, bats and some arboreal fauna, but not for ground-dwelling fauna.

Removal of habitat will reduce the mosaic of different habitats (noted in point 1) and reduce the quality of habitat (noted in point 2). This is given that the remaining Swamp Oak Forest vegetation within the majority of the remaining remnant is heavily impacted by weeds in comparison to the Scribbly Gum / Red Bloodwood Woodland.

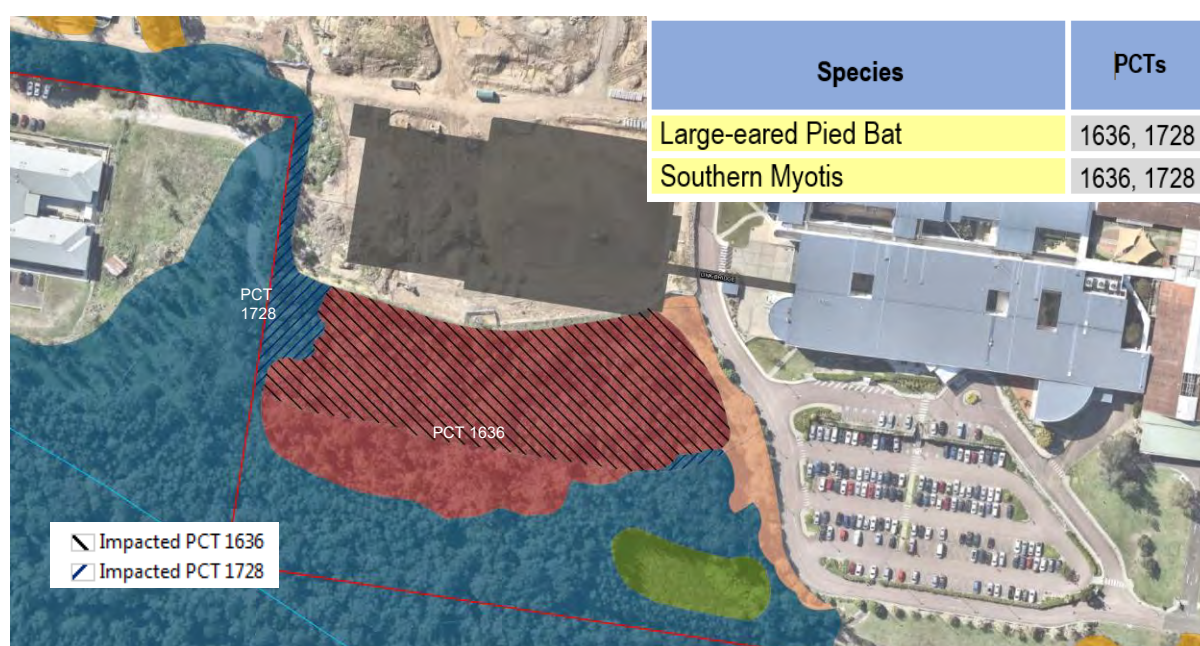


Figure 5 – Species credit species polygons



Figure 6 – Local connectivity



Impact Assessment

5

5.1 Potential ecological impacts

The direct, indirect and cumulative ecological impacts have been considered in respect to recorded biodiversity, threatening processes and extent of impact as a result of the proposed works:-

The direct impacts of the proposal within the subject site are considered as:

- Removal/modification 0.106ha of PCT 1728 / TEC vegetation (SOFF)
- Removal/modification 0.686ha of PCT 1636 / quality non-TEC vegetation
- Up to 0.792ha loss of vegetated habitat for threatened species
- Subsequent removal of threatened fauna species foraging habitat

The potential indirect impacts of the proposal are considered as:

- Edge effects such as weed incursions and changes to runoff causing increased nutrient flow into the adjacent native vegetation
- Minor reduction of arboreal connectivity for arboreal mammals
- Increased spill-over from noise, activity, scent and lighting effects into the adjacent quality natural habitat areas
- Concentrated stormwater runoff from solid surfaces and subsequent increased flows.

The potential cumulative impacts (combined results of past, current and future activities) of the proposal are considered as:

- Increased risk of weed invasion and fungal mobilisation or infections
- Cumulative loss of PCT 1636 within the locality
- Cumulative loss of PCT 1728 / SOFF within the locality
- Increased varied human presence and activity within the remaining natural habitat areas of the adjacent bushland remnant
- Edge effects from inappropriate use of remaining native vegetation areas such as additional clearing, dumping of materials, dumping of faecal, food or general waste and building refuse.

5.2 Avoid and minimise impacts

The following actions and designing of works have been undertaken to either avoid or minimise impacts on biodiversity values:

- APZs have been designed to the minimum standard for a special fire protection purpose development
- Development has been located taking advantage of the existing disturbed zones
- Fencing to exclude general access to quality areas of native vegetation

- Limit vegetation removal in APZ and selective vegetation retention (eg. Hollows & foraging trees)
- Integrated weed management and control of high threat exotics
- Monitoring for evidence of disease
- Adaptive management

5.3 Biodiversity credit requirements

5.3.1 *Serious & Irreversible Impacts (SAlls)*

The impact assessment provisions for threatened species outlined under Section 10.2.3 of the BAM have been applied to the recorded Little Bentwing-bat and Eastern Bentwing-bat (refer to Appendix 5). This has concluded that there are no SAlls caused by the proposal to threatened species.

Swamp Oak Floodplain Forest (SOFF) is listed in the BAM calculator as a candidate ecological community that meets the SAll principles and criteria. The thresholds for clearing of these communities have not yet been published to determine if they meet the criteria. Despite this, the impact footprint has been minimised and will not fragment or isolate the SOFF remnant. The proposal will not stop the gene flow of the remnants. The proposal impacts on SOFF, and as a candidate species is to be assessed against the SAll criteria (refer to Appendix 6).

Travers bushfire & ecology considers that the impact on SOFF is not considered as an SAll however the residual impacts are proposed to be offset.

5.3.2 *Impacts requiring offset*

The following impacts will require offsetting:

- 0.7ha* of PCT 1636
- 0.1ha* of PCT 1728
- loss of habitat for threatened species, including species credits for *Cryptostylis hunteriana*, *Eucalyptus camfieldii*, *Persicaria elatior*, large-eared Pied Bat and Southern Myotis

*Note: the BAM calculator rounds impact requirements to the nearest 0.1ha, hence the discrepancy with the values stated elsewhere in the BDAR.

5.4.3 *Impacts not requiring offset*

All areas of native vegetation impact will require offsetting and have been accounted for in the BAM calculator.

5.3.4 *Areas not requiring assessment*

Any native vegetation beyond the extent of the APZs have not been assessed.

5.4 Recommendations

The following recommendations are made to avoid, minimise or ameliorate the above potential ecological impacts and address threatening processes.

- A VMP is to be prepared for retained vegetation to the south of the subject site which are impacted by weeds. This will improve the quality of remaining habitat for potential use by fauna species. The VMP will include the following measures:
 - a) Where they adjoin the proposed works, the boundaries of the conservation areas shall be clearly marked out on-site to ensure their protection. All areas of natural vegetation retention shall be protected by fencing, prior to construction, to ensure that these areas are not damaged during the construction phase
 - b) Target weed control is to be undertaken within 10m of any works to control environmental weed species.
 - c) Standard *Phytophthora cinnamomi* and Myrtle Rust protocol applies to the cleaning of all plant, equipment, hand tools and work boots prior to delivery onsite to ensure that there is no loose soil or vegetation material caught under or on the equipment and within the tread of vehicle tyres. Any equipment onsite found to contain soil or vegetation material is to be cleaned in a quarantined work area or wash station and treated with anti-fungal herbicides.
 - d) Individuals of *Eucalyptus camfieldii* and *Tetratheca juncea* are to be protected in situ or replaced with propagated stock to maintain the local population. *Tetratheca juncea* is located just beyond the proposed APZ boundary.
 - e) Existing TEC - SOFF - should be restored or regenerated to achieve a maintain outcome.
 - f) A minimum of ten (10) all weather and durable nesting boxes targeting use by gliders or small possums should be placed within the remaining forest habitat to the south of the subject site. Boxes should be constructed all of weatherproof timber (marine ply), fasteners and external paint and appropriately affixed to a recipient tree under the guidance of a fauna ecologist.
- A Construction and Environment Management Plan (CEMP) is to be prepared, inclusive of recommendations of this BDAR, the VMP and the following additional measures
 - a) Construction activities should be intermittently supervised on-site and monitored by a project ecologist to ensure that the recommendations of this report are implemented. All staff involved with the development should undergo an induction and training program to reinforce the ecological and environmental objectives of the development
 - b) Erosion control measures are to be in place to reduce temporary erosion and sedimentation risks to adjacent vegetation and any nearby drainage channel.
 - c) During tree thinning for APZs, where possible protect or retain large trees that provide canopy leaders to surrounding vegetation and avoid canopy gaps of greater than 40m for arboreal gliders. Where canopy connectivity is lost, tree plantings or artificial bridges are to be implemented to restore connectivity. The use of medium strip planted trees can be used to halve the canopy break.
 - d) Standard *Phytophthora cinnamomi* and Myrtle Rust protocol applies to the cleaning of all plant, equipment, hand tools and work boots prior to delivery onsite to ensure that there is no loose soil or vegetation material caught under or on the equipment and within the tread of vehicle tyres. Any equipment onsite found to contain soil or vegetation material is to be cleaned in a quarantined work area or wash station and treated with anti-fungal herbicides.
 - e) Retain all hollow-bearing trees in-situ within the APZ areas where possible pending a health and safety assessment of these trees. Any hollow-bearing trees

that will require removal should be cleared under the supervision of a fauna ecologist to ensure appropriate animal welfare procedures are taken, particularly for threatened species. Hollows of high quality or with fauna recorded residing within should be sectionally dismantled for relocation and all hollows should be inspected for occupation, signs of previous activity and potential for reuse.

- An Integrated Landscape Plan is to be prepared incorporating the following measures:
 - a) Landscaping is to use locally occurring native plant species.
 - b) It is recommended that foraging habitat for the recorded threatened Grey-headed Flying-fox as well as other Powerful Owl prey species foraging habitat is replaced by locally native flowering eucalypts within landscaping areas
 - c) Standard *Phytophthora cinnamomi* and Myrtle Rust protocol applies to the cleaning of all plant, equipment, hand tools and work boots prior to delivery onsite to ensure that there is no loose soil or vegetation material caught under or on the equipment and within the tread of vehicle tyres. Any equipment onsite found to contain soil or vegetation material is to be cleaned in a quarantined work area or wash station and treated with anti-fungal herbicides.



BAM Credit Results

6

6.1 Ecosystem credits and species credits

Ecosystem credits and species credits that measure the impact of the development on biodiversity values have been calculated, assuming thinning of vegetation in APZs reducing both cover and abundance. The result of this means that all impacted areas will still have some future biodiversity value, and as such, the future vegetation integrity score will be above 0. There will be a significant drop in the scores, but as they still retain some value, the number of credits required is less. Future vegetation integrity score for each vegetation zone at the development site is shown in section 3.1.5.

Habitat suitability for threatened species has been considered in Section 4. Some species are considered for species credits, particularly if potential breeding habitat is compromised or impacted.

Ecosystem credits for plant community types (PCTs), ecological communities and threatened species habitat is shown below in Table 6.1. Species credits for threatened species are shown in Table 6.2.

Table 6.1 – Requirement for ecosystem credits

Zone	Veg. zone name	Veg. loss	integrity	Area (ha)	Candidate SAIL	Ecosystem credits
1	1636_Mod-Good		37.5	0.7	False	11
2	1728_Mod-Good		17.6	0.1	True	1
						Total: 12

Table 6.2 – Requirement for species credits

Veg. zone name	Veg. loss	integrity	Area (ha)	Candidate SAIL	Ecosystem credits
<i>Cryptostylis hunteriana</i>					
1636_Mod-Good		37.5	0.7	False	13
					Subtotal: 13
<i>Eucalyptus camfieldii</i>					
1636_Mod-Good		37.5	0.7	False	13
					Subtotal: 13
<i>Persicaria elatior</i>					
1728_Mod-good		17.6	0.1	False	1
					Subtotal: 1
Large-eared Pied Bat					
1636_Mod-Good		37.5	0.7	False	19
1728_Mod-Good		17.6	0.1	False	1
					Subtotal: 20
Southern Myotis					
1636_Mod-Good		37.5	0.7	False	13

1728_Mod-Good	17.6	0.1	False	1
				Subtotal: 14

6.2 Ecosystem credit classes

Table 6.3 – Ecosystem credit summary

PCT	TEC	Area (ha)	Credits
1636 - Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast	False	0.7	11
1728 - Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	Swamp Oak Floodplain Forest	0.1	1

Table 6.4 – Credit classes for PCT 877 and 1395 - Like for like options

PCT	Trade with PCTs	Trading groups	Containing HBT	In IBRA subregions
1636 - Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast	Sydney Coastal Dry Sclerophyll Forests (including PCTs 1138, 1253, 1625, 1636, 1638, 1776, 1778, 1782, 1786)	Sydney Coastal Dry Sclerophyll Forests - $\geq 50\%$ - $< 70\%$ cleared group (including Tier 6 or higher).	Yes	Wyong, Hunter, Pittwater and Yengo or any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1728 - Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (including PCTs 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808)	N/A	Yes	Wyong, Hunter, Pittwater and Yengo or any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

6.3 Species credit classes

Table 6.5 – Species credit summary

Species	Area (ha)	Biodiversity Risk Weighting	Credits
<i>Cryptostylis hunteriana</i>	0.7	2	13
<i>Eucalyptus camfieldii</i>	0.7	2	13
<i>Persicaria elatior</i>	0.1	1.5	1
Large-eared Pied Bat	0.8	3	20
Southern Myotis	0.8	2	14

All above-listed species need to be offset with the same species but anywhere in NSW.

6.4 Ecosystem and species credit costs

The costing of credits is provided in Table 6.6 and 6.7.

Table 6.6 – Ecosystem credit costs

IBRA sub region	PCT common name	Baseline price per credit	Dynamic coefficient	Market coefficient	Risk premium	Administrative cost	Methodology adjustment factor	Price per credit	No. of ecosystem credits	Final credits price
Wyong	1636 - Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast	\$2,062.67	0.8959531	1.299716	19.99%	\$20.00	1	\$4,123.72	11	\$45,360.96
Wyong	1728 - Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	\$7,067.26	0.8959531	1.299716	19.99%	\$20.00	1	\$12,396.33	1	\$12,396.33
Subtotal (excl. GST)										\$57,757.29
GST										\$5,775.73
Total ecosystem credits (incl. GST)										\$63,533.02

Table 6.7 – Species credit costs

Species profile ID	Species	Threat status	Price per credit	Risk premium	Administrative cost	No. of species credits	Final credits price
10187	<i>Cryptostylis hunteriana</i>	Vulnerable	\$150.00	19.99%	\$20.00	13	\$2,599.80
10287	<i>Eucalyptus camfieldii</i>	Vulnerable	\$173.02	19.99%	\$20.00	13	\$2,958.89
10590	<i>Persicaria elatior</i>	Vulnerable	\$150.00	19.99%	\$20.00	1	\$199.98
10157	Large-eared Pied Bat	Vulnerable	\$725.00	19.99%	\$20.00	20	\$17,798.55
10616	Southern Myotis	Vulnerable	\$725.00	19.99%	\$20.00	14	\$12,458.98
Subtotal (excl. GST)							\$36,016.20
GST							\$3,601.62
Total species credits (incl. GST)							\$39,617.82

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Fauna Survey Methodologies

A1

The fauna survey methods outlined within this Appendix are techniques employed by *Travers bushfire & ecology*, based on industry standards as well as additional methods found to be effective for select fauna groups. The fauna survey techniques deployed for each specific site are outlined within the survey effort table in the main body of this report. The techniques selected will depend upon the site characteristics and extent of available habitat as well as restrictions such as available survey time and weather conditions.

If any additional or target survey techniques for fauna species are undertaken, beyond the methods outlined within this Appendix, the details of these will be described within the main body of this report.

1 Standard survey techniques

1.1 Diurnal birds

Diurnal birds are typically identified visually and / or by calls during diurnal surveys. Habitat searches to identify nests, feathers, eggs, or signs of foraging may be utilised more specifically for identifying threatened diurnal bird species.

Visual observations are made more accurate with the use of binoculars and where necessary or practical, with the use of a spotting scope. Binoculars are carried by the fauna surveyor at all times during nocturnal and diurnal fauna surveys. A birding field guide is always available in the field when required for verifications.

Calls are identified in the field by the fauna surveyor. If an unknown call is heard it is cross-matched to comprehensive bird call reference libraries taken into the field. A call library of birds occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

Diurnal bird census points may be undertaken at large sites where the total area may not be effectively covered during the survey period, or as a measure to ensure focused bird only survey.

Song-meters may also be used for remote diurnal bird call surveys in pre-selected diurnal periods (particularly during the dawn chorus) over the deployment period.

1.2 Nocturnal birds

Searches for evidence of Owl roosts, key perches and potential Owl roosting / breeding hollows are made during diurnal site searches. Whitewash, feathers or regurgitated pellets give key information. Pellets are sent for analysis of contents to assist in identification where necessary.

Generally, the presence of nocturnal birds during the nocturnal period is first determined by quiet listening after dusk for calls by individuals emerging from diurnal roosts. Following this,

and provided no calls are heard, call-playback techniques are employed for threatened species that have suitable habitat present.

Threatened nocturnal birds known to provide response to call-playback techniques include Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebricosa*), Grass Owl (*Tyto longimembris*), Black Bittern (*Ixobrychus flavicollis*), Australian Bittern (*Botaurus poiciloptilus*) and Bush Stone-curlew (*Burhinus grallarius*).

Each call is typically played for five minute periods with five minute intervals of quiet listening for a response. This is followed with spotlighting and periods of quiet listening throughout the nocturnal survey.

Separation distances between broadcasting stations during a single night of survey are advised for different species within survey guidelines. These include 1km between Owl calls and 3km between Bush Stone-curlew calls. Subsequent to this, separate broadcasting stations will be deployed on the same night where sites of significant size are surveyed. Separations for bitterns are not advised and these may be broadcast at a number of stations along suitable habitat areas.

Where an owl species has been recorded or is known to occur, call-playback techniques will not be deployed for that species to prevent disturbance of breeding activity. Where a threatened owl is known to occur appropriate additional effort will be undertaken to identify appropriate nesting/roosting trees and identify signs of use as per the methods guided by owl specialist John Young. These techniques vary pending the time of year but all with a focus to identify key breeding and roosting habitat trees and areas.

Stag-watching at appropriate times of year will also be undertaken where suitable large hollows for Owl nesting / roosting show signs of activity or are located within development areas. Full covert or semi-covert *Reconyx*TM surveillance cameras may be mounted at suspected hollows to target owl use and behaviour.

Song-meters may also be used to remotely target presence of owls by recording calls in selected nocturnal periods (particularly after dusk and before dawn) in the early breeding period.

1.3 Arboreal mammals

Arboreal mammals may be surveyed using Elliott type A, B and / or C traps, small and / or large hair tubes, surveillance cameras, video endoscope, spotlighting, call-playback techniques, scat searches or searches for other signs of activity.

Baiting and layout for Elliott trapping and hair tubing are typically incorporated into terrestrial trapping and hair tubing effort, unless where target survey is undertaken. Standard baiting and layout is therefore described in Section A1.4 below within terrestrial survey methods. Where gliders are targeted, the standard bait mix may be additionally laced with a nectarivor powder mix used for feeding captive birds. Where Brush-tailed Phascogales are targeted the standard bait mix may be additionally laced with an insectivore powder mix. Where Eastern Pygmy Possum is targeted, the bait mix will be more heavily laced with honey.

Elliott traps for arboreal captures are placed onto tree mounted platforms that are attached to the trunk 2-3m above the ground, at an incline to facilitate drainage during inclement weather. Plastic sleeves are placed around or over traps when wet weather is forecast. Arboreal hair tubes are attached to the trunk of trees using rubber bands with the tube entry facing down, preventing water entry.

For all arboreal traps and hair tubes a mixture of honey and water is sprayed onto the trunk up to 8m above the trap and around the trap as a lure. Where Eastern Pygmy Possum is targeted, a high concentrate honey water mix is also sprayed from the base of trunk up and along connective branches.

Arboreal traps and hair tubes are placed in trees selected to bias target species. These are often flowering or sap flow trees for gliders, rough-barked trees for the Brush-tailed Phascogale and Banksias for the Eastern Pygmy Possum.

Surveillance cameras may be used to target arboreal mammals in instances where the camera can be placed targeting a location on a tree where baiting is placed. This method may utilise the efforts of tree climbers to permit placement at a good height, particularly in instances where scratches indicate regular usage patterns, or a hollow is a suspected den.

A videoscope is used for active observations of hollow cavities for the presence of arboreal mammals (and other hollow-dependent fauna). Where a cavity extends beyond the cable distance an angle drill hole is made from the outside so sections can be viewed down to the base. Single photo or video footage may be recorded to assist identification or where only nest bedding material is recorded. This may also be used for later verification of identification.

Where habitat is suitable, the presences of Koala (*Phascolarctos cinereus*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*) may be targeted by call-playback techniques. Calls are played for five minute periods during nocturnal surveys. This is followed by quiet listening and spotlighting. Arboreal gliders are also identified from characteristic sap feeding scars on select tree species.

1.3.1 Koala survey

Koala survey is undertaken where the site is considered to provide potential habitat under the definitions of SEPP 44 - Koala Habitat Protection, or in the presence of feed trees listed in Appendix 1 of the Recovery Plan for the Koala. Habitat may also be defined according to locally prepared Koala Plans of Management.

SEPP 44 is applied to land within Local Government Areas (LGAs) listed under Schedule 1 of the Policy. Part 2 is applied to land which has an area of greater than 1ha or has, together with any adjoining land in the same ownership, an area of more than 1ha.

To determine Potential Koala Habitat (PKH) under the definitions of SEPP 44 an estimate of the percentage density of each tree species within vegetation communities is determined by averaging the percentage of stems counted. PKH is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the Policy.

Where Koala habitat is considered to be present, the site will be surveyed on foot, with known Koala food trees being inspected for signs of use. Trees are inspected for characteristic scratch and claw marks on the trunk and scats around the base of each tree. Koalas may also be targeted during nocturnal survey involving call-playback techniques and spotlighting.

For large sites, predetermined survey grids may be employed within portions of communities where feed trees are present. At each vertex on the grid, pellet searches in accordance with the Spot Assessment Technique (SAT) (*Phillips & Callaghan* 2008) are undertaken. Alternatively search quadrats may be undertaken to determine presence / absence. All Koala feed trees within quadrats are searched for signs of activity including characteristic

claw 'pock' marks on the trunk and faecal pellets around the base. For any survey technique, the location and density of Koala droppings, if found, are documented.

1.4 *Terrestrial mammals*

Various traps may be used to survey for the presence of terrestrial mammals. These include Elliott trapping, medium and large cage trapping, small and large hair tubing and pitfall traps. Other survey methods for terrestrial mammals include the use of surveillance cameras, song-meters, spotlighting and activity searches.

Arboreal and terrestrial Elliott traps and hair tubes are placed in grids, or more commonly along trap-lines of 5-10 traps separated by distances of 20-50m, depending on site size and variation of habitat. Trap or hair tube sizes selected at each trap station may alternate or may have an emphasis on certain sizes according to target species.

Selection of terrestrial Elliott trap, cage trap, hair tube or pitfall trap locations has an emphasis on nearby foliage, runways, shelters and signs of activity.

Standard bait mix for all Elliott traps, medium cage traps and hair tubes is a mixture of rolled oats, honey and peanut butter. Standard bait mix may be supplemented with sardines in large hair tubes or cage traps to simultaneously target Spotted-tailed Quoll. Cage traps may also be baited solely with meat, chicken or roadkill to target Spotted-tailed Quoll. Where Potoroos or Bandicoots are targeted, truffle oil may be used to lace the standard bait mix or used on its own.

Surveillance cameras are used in terrestrial mammal surveys particularly for detection of a broad target group or shy species. The surveillance camera is mounted on a tree and directed towards a closed baited trap or canister. Surveillance cameras may also be used to detect use or monitor activity at burrows, hollows, nests, runways, etc.

Song-meters may be used as a supplementary surveying tool to identify mammal calls including Yellow-bellied Glider, Squirrel Glider and Spotted-tailed Quoll.

During diurnal site searches, assessment is made of 'found' scats, markings, diggings, runways and scratches located. Any scats or pellets not readily identifiable (particularly predator scats) may be collected and sent to Barbara Triggs for identification of contents, hair or bone fragments.

1.5 *Bats*

Micro-chiropteran bats are surveyed by echolocation using ultrasonic recording detectors or trapped using harp (Constantine) traps, mist nets or trip lines. Microchiropteran bats are also surveyed by searches of subterranean habitats such as caves, tunnels or shafts where present, or by searching structures such as under bridges and abandoned buildings or wall / ceiling cavities, where entry is possible.

Ultrasonic recording detectors are used in fixed passive monitoring positions. Active monitoring may also be used in conjunction with spotlighting or during stag-watching for greater accuracy of recorded call identification. Active monitoring utilises a handheld sonograph recording microbat calls in real-time. Spotlighting of the microbat is then used to determine size and wing morphology to assist in finer differentiation between species with similar call shape and frequencies.

Harp traps and mist nets are placed along suitable 'flyways' such as along open narrow road / river corridors to maximise the likelihood of captures. Traps may be purpose set to capture

bats emerging from roosts by being placed at the entry of tunnels / caves or draped over the edge of bridges. Trip lines are placed over water to trip low flying drinking bats into the water. These bats are collected as they swim to the water's edge.

Harp traps are checked during early nocturnal survey, as well as each morning. Mist nets and trip lines require constant monitoring. Captured bats are identified using field identification guides. Bats are released at the point of capture after dusk or placed under trunk bark / splits of nearby trees.

Mega-chiropteran bat species, such as Grey-headed Flying-fox, are surveyed by targeting flowering / fruiting trees during spotlighting activities and by listening to distinctive vocalisations. Suitable roosting habitat is searched for presence of small or large established camps during diurnal survey periods.

1.6 *Amphibians*

Amphibians are surveyed by vocal call identification, call-playback, spotlighting along the edge of water-bodies, pitfall trapping, funnel trapping, by driving along sealed roads near waterways, habitat searches and collection of tadpoles.

Calls are identified in the field by the fauna surveyor. For similar calling species, or if an unknown male call is heard, it is cross-matched to frog call reference libraries taken into the field. A call library of frogs occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

Threatened frog species that call in chorus may be targeted by use of call-playback techniques where suitable habitat exists, with some species more reliable than others in providing a response. Red-crowned Toadlet may also be targeted by clapping and loud retort along suitable habitat drainages in order to evoke a call response.

Any amphibians found are visually identified and, when required to be examined, are handled with latex gloves and kept moist until release. Any tadpoles requiring capture are collected with a scoop net and placed within a snap-lock clear plastic bag for analysis of colour and morphological features. Where tadpole identification cannot be made in the field tadpoles are placed in a small glass box with laminated grid paper and dorsal and lateral photos are taken. These are supplied to Marion Anstis or Dr Arthur White for identification.

Song-meters may also be used to remotely record frog calls in selected periods (particularly during dusk) close to breeding areas over a preselected recording period.

Amphibian survey yields best results during, or following, wet periods with seasonal breeding and subsequent male calling varying according each species. Targeted survey is thus undertaken in appropriate seasons.

1.7 *Reptiles*

Reptiles are surveyed opportunistically during diurnal site visit(s), but also by habitat searches, pitfall trapping, funnel trapping, by driving along roads on humid nights and by camera surveillance at burrows.

Habitat searches for reptiles are undertaken in likely localities such as under logs, rocky slabs on rock surfaces, under sheet debris, under bark exfoliations and leaf litter at the base of trees and along the edge of wetlands. Aspect and land surface thermal properties are considered to determine best search locations particularly along rocky escarpments.

During warmer months, spotlighting may assist survey effort particularly during humid conditions.

1.8 Invertebrates

Target survey is undertaken for Cumberland Plain Land Snail (*Meridolum corneovirens*) or Dural Land Snail (*Pommerhelix duralensis*) when in proximity to previous *Bionet* records and particularly where typical host vegetation communities are present. The most appropriate areas of observed habitat are searched. Dense areas of leaf litter with likely moisture retaining properties are scraped using a three pronged rake. Logs, stumps, artificial refuse and rocks are also turned over. In large survey areas, search quadrats are undertaken evenly across highest quality habitat areas to estimate population size.

The top (spiral side), side (showing aperture) and underside (showing umbilicus) of snail specimens found are photographed and sent to Michael Shea or Frank Koehler of the Australian Museum Malacology Unit for confirmation of identification.

2 Habitat trees

Hollow-bearing tree surveys use a *Trimble* handheld GPS unit to log both field reference locations as well as tree data. Data such as hollow types, hollow size, tree species, diameter at breast height, canopy spread and overall height are documented. A metal tag with the tree number is placed on the trunk for field relocation purposes. Other habitat features such as nests and significant sized mistletoe for foraging are also noted.

3 Survey effort table descriptors:

Target - Where effort is specifically concentrated towards an individual species. Selected target species will be identified within the survey effort table and where necessary described within the report.

Opportunistic - Where birds are identified by observation, call or indirect methods as the opportunity arises.

Habitat search - Where suitable areas of habitat for selected fauna groups such as frogs, reptiles and invertebrates are specifically searched.

Diurnal bird census point(s) - Bird surveys are undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. Size and time will be specified in the survey effort table. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently census points are selected to adequately represent each of the habitat areas present and particularly areas designated for proposed development. Often census points are commenced at locations where bird activity is noticeably high.

Spotting-scope outlook - A *Nikon* spotting scope with 16~47 zoom at x60 magnification on a mounted tripod is used for distant inspections of diurnal birds. This is undertaken at wetlands for viewing waterfowl and waders but also other difficult to access areas. It may also be used for inspecting activity at nests, hollows and combined with spotlight for a panoramic search in open areas.

Call-playback - This involves broadcasting pre-recorded calls from CD through a 15 watt *Toa 'Faunatech'*TM amplifier to evoke a response from a target species known to reply. Species selected for call-playback will be indicated in the survey effort table.

Spotlighting - Is carried out using a hand held LED spotlight with varied light intensity settings. This technique involves walking amongst the woodland areas, forest fringes, along roads, trails and fence lines so that a maximum number of trees can be observed. Intensity

is regulated depending on the vegetation structure and distances viewed to enable eyeshine without retina damage to observed animals. Spotlighting around water-bodies and particularly along the shallow fringes is used for finding frogs. Spotlighting is used in combination with binoculars or spotting scope for closer night inspections.

Stag-watching - Involves watching hollows in the dusk period approximately 15 minutes prior to dark until 30 minutes following dark. Placement of the observer on the ground allows for a silhouette of any emerging fauna to be seen against the lighter sky background such that a spotlight is not required, which would likely to disrupt emergence behaviour. Where any movement is observed, a spotlight may then be used for identification purposes.

Search quadrats - Are undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently quadrats are selected to adequately represent each of the suitable habitat areas present and particularly areas designated for proposed development. The use of this technique simply as an initial time-effective suitable indicator of presence / absence of Koalas has been discussed with Koala expert, Stephen Phillips.

Koala Spot Assessment Technique (SAT) - Method outlined by *Phillips & Callaghan* (2008) and accepted by the Australian Koala Foundation to determine Koala activity levels. Activity levels are calculated from the proportion of trees showing signs of Koala use as indicated by the presence of scats as well as site location within the state.

Elliott trapping - Using *Elliott* type A (33x10x10cm) and Type B (45x15x15cm), B and / or Type C traps for trapping small sized mammals. Trapping nights' effort will be indicated in the survey effort table. Trapping layout, trap sizes, baiting and trapping period will be outlined within the site specific methodology section.

Medium cage trapping - Using medium sized cage traps (17x17x45cm foldout cages with tread-plate mechanism or 22x25x58cm rigid cage with tread-plate mechanism) for trapping up to cat/bandicoot sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Large cage trapping - Using large sized cage traps (25x25x50cm foldout cages with pull lever (meat) mechanism, 28x28x60cm foldout cages with tread-plate mechanism or 30x30x70cm rigid cage with tread-plate mechanism) for trapping up to quoll sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Hair tubing - Using small (40mm diameter x 120mm long) and/or large (90mm diameter x 200mm long) PVC pipe sections for collecting mammal hair samples. At one end of each tube is an enclosed chamber where the bait is placed and capped. Small drill holes in the inside face of the chamber allow the smell of the bait to permeate out through the tube without allowing access to the bait. At the other open entry end, double-sided tape is attached around the inner rim so hair samples of animals entering the tube are collected. Hair samples collected are sent to Barbara Triggs for identification. Trapping layout, tube sizes, baiting and trapping period will be outlined within the site specific methodology section.

EPP denning tubes - Using (80mm diameter x 240mm long) PVC pipe sections to provide a nesting/denning opportunity for Eastern Pygmy Possum. Both ends are covered and sealed with PVC caps. A 60mm diameter cardboard post-pack tube wrapped in bubble wrap for insulation and capped at the base is placed inside the PVC pipe. A 33mm drill hole on the side at one end permits access and *Velcro*TM or similar tape stuck down the internal cylinder allows the animal to climb down to the base. Cut lines around the outer surface of the tube permit small mammals to climb up the outside. Denning tubes are placed vertically in shrub trees (preferably flowering banksias). If no animals are found residing within the tube after a prolonged survey period (generally 6 weeks) use may then instead also be identified from bedding material present. Pygmy Possums use fine bedding material such as *Isopogon* and

Banksia ericifolia by comparison to Feather-tail Gliders and Antechinus which use eucalypt leaves.

Pitfall trapping - Is used to survey for small terrestrial mammals, frogs, reptiles and invertebrates. Pitfall trapping involves the use of 15cm diameter and 60cm long PVC stormwater pipe sections placed vertically into pre-dug holes. The pipe is placed and set firm with surrounding soil so that the top rim is level with the ground surface. Drift fences made of damp-proof-course 270mm wide are held tight and upright by wooden and steel pegs and run along the length of each trap-line. Drift fences are run over the middle of each pit in the trap line ensuring at least 5m of fencing is run along each side of each pit. Ground fauna passing beyond the pitfall transect are diverted towards the pits along the fence line.

Funnel trapping - Is used to survey mainly for frogs and reptiles. Funnel traps are 18cm x 18cm x 75cm long and constructed of shade cloth with an internal spring and wire frame in a similar design to yabby traps. At each end an inward facing funnel directs fauna through a 4cm hole and into the trap. Herpetofauna search the walls and corners for an exit and discover it difficult to re-find the internal exit hole. As with pitfall traps, funnel traps are used with drift fences that divert fauna towards the trap entry. At least 5m of fencing is run between each funnel trap which may be placed on either side of the fence. Trapping layout, target species, fence lengths and trapping period will be outlined within the site specific methodology section.

Passive microbat monitoring - Involves leaving the *Anabat*TM (Mk2 or SD-2) or *SM4Bat*TM zero-crossing recorders in a fixed mounted position to record call-sequences of passing bats. Recording locations are determined in order to represent different available foraging structures for various micro-chiropteran bat species. Dams, cleared flyways, high insect activity areas, forest edges and ecotones are particularly targeted. Bat call recordings are analysed using *Analook*TM 3.7.23 computer software.

Active microbat monitoring - Is a method of active microbat recording during stag-watching or during nocturnal spotlighting survey. Active monitoring involves walking with an *Echo Meter Touch*TM microphone allied to a mobile acoustics spectrogram app on *iPhone*TM for viewing call-sequences in real-time. When calls are heard, the transducer microphone is actively directed towards the calling animal with the aid of a spotlight, so longer and clearer call sequences may be recorded. When calls of a potential threatened species are observed on the sonograph a view by spotlight of the bat size and wing morphology is attempted for greater identification accuracy.

Active vehicle microbat monitoring - Is a method of active microbat recording deployed when large distances need to be covered in a nocturnal survey period. A *Hi-mic*TM extension cable allows the transducer microphone to be placed on a bracket on the roof of a travelling vehicle so calls may be viewed whilst driving. The vehicle travels at no more than 40km/h to prevent wind interference. When calls of a potential threatened species are observed on the dash mounted PDA screen, active spotlighting is undertaken.

Harp trapping - Is used to capture microchiropteran bats. Harp traps have an aluminium frame with a two-bank 4.2m² area and calico capture bag set along the base area.

Mist netting - Is used to capture microchiropteran bats. The mist net capture area is 2.4m high, 9m wide and supported by two 3.5m poles which are braced with ropes and pegs. Design is a 0.08mm ultrafine nylon monofilament thread arranged in a 14x14mm mesh, with four horizontal capture pockets. These features are specific for the use to capture micro-chiropteran bat species and are provided from the only known supplier in Poland.

Trip lining - Is used to capture microchiropteran bats. Fishing line is strung tight on pegs in a zig-zag pattern across open water-bodies just above the water surface to trip drinking bats into the water.

Surveillance camera - Is used to remotely monitor activity at burrows, hollows, etc. or to survey for species presence at baited stations. A *Reconyx Hyperfire*TM HC500, HC550 or HC600 digital weatherproof camera with a passive motion detector and a night-time infrared illuminator is used depending on the target outcome. Full covert or semi-covert cameras will be used to maximise recordings or for behaviour, whilst white-flash cameras will be used for colour identification. The camera is mounted on a tree or tripod and takes three consecutive photo frames on the detection of movement up to 30m away or the detection of a heat/cold source different to the ambient temperature.

Song-meters - are used to remotely record animal calls. SM4 bioacoustics song-meters may be programmed to record during select periods in the day depending on the targeted activity. *Song Scope*TM software may be used to create a recogniser file and determine the frequency of calls over the recorded period, which may be effective in determining local breeding activity, numbers and locations.

Videoscope - is used for active observations of hollow cavities for the presence of arboreal mammals and other hollow-dependent fauna. A *Dellon*TM industrial endoscope with a 1m cable and rotational camera head and LED light allow real-time inspection down irregular shaped cavities to be viewed on the attached LCD screen. Single photo or video footage may be recorded.

Weather conditions - Survey effort for each fauna group accounting for methods undertaken, duration, and weather conditions are provided in the survey effort table. Weather details are documented for all survey techniques and include:

- air temperature
- cloud cover
- rain (e.g. none, light drizzle, heavy drizzle, heavy rain)
- recent rain events (where relevant)
- wind strength e.g. calm, light (leaves rustle), moderate (moves branches), strong (moves tree crowns)
- wind direction
- moon (where relevant) (e.g. none, 1/4 moon, 1/2 moon, 3/4 moon)



Threatened & Migratory Species Habitat Assessment

A2

Table A2.1 provides an assessment of potential habitat within the subject site for state and nationally listed threatened flora species recorded within 10km on the Atlas of NSW Wildlife (OEH) or indicated to have potential habitat present within 10km on the *EPBC Act* Protected Matters Tool.

Table A2.1 – Threatened flora habitat assessment

Scientific name DATABASE SOURCE1	BC Act	EPBC Act	Growth form and habitat requirements <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on site			
					Suitable habitat present (✓)	Nearby and / or high number of record(s) (✓) <i>Notes 1, 2 & 3</i>	Record(s) from recent years (✓) <i>Notes 1, 2 & 3</i>	Potential to occur
<i>Acacia bynoeana</i> OEH EPBC	E1	V	Erect or spreading shrub to 0.3m high growing in heath and dry sclerophyll open forest on sandy soils. Often associated with disturbed areas such as roadsides. <i>Distribution limits N-Newcastle S-Berrima.</i>	x	marginal	x	2008	not likely
<i>Angophora inopina</i> OEH EPBC	V	V	Small tree in open sclerophyll forest growing on deep sandy soils with associated lateritic outcrops. <i>Distribution limits N-Wyee S-Gorokan with a disjunct population near Karuah.</i>	x	✓	2km NE	✓	low
<i>Caladenia tessellata</i> OEH EPBC	E1	V	Terrestrial orchid. Clay-loam or sandy soils. LHCCREMS guidelines suggest the species grows in Map Unit 34 – Coastal Sand Wallum Woodland - Heath. Flowers in September – November. <i>Distribution limits N-Swansea S-south of Eden.</i>	x	x	-	-	x

Scientific name DATABASE SOURCE1	BC Act	EPBC Act	Growth form and habitat requirements Distribution limit	Recorded on site (✓)	If not recorded on site			
					Suitable habitat present (✓)	Nearby and / or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur
<i>Callistemon linearifolius</i> OEH	V	-	Shrub to 4m high. Dry sclerophyll forest on coast and adjacent ranges. <i>Distribution limits N-Nelson Bay S-Georges River.</i>	x	marginal	2km NE	2016	unlikely
<i>Chamaesyce psammogeton</i> OEH	E1	-	Prostrate herb. Coastal dunes. <i>Distribution limits N-Tweed Heads S-Jervis Bay.</i>	x	x	-	-	x
<i>Corunastylis</i> sp. Charmhaven OEH EPBC	E4a	CE	Terrestrial orchid currently only known from the Wyong Shire of NSW in the Gorokan/Charmhaven area. It occurs within low woodland to heathland with a shrubby understorey and ground layer. Dominants include <i>Allocasuarina littoralis</i> , <i>Leptospermum juniperinum</i> , <i>Melaleuca nodosa</i> , <i>Callistemon linearis</i> and <i>Schoenus brevifolius</i> . Flowers likely in Feb-Mar.	x	x	-	-	x
<i>Cryptostylis hunteriana</i> OEH EPBC	V	V	Saprophytic orchid. Grows in swamp heath on sandy soils. <i>Distribution limits N-Gibraltar Range S-south of Eden.</i>	x	✓	2km NW	2017	low
<i>Cynanchum elegans</i> EPBC	E1	E	Climber or twiner to 1m. Grows in rainforest gullies, scrub & scree slopes. <i>Distribution limits N-Gloucester S-Wollongong.</i>	x	x	-	-	x
<i>Diuris praecox</i> OEH EPBC	V	V	Terrestrial orchid. Grows in sclerophyll forest near the coast. <i>Distribution limits N-Nelson Bay S-Ourimbah.</i>	x	✓	x	x	not likely
<i>Eucalyptus camfieldii</i> OEH EPBC	V	V	Stringybark to 10m high. Grows on coastal shrub heath and woodlands on sandy soils derived from alluviums and Hawkesbury sandstone. <i>Distribution limits N-Norah Head S-Royal NP.</i>	✓	✓	-	-	recorded

Scientific name DATABASE SOURCE1	BC Act	EPBC Act	Growth form and habitat requirements Distribution limit	Recorded on site (✓)	If not recorded on site			
					Suitable habitat present (✓)	Nearby and / or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur
<i>Genoplesium baueri</i> EPBC	E1	E	A terrestrial orchid that grows in sparse sclerophyll forest and moss gardens over sandstone. Flowers Feb–Mar. <i>Distribution limits</i> N – Hunter Valley S – Nowra.	x	x	-	-	x
<i>Genoplesium insigne</i> OEH EPBC	E1	CE	Terrestrial orchid. Found in <i>Themeda</i> patches among shrubs and sedges in heathland and forest. <i>Known from 3 localities in Wyong-Charmhaven area</i> . Occurs in vegetation dominated by Scribbly Gum, Red Bloodwood, Smooth-barked Apple and Black She-oak at Charmhaven. Flowers Sept-Oct.	x	✓	3km N	✓	low
<i>Grevillea parviflora</i> subsp. <i>parviflora</i> OEH EPBC	V	V	Open to erect shrub to 1m. Grows in woodland on light clayey soils. <i>Distribution limits</i> N-Cessnock S-Appin.	x	✓	1km NW	✓	low
<i>Maundia triglochinosoides</i> OEH	V	-	A reed-like herb which grows in swamps and shallow fresh water on clay. <i>Distribution Limits</i> N-Qld border S-Wyong.	x	x	-	-	x
<i>Melaleuca groveana</i> OEH	V	-	Shrub or tree 2-5, rarely 10m high. Grows in heath, often on exposed sites. <i>Distribution limits</i> N-Werrikimbee NP S-Yengo NP.	x	marginal	x	-	x
<i>Melaleuca biconvexa</i> OEH EPBC	V	V	Tall shrub. Grows in wetlands adjoining perennial streams and on the banks of those streams, generally within the geological series known as the Terrigal Formation. <i>Distribution limits</i> N-Port Macquarie S-Jervis Bay.	x	marginal	2km SE	✓	unlikely
<i>Pelargonium striatellum</i> sp. EPBC	E1	E	Herb to 90cm tall which grows in damp places especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. <i>Varied distribution from SE NSW to QLD</i> .	x	x	-	-	x

Scientific name DATABASE SOURCE1	BC Act	EPBC Act	Growth form and habitat requirements Distribution limit	Recorded on site (✓)	If not recorded on site			
					Suitable habitat present (✓)	Nearby and / or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur
<i>Persicaria elatior</i> OEH EPBC	V	V	Herb to 90cm tall which grows in damp places especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. Varied distribution from SE NSW to QLD.	x	low	x	-	low
<i>Persoonia hirsuta</i> EPBC	E1	E	Erect to decumbent shrub. Grows in dry sclerophyll forest and woodland on Hawkesbury sandstone with infrequent fire histories. <i>Distribution limits N-Glen Davis S-Hill Top.</i>	x	marginal	x	-	x
<i>Prostanthera askania</i> OEH	E1	E	Erect shrub. Grows in sclerophyll forest on ridges in or adjacent to Rainforest. <i>Distribution limits Strickland SF region.</i>	x	marginal	5km SW	x	x
<i>Prostanthera junonis</i> EPBC	E1	E	Small shrub. Grows in sclerophyll forest and heath in shallow soil on sandstone. <i>Distribution limits Somersby region.</i>	x	x	-	-	x
<i>Pultenaea glabra</i> EPBC	V	V	Erect shrub. Grows in moist, sheltered section of dry sclerophyll forest on sandstone in Higher Blue Mountains and Glen Davis areas.	x	x	-	-	x
<i>Rhizanthella slateri</i> EPBC	V	E	Underground orchid that is poorly known. Grows in sclerophyll forests. Usually only seen if the soil is disturbed. Flowers in Oct – Nov.	x	x	-	-	x
<i>Rutidosia heterogama</i> OEH EPBC	V	V	Erect herb to 30cm. Grows mostly in heath, often along roadsides. <i>Distribution limits N-Maclean S-Hunter Valley.</i>	x	marginal	2.5km N	✓	unlikely
<i>Syzygium paniculatum</i> OEH EPBC	V	V	Small tree. Subtropical and littoral rainforest on sandy soil. <i>Distribution limits N-Forster S-Jervis Bay.</i>	x	x	-	-	x

Scientific name DATABASE SOURCE1	BC Act	EPBC Act	Growth form and habitat requirements Distribution limit	Recorded on site (✓)	If not recorded on site			
					Suitable habitat present (✓)	Nearby and / or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur
<i>Tetratheca glandulosa</i> OEH	V	-	Spreading shrub to 0.2m high. Sandy or rocky heath or scrub. Distribution limits N-Mangrove Mountain S-Port Jackson.	x	x	-	-	x
<i>Tetratheca juncea</i> OEH EPBC	V	V	Prostrate shrub to 1m high. Dry sclerophyll forest and heath. Distribution limits N-Bulahdelah S-Port Jackson.	✓ previous report	marginal	3km N	✓	low
<i>Thelymitra adorata</i> OEH EPBC	E4a	CE	A terrestrial orchid with dark bluish-purple flowers, presented in mid-late spring. Currently known from a few localised occurrences in the area bounded by the towns of Wyong, Warnervale and Wyongah.	x	marginal	<1km	✓	unlikely
<i>Thesium australe</i> EPBC	V	V	Erect herb to 0.4m high. Root parasite. Themeda grassland or woodland often damp. Distribution limits N-Tweed Heads S-south of Eden.	x	x	-	-	x
OEH	- Denotes species listed within 10km of the subject site on the <i>Atlas of NSW Wildlife</i>							
EPBC	- Denotes species listed within 10km of the subject site in the <i>EPBC Act</i> habitat search							
TBE	- Denotes additional species considered by <i>Travers bushfire & ecology</i> to have potential habitat based on regional knowledge and other records							
V	- Denotes vulnerable listed species under the relevant Act							
E or E1	- Denotes endangered listed species under the relevant Act							
E4a or CE	- Denotes critically endangered listed species under the relevant Act							
NOTE:	1. This field is not considered if no suitable habitat is present within the subject site 2. 'records' refer to those provided by the <i>Atlas of NSW Wildlife</i> 3. 'nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle							

Table A2.2 provides an assessment of potential habitat within the subject site for state and nationally listed threatened fauna species recorded within 10km on the *Atlas of NSW Wildlife* (OEH) or indicated to have potential habitat present within 10km on the *EPBC Act* Protected Matters Tool.

Table A2.2 – Threatened fauna habitat assessment

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur	
Wallum Froglet <i>Crinia tinnula</i> OEH	V	-	Found in acidic paperbark swamps and wallum country with dense groundcover. Breeds in temporary and permanent pools and ponds of high acidity. <i>Distribution limit: N-Tweed Heads S-Kurnell.</i>	x	marginal (no breeding habitat)	✓	✓	unlikely	✓
Giant Burrowing Frog <i>Heleioporus australiacus</i> EPBC	V	V	Inhabits open forests and riparian forests along non-perennial streams, digging burrows into sandy creek banks. <i>Distribution limit: N-Near Singleton S-South of Eden.</i>	x	x	-	-	x	x
Stuttering Frog <i>Mixophyes balbus</i> EPBC	E	V	Terrestrial inhabitant of rainforest and wet sclerophyll forests. <i>Distribution limit: N-near Tenterfield S-South of Bombala.</i>	x	x	-	-	x	x
Giant Barred Frog <i>Mixophyes iteratus</i> OEH EPBC	E	E	Terrestrial inhabitant of rainforest and open forests. <i>Distribution limit: N-Border Ranges National Park. S-Narooma.</i>	x	x	-	-	x	x

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur	
Green and Golden Bell Frog <i>Litoria aurea</i> OEH EPBC	E	V	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. <i>Distribution limit: N-Byron Bay S-South of Eden.</i>	X	X	-	-	X	X
Green-thighed Frog <i>Litoria brevipalmata</i> OEH	V	-	Found in rainforests and open forests within or at the edge of streams, swamps, lagoons, dams and ponds. <i>Distribution limit: N-Border Ranges National Park. S-Near Gosford.</i>	X	X	-	-	X	X
Littlejohn's Tree Frog <i>Litoria littlejohnii</i> EPBC	V	V	Found in wet and dry sclerophyll forest associated with sandstone outcrops at altitudes 280-1,000m on eastern slopes of Great Dividing Range. Prefers flowing rocky streams. <i>Distribution limit: N-Hunter River S-Eden.</i>	X	X	-	-	X	X
Mahony's Toadlet <i>Uperoleia mahonyi</i> OEH	Preliminary listing E	-	Inhabits ephemeral and semi-permanent swamps and swales on the coastal fringe of its range. Known records occur in heath or wallum habitats almost exclusively associated with leached (highly nutrient impoverished) white sand. Commonly associated with acid paperbark swamps, also is known to occur in wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland. <i>Distribution limit: N-Seal Rocks S-Kangy Angy (to date)</i>	X	X	-	-	X	X

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur	
Broad-headed Snake <i>Hoplocephalus bungaroides</i> EPBC	E	V	Sandstone outcrops, exfoliated rock slabs and tree hollows in coastal and near coastal areas. <i>Distribution limit: N-Mudgee Park. S-Nowra.</i>	x	x	-	-	x	x
Stephens' Banded Snake <i>Hoplocephalus stephensii</i> OEH	V	-	A nocturnal and partly arboreal species that inhabits open and closed forest communities sheltering under bark, in hollows and under exfoliating slabs of granite. <i>Distribution limit: N-Border Ranges National Park. S-Gosford.</i>	x	Sub-optimal	x	x	Not likely	x
Wompoo Fruit-dove <i>Ptilinopus magnificus</i> OEH	V	-	Inhabits large undisturbed patches of lowland and adjacent highland rainforest and moist eucalypt forests where it feeds on fruit. <i>Distribution limit: N-Tweed Heads. S-Sydney.</i>	x	x	-	-	x	x
Rose-crowned Fruit-dove <i>Ptilinopus regina</i> OEH	V	-	Occurs in dense rainforests with a substantial understorey where it feeds entirely on fruit. <i>Distribution limit: N-Tweed Heads. S-Wollongong.</i>	x	x	-	-	x	x
Superb Fruit-dove <i>Ptilinopus superbus</i> OEH	V	-	Rainforests, adjacent mangroves, eucalypt forests, scrubland with native fruits. <i>Distribution limit: N-Border Ranges National Park. S-Batemans Bay.</i>	x	x	-	-	x	x

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur	
Black-necked Stork <i>Ephippiorhynchus asiaticus</i> OEH	E	-	Occurs in tropical to warm temperate terrestrial wetlands, estuarine and littoral habitats such as mangroves, tidal mudflats, floodplains, open woodlands, irrigated lands, bore drains, sub-artesian pools, farm dams and sewerage ponds. <i>Distribution limit: N-Tweed Heads. S-Nowra.</i>	x	x	-	-	x	x
Australasian Bittern <i>Botaurus poiciloptilus</i> OEH EPBC	E	E	Found in or over water of shallow freshwater or brackish wetlands with tall reedbeds, sedges, rushes, cumbungi, lignum and also in ricefields, drains in tussocky paddocks, occasionally saltmarsh, brackish wetlands. <i>Distribution limit: N-North of Lismore. S-Eden.</i>	x	x	-	-	x	x
Black Bittern <i>Ixobrychus flavicollis</i> OEH	V	-	Found in shadowy, leafy waterside trees such as callistemons, casuarinas, paperbarks, eucalypts, mangroves and willows along tidal creeks, freshwater and brackish streams and ponds, sheltered mudflats and oyster slats. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x
White-bellied Sea Eagle <i>(Haliaeetus leucogaster)</i> OEH	V	-	Occupies coasts, islands, estuaries, inlets, large rivers, inland lakes and reservoirs. <i>Sedentary; dispersive. N-Tweed Heads. S-South of Eden.</i>	✓ (Abel Ecology 2017)	-	-	-	-	✓

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur	
Little Eagle <i>Hieraaetus morphnoides</i> OEH	V	-	Utilises plains, foothills, open forests, woodlands and scrublands; river red gums on watercourses and lakes. <i>Distribution limit</i> - N-Tweed Heads. S-South of Eden.	x	✓	✓	x	low	✓
Square-tailed Kite <i>Lophoictinia isura</i> OEH	V	-	Utilises mostly coastal and sub-coastal open forest, woodland or lightly timbered habitats and inland habitats along watercourses and mallee that are rich in passerine birds. <i>Distribution limit</i> : N-Goondiwindi. S-South of Eden.	x	✓	✓	✓	✓	✓
Eastern Osprey <i>Pandion cristatus</i> OEH	V	-	Utilises waterbodies including coastal waters, inlets, lakes, estuaries and offshore islands with a dead tree for perching and feeding. <i>Distribution limit</i> : N-Tweed Heads. S-South of Eden.	x	x	-	-	x	x
Black Falcon <i>Falco subniger</i> OEH	V	-	Inhabits plains, grasslands, foothills, timbered watercourses, wetland environs, crops; occasionally over towns and cities. N-Tweed Heads. S-South of Eden	x	x	-	-	x	x
Bush Stone-curlew <i>Burhinus grallarius</i> OEH	E	-	Utilises open forests and savannah woodlands, sometimes dune scrub, savannah and mangrove fringes. <i>Distribution limit</i> : N-Border Ranges National Park. S-Near Nowra.	x	x	-	-	x	x

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur	
Comb-crested Jacana <i>Irediparra gallinacean</i> OEH	V	-	Floating vegetation of deep and permanent vegetation-choked tropical and warm temperate wetlands and dams. Occasionally feeds along muddy wetland margins. <i>Distribution limit: N-Tweed Heads. S-Ku-ring-gai Chase National Park.</i>	x	x	-	-	x	x
Australian Painted Snipe <i>Rostratula australis</i> EPBC	E	E	Most numerous within the Murray-Darling basin and inland Australia within marshes and freshwater wetlands with swampy vegetation. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x
Black-tailed Godwit <i>Limosa limosa</i> OEH	V	-	Regular summer migrant that forages along tidal mudflats, estuaries, sandspits, shallow river margins, sewerage ponds, inland on large shallow fresh or brackish waters. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x
Eastern Curlew <i>Numenius madagascariensis</i> OEH	-	CE	Primarily coastal especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. Often recorded among saltmarsh and on mudflats fringed by mangroves and also in coastal saltworks and sewage farms. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur	
Gang-gang Cockatoo <i>Callocephalon fimbriatum</i> OEH	V	-	Prefers wetter forests and woodlands from sea level to > 2,000m on the Great Dividing Range, timbered foothills and valleys, timbered watercourses, coastal scrubs, farmlands and suburban gardens. <i>Distribution limit: mid north coast of NSW to western Victoria.</i>	x	Marginal	x	✓	Not likely	x
Glossy Black-Cockatoo <i>Calyptorhynchus lathamii</i> OEH	V	-	Open forests with <i>Allocasuarina</i> species and hollows for nesting. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	✓	✓	✓	✓	✓
Little Lorikeet <i>Glossopsitta pusilla</i> OEH	V	-	Inhabits forests, woodlands; large trees in open country; timbered watercourses, shelterbeds, and street trees. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	✓	✓	✓	✓	✓
Swift Parrot <i>Lathamus discolour</i> OEH EPBC	E	E	Inhabits eucalypt forests and woodlands with winter flowering eucalypts. <i>Distribution limit: N-Border Ranges National Park. S-South of Eden.</i>	x	x	-	-	x	x
Barking Owl <i>Ninox connivens</i> OEH	V	-	Inhabits principally woodlands but also open forests and partially cleared land and utilises hollows for nesting. <i>Distribution limit: N-Border Ranges National Park. S-Eden.</i>	x	✓	✓	✓	✓	✓

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓) Notes 1,2 & 3	Nearby and/or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur	
Powerful Owl <i>Ninox strenua</i> OEH	V	-	Forests containing mature trees for shelter or breeding and densely vegetated gullies for roosting. <i>Distribution limits: N-Border Ranges National Park. S-Eden.</i>	✓ (Abel Ecology 2017)	-	-	-	-	✓
Masked Owl <i>Tyto novaehollandiae</i> OEH	V	-	Open forest and woodlands with cleared areas for hunting and hollow trees or dense vegetation for roosting. <i>Distribution limit: N-Border Ranges National Park. S-Eden.</i>	x	✓	✓	✓	✓	✓
Sooty Owl <i>Tyto tenebricosa</i> OEH	V	-	Tall, dense, wet forests containing trees with very large hollows. <i>Distribution limit: N-Border Ranges National Park. S-South of Eden.</i>	x	x	-	-	x	x
Brown Treecreeper <i>Climacteris picumnus victoriae</i> OEH	V	-	Occupies eucalypt woodlands, open woodland lacking a dense understorey with fallen dead timber. <i>Distribution limit: (Sub species victoriae) Central NSW west of Great Div. Cumberland Plains, Hunter Valley, Richmond, Clarence, and Snowy River Valleys.</i>	x	marginal	x	✓	Not likely	x
Eastern Bristlebird <i>Dasyornis brachypterus</i> EPBC	E	E	Coastal woodlands, dense scrubs and heathlands, especially where low heathland borders taller woodland or dense tall tea-tree. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur	
Speckled Warbler <i>Chthonicola sagittata</i> OEH	V	-	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. <i>Distribution limit: N-Urbanville. S-Eden.</i>	x	x	-	-	x	x
Regent Honeyeater <i>Xanthomyza Phrygia</i> OEH EPBC	E4A	CE	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. <i>Distribution limit: N-Urbanville. S-Eden.</i>	x	x	-	-	x	x
White-fronted Chat <i>Epithianura albifrons</i> OEH	V	-	Found in open damp ground, grass clumps, fencelines, heath, samphire saltmarshes, mangroves, dunes, saltbush plains. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	✓	x	x	Not likely	x
Painted Honeyeater <i>Grantiella picta</i> OEH EPBC	V	V	A nomadic bird occurring in low densities within open forest, woodland and scrubland feeding on mistletoe fruits. Inhabits primarily Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. <i>Distribution limit: N-Boggabilla. S-Albury with greatest occurrences on the inland slopes of the Great Dividing Range.</i>	x	x	-	-	x	x
Varied Sittella <i>Daphoenositta chrysoptera</i> OEH	V	-	Open eucalypt woodlands / forests (except heavier rainforests); mallee, inland acacia, coastal tea-tree scrubs; golf courses, shelterbelts, orchards, parks, scrubby gardens. <i>Distribution limit: N-Border Ranges National Park. S-South of Eden.</i>	x	✓	✓	✓	✓	✓

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur	
Dusky Woodswallow <i>Artamus cyanopterus</i> OEH	V	-	Found in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests. Prefers habitat with an open understorey. Often observed in farmland tree patches or roadside remnants. <i>Widespread in eastern, southern and south-western Australia.</i>	x	✓	✓	x	low	✓
Scarlet Robin <i>Petroica boodang</i> OEH	V	-	Found in foothill forests, woodlands, watercourses; in autumn-winter, more open habitats: river red gum woodlands, golf courses, parks, orchards, gardens. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	✓(Abel Ecology 2017)	-	-	-	-	✓
Flame Robin <i>Petroica phoenicea</i> OEH	V	-	Summer: forests, woodlands, scrubs, from sea-level to c. 1800 m. Autumn-winter: open woodlands, plains, paddocks, golf courses, parks, orchards. <i>Distribution limit: N northern NSW tablelands. S-South of Eden.</i>	x	✓	x	x	unlikely	✓
Diamond Firetail <i>Stagonopleura guttata</i> OEH	V	-	Found in eucalypt woodlands, forests and mallee where there is grassy understorey west of the Great Div. also drier coastal woodlands of the Cumberland Plain and Hunter Richmond and Clarence River Valleys. <i>Distribution limit: N-Rockhampton Q. S-Eyre Pen Kangaroo Is. SA.</i>	x	x	-	-	x	x

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur	
Spotted-tailed Quoll <i>Dasyurus maculatus</i> OEH EPBC	V	E	Dry and moist open forests containing rock caves, hollow logs or trees. <i>Distribution limit: N-Mt Warning National Park. S-South of Eden.</i>	x	x	-	-	x	x
Koala <i>Phascolarctos cinereus</i> OEH EPBC	V	V	Inhabits both wet and dry eucalypt forest on high nutrient soils containing preferred feed trees. <i>Distribution limit: N-Tweed Heads. S-South of Eden.</i>	x	marginal	x	x	Not likely	x
Eastern Pygmy Possum <i>Cercatetus nanus</i> OEH	V	-	Found in a variety of habitats from rainforest through open forest to heath. Feeds on insects but also gathers pollen from banksias, eucalypts and bottlebrushes. Nests in banksias and myrtaceous shrubs. <i>Distribution limit: N-Tweed Heads. S-Eden.</i>	x	Sub-optimal	x	✓	unlikely	x
Yellow-bellied Glider <i>Petaurus australis</i> OEH	V	-	Tall mature eucalypt forests with high nectar producing species and hollow bearing trees. <i>Distribution limit: N-Border Ranges National Park. S-South of Eden.</i>	x	x	-	-	x	x
Squirrel Glider <i>Petaurus norfolcensis</i> OEH	V	-	Mixed aged stands of eucalypt forest & woodlands including gum barked & high nectar producing species & hollow bearing trees. <i>Distribution limit: N-Tweed Heads. S-Albury.</i>	x	✓	✓	✓	✓	✓

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur	
Greater Glider <i>Petauroides volans</i> OEH EPBC	-	V	Favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species. Population density is optimal at elevation levels at 845 m above sea level. Prefer overstorey basal areas in old-growth tree stands. Highest abundance typically in taller, montane, moist eucalypt forests, with relatively old trees and abundant hollows <i>Distribution limit: N-Border Ranges National Park. S- South of Eden.</i>	x	x	-	-	x	x
Long-nosed Potoroo <i>Potorous tridactylus</i> OEH EPBC	V	V	Coastal heath and dry and wet sclerophyll forests with a dense understorey. <i>Distribution limit: N-Mt Warning National Park. S-South of Eden.</i>	x	✓	x	✓	unlikely	✓
Brush-tailed Rock-wallaby <i>Petrogale penicillata</i> EPBC	E	V	Found in rocky gorges with a vegetation of rainforest or open forests to isolated rocky outcrops in semi-arid woodland country. <i>Distribution limit: N-North of Tenterfield. S-Bombala.</i>	x	x	-	-	x	x
Grey-headed Flying-fox <i>Pteropus poliocephalus</i> OEH EPBC	V	V	Found in a variety of habitats including rainforest, mangroves, paperbark swamp, wet and dry open forest and cultivated areas. Forms camps commonly found in gullies and in vegetation with a dense canopy. <i>Distribution limit: N-Tweed Heads. S-Eden.</i>	✓(Abel Ecology 2017)	-	-	-	-	✓

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur	
Yellow-bellied Sheathtail-bat <i>Saccolaimus flaviventris</i> OEH	V	-	Rainforests, sclerophyll forests and woodlands. <i>Distribution limit: N-North of Walgett. S-Sydney.</i>	x	✓	✓	✓	✓	✓
East-coast Freetail Bat <i>Micronomus norfolkensis</i> OEH	V	-	Inhabits open forests and woodlands foraging above the canopy and along the edge of forests. Roosts in tree hollows, under bark and buildings. <i>Distribution limit: N-Woodenbong. S-Pambula.</i>	✓	-	-	-	-	✓
Large-eared Pied Bat <i>Chalinolobus dwyeri</i> OEH EPBC	V	V	Warm-temperate to subtropical dry sclerophyll forest and woodland. Roosts in caves, tunnels and tree hollows in colonies of up to 30 animals. <i>Distribution limit: N-Border Ranges National Park. S-Wollongong.</i>	x	marginal	✓	✓	low	✓
Eastern Falsistrelle <i>Falsistrellus tasmaniensis</i> OEH	V	-	Recorded roosting in caves, old buildings and tree hollows. <i>Distribution limit: N-Border Ranges National Park. S-Pambula.</i>	x	✓	✓	✓	✓	✓
Golden-tipped Bat <i>Kerivoula papuensis</i> OEH	V	-	Rainforest and adjoining moist open forest habitats, roosting in tree hollows and dense vegetation. <i>Distribution limit: N-Border Ranges Nation Park. S-South of Eden.</i>	x	x	-	-	x	x

Common name Scientific name Database source	BC Act	EPBC Act	Preferred habitat Distribution limit	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur	
Little Bentwing-bat <i>Miniopterus australis</i> OEH	V	-	Roosts in caves, old buildings and structures in the higher rainfall forests along the south coast of Australia. <i>Distribution limit: N-Border Ranges National Park. S-Sydney.</i>	✓	-	-	-	-	✓
Eastern Bentwing-bat <i>Miniopterus orianae oceanensis</i> OEH	V	-	Prefers areas where there are caves, old mines, old buildings, stormwater drains and well-timbered areas. <i>Distribution limit: N-Border Ranges National Park. S-South of Eden.</i>	✓	-	-	-	-	✓
Large-footed Myotis <i>Myotis macropus</i> OEH	V	-	Roosts in caves, mines, tunnels, buildings, tree hollows and under bridges. Forages over open water. <i>Distribution limit: N-Border Ranges National Park. S-South of Eden.</i>	✓ (Possible-Abel Ecology 2017)	-	-	-	-	✓
Greater Broad-nosed Bat <i>Scoteanax rueppellii</i> OEH	V	-	Inhabits areas containing moist river and creek systems, especially tree lined creeks. <i>Distribution limit: N-Border Ranges National Park. S-Pambula.</i>	✓	-	-	-	-	✓

Common name <i>Scientific name</i> Database source	BC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1, 2 & 3	Record(s) from recent years (✓) Notes 1, 2 & 3	Potential to occur	
Eastern Cave Bat <i>Vespadelus troughtoni</i> OEH	V	-	Inhabits drier open forests and woodlands. Roosts in well-lit parts of caves and mineshafts. <i>Distribution limit: Along GDR from N-Tweed Heads. S-Kempsey.</i>	x	marginal	x	✓	unlikely	✓
Eastern Chestnut Mouse <i>Pseudomys gracilicaudatus</i> OEH	V	-	Inhabits heathland including dense wet heath and swampy areas, occasionally in woodland with grassy understorey. <i>Distribution limit: N-Border Ranges National Park. S-Brisbane Water National Park.</i>	x	✓	x	✓	unlikely	✓
New Holland Mouse <i>Pseudomys novaehollandiae</i> EPBC	-	V	Occurs in heathlands, woodlands, open forest and paperbark swamps and on sandy, loamy or rocky soils. Coastal populations have a marked preference for sandy substrates, a heathy understorey of leguminous shrubs less than 1m high and sparse ground litter. Recolonise of regenerating burnt areas. <i>Distribution limit: N-Border Ranges National Park. S-South of Eden.</i>	x	x	-	-	x	x
Giant Dragonfly <i>Petalura gigantean</i> OEH	E	-	Inhabits large relatively deep permanent swamps and bogs with high water quality and moss or other soft vegetation along the edge for egg laying. <i>It occurs in the far NE NSW, south to Kempsey, & in a patch between Gosford & Nowra.</i>	x	x	-	-	x	x

Common name <i>Scientific name</i> Database source		BC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on site				Considered in significance of impact test (✓) (Refer to Appendix 3)
						Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) Notes 1,2 & 3	Record(s) from recent years (✓) Notes 1,2 & 3	Potential to occur	
Australian Greyling <i>Prototroctes maraena</i> EPBC		Part 2, Section 19 – Protected Fish (FM Act 1994)	V	Clear, moderate to fast flowing water in the upper reaches of rivers (sometimes to altitudes above 1,000m). Typically found in gravel bottom pools. Often forming aggregations below barriers to upstream movement (e.g. weirs, waterfalls).	x	x	-	-	x	x
OEH	Denotes species listed within 10km of the subject site on the <i>Atlas of NSW Wildlife</i>									
EPBC	Denotes species listed within 10km of the subject site in the <i>EPBC Act</i> habitat search									
V	Denotes vulnerable listed species under the relevant Act									
E or E1	Denotes endangered listed species under the relevant Act									
E4a or CE	Denotes critically endangered listed species under the relevant Act									
NOTE:	1. This field is not considered if no suitable habitat is present within the subject site 2. 'records' refer to those provided by the <i>Atlas of NSW Wildlife</i> 3. 'nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle									
Unlikely	Represents such a low margin but not enough to 100% rule it one. A significance of impact test is required.									
Not likely	Means 0% change of occurring, despite there being potential habitat. A significance of impact test is not applied to these species.									

Table A2.3 provides an assessment of potential habitat within the subject site for nationally *protected* migratory fauna species recorded within 10km on the *EPBC Act* Protected Matters Tool. Nationally *threatened* migratory species are considered in Table A2.2.

Table A2.3 – Migratory fauna habitat assessment

Common name Scientific name	Preferred habitat Migratory breeding	Suitable habitat present (✓)	Recorded on site (✓)	Comments
Oriental Cuckoo (<i>Cuculus optatus</i>)	Mainly inhabits forests, occurring in coniferous, deciduous and mixed forest. It feeds mainly on insects and their larvae, foraging for them in trees and bushes as well as on the ground.	✓	x	-
White-throated Needletail (<i>Hirundapus caudacutus</i>)	Airspace over forests, woodlands, farmlands, plains, lakes, coasts, towns; companies often forage along favoured hilltops and timbered ranges. Breeds Siberia, Himalayas, east to Japan. Summer migrant to eastern Australia.	✓	x	-
Fork-tailed Swift (<i>Apus pacificus</i>)	Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities. Breeds Siberia, Himalayas, east to Japan south east Asia. Summer migrant to east Australia. Mass movements associated with late summer low pressure systems into east Australia. Otherwise uncommon.	✓	x	-
Black-faced Monarch (<i>Monarcha melanopsis</i>)	Rainforests, eucalypt woodlands; coastal scrubs; damp gullies in rainforest, eucalypt forest; more open woodland when migrating. Summer breeding migrant to coastal south east Australia, otherwise uncommon.	✓	x	-
Spectacled Monarch (<i>Monarcha trivirgatus</i>)	Understorey of mountain / lowland rainforest, thickly wooded gullies, waterside vegetation, mostly well below canopy. Summer breeding migrant to south-east Qld and north-east NSW down to Port Stephens from Sept / Oct to May. Uncommon in southern part of range.	x	-	-
Satin Flycatcher (<i>Myiagra cyanoleuca</i>)	Heavily vegetated gullies in forests, taller woodlands, usually above shrub-layer; during migration, coastal forests, woodlands, mangroves, trees in open country, gardens. Breeds mostly south-east Australia and Tasmania over warmer months, winters in north east Qld.	✓	x	-
Rufous Fantail (<i>Rhipidura rufifrons</i>)	Undergrowth of rainforests / wetter eucalypt forests / gullies; monsoon forests, paperbarks, sub-inland and coastal scrubs; mangroves, watercourses; parks, gardens. On migration, farms, streets buildings. Breeding migrant to south-east Australia over warmer months. Altitudinal migrant in north-east NSW in mountain forests during warmer months.	✓	x	-
Yellow Wagtail (<i>Motacilla flava</i>)	The yellow wagtail typically forages in damp grassland and on relatively bare open ground at edges of rivers, lakes and wetlands, but also feeds in dry grassland and in fields of cereal crops.	x	-	-

Common name Scientific name	Preferred habitat Migratory breeding	Suitable habitat present (✓)	Recorded on site (✓)	Comments
Swinhoe's Snipe (<i>Gallinago megala</i>)	During the non-breeding season Swinhoe's Snipe occurs at the edges of wetlands, eg. wet paddy fields, swamps and freshwater streams. Also known in grasslands, drier cultivated areas and market gardens. Habitat specific to Australia includes the dense clumps of grass and rushes around the edges of fresh and brackish wetlands. This includes swamps, billabongs, river pools, small streams and sewage ponds. Also found in drying claypans and inundated plains pitted with crab holes. <i>Breeds in central Siberia and Mongolia and moving south for the boreal winter.</i>	×	-	-
Pin-tailed Snipe (<i>Gallinago stenura</i>)	During non-breeding period the Pin-tailed Snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as claypans in more arid parts of species' range. It is also commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands. <i>Breeds in Russia. Australian distribution is not well understood. There are confirmed records from NSW, with a single banded bird reported near West Wyalong.</i>	×	-	-
Latham's Snipe (<i>Gallinago hardwickii</i>)	Soft wet ground or shallow water with tussocks and other green or dead growth; wet parts of paddocks; seepage below dams; irrigated areas; scrub or open woodland from sea-level to alpine bogs over 2,000m; samphire on saltmarshes; mangrove fringes. <i>Breeds Japan. Regular summer migrant to Australia. Some overwinter.</i>	×	-	-
Bar-tailed Godwit (<i>Limosa lapponica</i>)	The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh.	×	-	-
Black-tailed Godwit (<i>Limosa limosa</i>)	Primarily coastal habitat environment. The species is commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit; occasionally recorded on rocky coasts or coral islets. The use of habitat often depends on the stage of the tide. It is also found in shallow and sparsely vegetated, near-coastal, wetlands; such as saltmarsh, saltflats, river pools, swamps, lagoons and floodplains. There are a few inland records, around shallow, freshwater and saline lakes, swamps, dams and bore-overflows. They also use lagoons in sewage farms and saltworks	×	-	-



Significance of Impact Test

A3

Section 7.2 of the *BC Act* requires a determination as to whether a development or activity is likely to significantly affect threatened species or ecological communities, or their habitats. Henceforth this is referred to as the 'Significance of Impact Test' (SOI). This test does not need to be applied to state significant development assessments which are required to be assessed according to the BOS.

However the information presented in Part A of the SOI test is informative for assessing impacts.

Threatened flora

Scientific name	BC Act	Potential to occur	Potential impact
<i>Angophora inopina</i>	V	low	Removal of 0.686 ha of low potential habitat
<i>Callistemon linearifolius</i>	V	unlikely	Removal of 0.686 ha of unlikely habitat
<i>Cryptostylis hunteriana</i>	V	low	Removal of 0.686 ha of low potential habitat
<i>Eucalyptus camfieldii</i>	V	recorded (probable)	Removal of 0.686 ha of known habitat
<i>Genoplesium insigne</i>	E1	low	Removal of 0.686 ha of low potential habitat
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V	low	Removal of 0.686 ha of low potential habitat
<i>Melaleuca biconvexa</i>	V	unlikely	Removal of 0.686 ha of unlikely habitat
<i>Rutidosia heterogama</i>	V	unlikely	Removal of 0.686 ha of unlikely habitat
<i>Tetratheca juncea</i>	V	recorded	Removal of 0.686 ha of known habitat
<i>Thelymitra adorata</i>	E4a	unlikely	Removal of 0.686 ha of unlikely habitat

Threatened fauna

Common name	BC Act	Potential to occur	Potential impact
East-coast Freetail Bat	V	recorded	Direct – on foraging habitat, unlikely on roosting/breeding habitat
Little Bentwing-bat	V	recorded	None anticipated
Eastern Bentwing-bat	V	recorded	None anticipated
Greater Broad-nosed Bat	V	recorded	Direct – on foraging habitat, unlikely on roosting/breeding habitat
White-bellied Sea Eagle	V	recorded (Abel)	None anticipated
Powerful Owl	V	recorded (Abel)	Direct – on likely foraging and potential roosting habitat
Scarlet Robin	V	recorded (Abel)	Direct – on potential foraging, roosting & breeding habitat
Grey-headed Flying-fox	V	recorded (Abel)	Direct – on foraging habitat
Large-footed Myotis	V	recorded (Abel)	None anticipated
Square-tailed Kite	V	✓	None anticipated
Glossy Black-Cockatoo	V	✓	Direct – on potential foraging and unlikely nesting habitat
Little Lorikeet	V	✓	Direct – on suitable foraging habitat

Common name	BC Act	Potential to occur	Potential impact
Barking Owl	V	✓	Direct – on suitable foraging habitat, unlikely on roosting/breeding habitat
Masked Owl	V	✓	Direct – on suitable foraging habitat
Varied Sittella	V	✓	Direct – on suitable foraging, roosting & breeding habitat
Squirrel Glider	V	✓	Direct – on suitable foraging, unlikely on denning/breeding habitat
Yellow-bellied Sheath-tail-bat	V	✓	Direct – on suitable foraging, unlikely on roosting/breeding habitat
Eastern Falsistrelle	V	✓	Direct – on suitable foraging, unlikely on roosting/breeding habitat
Little Eagle	V	low	None anticipated
Dusky Woodswallow	V	low	Direct – on low potential foraging habitat
Large-eared Pied Bat	V	low	Direct – on low potential foraging habitat
Wallum Froglet	V	unlikely	Direct – on unlikely dispersal/shelter habitat
Flame Robin	V	unlikely	Direct – on unlikely foraging, roosting & breeding habitat
Long-nosed Potoroo	V	unlikely	Direct – on unlikely foraging, shelter & breeding habitat
Eastern Cave Bat	V	unlikely	Direct – on unlikely foraging habitat
Eastern Chestnut Mouse	V	unlikely	Direct – on unlikely foraging, shelter & breeding habitat

Summary of threatened species recorded

Eucalyptus camfieldii

This species is a tree or mallee to 10m high, but often less. It has persistent stringy bark which is grey to red-brown. Juvenile leaves are heart shaped. It grows in coastal shrub heath on sandy soils on sandstone, often in areas with restricted drainage. Its distribution is from Gosford in the north to the Royal National Park in the south (Harden 1994). Two (2) individual trees were found on site that were considered to be probably members of this species. These trees were in poor condition with no juvenile or flowering material. A specimen sent to the NSW Herbarium prompted the following determination:

“Eucalyptus camfieldii <-> *capitellata* (intergrade or hybrid), juvenile material required for more detailed diagnosis det. A.E. Orme 14 Sep 2018”

In the absence of better material for diagnosis, we take a conservative approach regarding the identification of this species, and treat it as *E. camfieldii* for the purposes of this assessment. It is considered that the action proposed is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction. The retention and protection of these trees within the proposed APZ is possible whilst still complying with APZ requirements, and should be a priority.

Tetratheca juncea

Tetratheca juncea occurs chiefly in coastal districts on sandy, and occasionally swampy, heath and open forest (Fairly & Moore, 1989; Harden, 1994). A review of the distribution of *T. juncea* suggests that it is concentrated around Lake Macquarie with small populations occurring as far north as Bulahdelah and south to the Wyong area (SWC Consultancy, 1992; Ecological Surveys and Management, 1998). *Tetratheca juncea* has been recorded at a number of localities within the Lake Macquarie area including Toronto, Buttaba, Yarrowonga Park, Croudace Bay, Nords Wharf, Valentine, Awaba, Chain Valley Bay, Nine Mile Beach, Lake Macquarie State Recreation Area, Gwandalan and Windale (Ecological Surveys and Management, 1998). The preferred habitat for this species is described as being on a southerly aspect (161° - 240°) on ridges and upper slopes with good drainage with dry understorey (Ecological Surveys and Management, 1998). The preferred soil types in descending order are Awaba, Warners Bay, Gateshead, Norah Head, Doyalson and Killingworth soil landscapes (Ecological Surveys and Management, 1998).

One (1) individual of *T. juncea* observed within the study area just to the south of the subject site during surveys undertaken. An earlier report by *RPS* states that *Tetratheca juncea* (Black-eyed Susan) was recorded within the study area in 2002 (S. Styman pers. comm. 3 June 2014, in *RPS* 2014). No individuals of *T. juncea* were observed within the subject site.

Targeted searches by *RPS* and *Abel Ecology* during peak flowering time in 2014 and 2017 failed to locate the species within the study area. This indicates that the population of *T. juncea* within the study area is quite small. It is considered that the action proposed is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Powerful Owl

The Powerful Owl inhabits mature rainforest and wet and dry eucalypt forest. Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal mammals. Roosting is generally within dense foliage of mid-canopy trees in sheltered gullies. Large trees with hollows at least 45cm in diameter and 100cm deep are required for nesting. Mated pairs of Powerful Owl roost together or separately, maintaining several roost sites throughout their territory, which are used in rotation (Lindsey 1992), and shifting with the availability of prey. A pair is generally faithful to a traditional nesting hollow. Powerful Owls form pairs for life, and are strongly territorial. Estimates of the home range of this species vary greatly, but territories are thought to range from 800 to 1500 hectares (Kavanagh 1997).

Survey by *Abel Ecology* in August 2017 recorded a female Powerful Owl roosting within the study area for that assessment located to the nearby north-west of the subject site for this assessment. The *Abel Ecology* report recognised that a number of large hollows were present on site and concluded that no active nest was found during that breeding season.

A female found roosting in August would be expected to be located close to a nesting location. Therefore *Travers bushfire & ecology* gave careful consideration to suitable hollows within the current subject site as well as nearby. The larger hollows located within the subject site were considered unsuitable for nesting use due to their size and height. No signs of roosting activity was found within the subject site and nearby. Therefore it is concluded that the subject site provides potential roosting and likely foraging habitat for at least one Powerful Owl from the local breeding pair. Foraging habitat is most notable by the recorded presence of prey species Common Ringtail Possum, Sugar Glider and Grey-headed Flying-fox.

Given the study area does not support breeding habitat and no recent roosting evidence was found during the current breeding period, it is concluded that the removal of habitat within the study area is not significant to a local breeding pair and therefore not likely to significantly impact a local population. Given however that the study area likely supports periodic foraging it is recommended that the conserved swamp forest and corridor to the south is maintained and enhanced to support prey species habitat.

The subject site has a notable high density of hollows due to the presence of Smooth-barked Apple and Scribbly Gum trees however hollow density soon diminishes significantly beyond the subject site. No hollows are likely to be impacted as part of the proposal however the thinning of vegetation for APZs surrounding the recorded hollows will make them less viable for use by some species, particularly Common Ringtail Possum. Therefore nesting boxes designed for gliders / ringtail possums should be placed within the remaining habitat areas to the south.

Augmented and relocated hollows have been placed on telegraph poles as part of previous hollow replacement works efforts from the previous hospital proposal. These hollows are not considered to be effective and located in an area unlikely to be used in a significant way. Nesting boxes to the south however remain absent and the existing older boxes within the subject site itself, have all fallen apart.

White-bellied Sea-Eagle

The White-bellied Sea-Eagle is mostly recorded in coastal lowlands, but can occupy habitats up to 1400 m above sea level on the Northern Tablelands of NSW. It also extends inland along some of the larger waterways, especially in eastern Australia. Habitats occupied are characterised by the presence of large areas of open water (larger rivers, freshwater swamps, lakes, billabongs, reservoirs, but also saltmarsh and sewage ponds). They also occur at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves. Birds have been recorded in (or flying over) a variety of terrestrial habitats including coastal dunes, tidal flats, grassland, heathland, woodland, forest (including rainforest) and even urban areas.

Breeding territories are located close to water, and mainly in tall open forest or woodland, although nests are sometimes located in other habitats such as dense forest (including rainforest), closed scrub or in remnant trees on cleared land. The breeding season extends from June to January and the nest is a large structure composed of sticks and lined with leaves, grass or seaweed. Pairs usually return to the same breeding territory each year, and often the same nest, although territories tend to contain one or two additional, less developed nests. Breeding pairs tend to be widely dispersed, and are generally separated by distances of several kilometres or more.

The White-bellied Sea Eagle was recorded by *Abel Ecology* in 2017 however the recorded location was not described and the species was not assessed in any detail. It is expected that it was probably recorded in flight overhead as the study area is not likely to support any nesting, perching or core foraging habitat. No raptor nests were observed within or close to the subject site as part of recent surveys.

Given that no likely breeding or important perching/foraging habitat will be impacted the White-bellied Sea Eagle will not likely be significantly impacted by the proposal.

Scarlet Robin

The Scarlet Robin is found in south-eastern Australia and south-west Western Australia. In NSW it occupies open forests and woodlands from the coast to the inland slopes (Higgins and Peter 2002). In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. It forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. The Scarlet Robin builds an open cup nest of plant fibres and cobwebs, sited in the fork of 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 (Higgins and Peter 2002; Debus 2006a,b).

It is considered that the subject site provides suitable foraging, roosting and breeding habitat for the Scarlet Robin.

The Scarlet Robin was recorded by *Abel Ecology* in 2017 however the recorded location was not described, the species was not recognised as being threatened and was not assessed in any detail. A recording of this species within the study area would be significant given that the species has only been recorded once previously within 10km. A possible robin call thought more likely the non-threatened Rose Robin was heard during recent survey by

Travers bushfire & ecology at the stormwater detention pond to the nearby south of the subject site. A song-meter was deployed on this date (12/9/2018) for one week with no recorded calls confirming any presence of Scarlet Robin. The species is not expected to occur therefore the proposal is unlikely to significantly impact on a local population.

Grey-headed Flying-fox

Grey-Headed Flying-foxes are canopy feeding frugivores and nectarivores, inhabiting a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. This species roosts in camps, which may contain tens of thousands of individuals.

Camps are commonly formed in gullies, typically not far from water and usually in vegetation with a dense canopy (Tidemann 1998). Camps can be found in riparian rainforest patches, Melaleuca stands, mangroves, riparian woodland or modified vegetation in urban areas. Loyalty to a site is high and some camps in NSW have been used for over a century (NSW NPWS 2001). Some camps are used at the same time every year by hundreds of thousands of flying-foxes while others are used sporadically by a few hundred individuals (Strahan 1995). Generally foraging is within 20km of camps but individuals are known to commute up to 50km to a productive food source.

A Grey-headed Flying-fox was recorded foraging somewhere within the study area by Abel Ecology in 2017. The subject site provides only seasonal foraging habitat for the Grey-headed Flying-fox as no suitable roosting or subsequent breeding habitat is present. Foraging habitat is otherwise well represented in the surrounding locality such that removal of habitat will not significantly impact on a local population. It is recommended that foraging habitat is replaced by locally native flowering eucalypts within landscaping areas.

Little Bentwing-bat & Eastern Bentwing-bat

These two species are considered here together because of their similar roosting/breeding habitat requirements and subsequent assessment outcome.

The Little Bentwing-bat forages below the canopy within open forests and woodlands, feeding on small insects (Dwyer 1995b). This species roosts in caves, tunnels, tree hollows and occasionally old buildings (Dwyer 1995b). Caves are an important resource for this species, particularly for breeding where maternity caves must have suitable temperature, humidity and physical dimensions to permit breeding (Dwyer 1995b). One record exists of this species utilising a tree hollow however hollows are not currently considered as preferred habitat for this species (pers. com. Brad Law).

The Eastern Bentwing-bat forages above and below the canopy within open forests and woodlands, feeding on small flying insects, predominantly moths (Dwyer 1995). The Eastern Bentwing-bat is known to roost in a range of habitats including stormwater channels, under bridges, occasionally in buildings, old mines and, in particular, caves (Dwyer 1995). Caves are an important resource for this species, particularly for breeding where maternity caves must have suitable temperature, humidity and physical dimensions to permit breeding (Dwyer 1995). Roost sites in tree hollows have not been reported within the literature reviewed. This species has not been identified as utilising culverts for maternity roosts. Maternity roosts rather are occupied by up to 100 000 females with only 12 maternity roosts known throughout the complete range (Hoy & Hall 2008).

It is considered that the subject site provides suitable foraging only habitat for the Little Bentwing-bat and Eastern Bentwing-bat. It is expected that anywhere between 1 and 10 individual bats of each species would routinely utilise the study area for foraging. The Little

Bentwing-bat would forage more predominantly below the canopy where an open structure below the shrub layer permits. The Eastern Bentwing-bat would forage more predominantly above the canopy and down in more open areas. Concentrated activity is likely in some locations such as along the creek, forest fringes and trails, particularly for the Eastern Bentwing-bat.

Whilst foraging by both species may be more concentrated in some habitats (mostly based on structure and insect activity) no specific valued habitat features within the subject site are identified. No important roosting or breeding habitat is likely present within the subject site. Roosting locations are expected to occur throughout the locality and many of these are likely within man-made structures.

Given the highly mobile nature of both of these species, the absence of any important habitat, their known ability to move across and utilise some urban landscapes and that the proposed development will not inhibit local movements and dispersal, neither species will be likely significantly impacted by the proposed habitat clearance.

East-coast Freetail Bat

The East-coast Freetail Bat forages above the canopy of open forests and woodlands and in clearings at forest edges, feeding on small insects (Allison, Hoyer & Law 2008). This species is thought to roost predominantly in tree hollows but also under loose bark and occasionally in houses and outbuildings (Allison, Hoyer & Law 2008). Until recent findings of a roost within mangroves, all known natural roosts had occurred within hollow spouts of large mature eucalypts. The species is often found close to dams and waterholes. The East-coast Freetail Bat species will utilize paddock trees and isolated remnant vegetation when in proximity to larger forest remnants (Allison, Hoyer & Law 2008).

It is considered that the subject site provides suitable roosting, breeding and foraging habitat for the East-coast Freetail Bat, particularly given presence of hollows of various types and size characteristics.

This species was recorded during recent surveys within the subject site but also during previous surveys within the study area by *RPS* (2014) and *Abel Ecology* (2017). Recent microbat surveys over seven nights confirmed presence of the East-coast Freetail Bat on most nights within 1 hour after dark as well as at between 3-4am in the early morning suggesting that a roost site may be nearby.

Recent studies by Anna McConville from the University of Newcastle found the preferred habitat for East-coast Freetail Bat was identified as productive floodplain areas, especially freshwater wetland, with urban land use and dry sclerophyll forest avoided.

The recorded hollows within the subject site should all be retainable by the proposal and this species is known to utilise paddock tree for roosting, direct impacts on a roosting/breeding by the proposal site is unlikely. Roost sites may be indirectly impacted by the clearance of surrounding habitat for APZ purposes. Only two hollow-bearing trees (HT1 & HT2) are located within the central portions of this APZ, with all other hollows located at the outer extent or beyond. HT2 was considered the most suitable of the two for roosting and was therefore stag-watched during recent survey with no emergence recorded.

Given that roosting / breeding habitat will not likely be impacted and foraging habitat will remain well represented in the immediate locality the proposal is unlikely to result in a significant impact on this species.

Large-footed Myotis

The Large-footed Myotis inhabits rainforests and open forests containing creeks and lakes over which it feeds and roosts in tree hollows, caves, mines, under bridges, in tunnels and occasionally buildings (Richards 1995). The Large-footed Myotis predominantly forages along creeklines and over waterbodies where it takes insects and small fish from on and just below the water surface (Richards 1995).

This species has a strong association with streams and permanent waterways, most frequently at low elevations and in flat or undulating country and usually in areas that are vegetated rather than cleared. They will live in most habitat types as long as it is near water (Churchill 2008).

The Large-footed Myotis was recorded to a 'possible' level of certainty by both *RPS* (2014) and *Abel Ecology* (2017). It is expected that these recordings were likely over the dam to the north-west of the current subject site. This dam is not part of the recent study area and the species was not detected. Nonetheless hollows within the subject site may provide suitable roosting / breeding habitat for the Large-footed Myotis. Therefore the assessment outcome for this species will be the same as the East-coast Freetail Bat above and no significant impact is likely to result on a local population, based mainly on the retention of hollows. Mitigation measures are advised to ensure that no impacts on any roosting colonies of microbats occurs in the case that any hollows will be required for removal.

Greater Broad-nosed Bat

The Greater Broad-nosed Bat inhabits a variety of habitats including moist gullies in mature coastal forest, rainforest, open woodland, Melaleuca swamp woodland, wet and dry sclerophyll forests, cleared paddocks with remnant trees and tree lined creeks in open areas (Churchill 2008). The Greater Broad-nosed Bat predominantly forages within open forest, woodlands, along vegetated creeklines and small river systems (Hoye and Richards 1995).

This species roost in tree hollows, cracks and fissures in trunks and dead branches, under exfoliating bark as well as the roof of old buildings (Churchill 2008, Hoye & Richards 1995). The Greater Broad-nosed Bat feeds on large slow flying beetles and moths (Dwyer 1965; Vestjens and Hall 1977). This species is a slow flier and generally hunts for insects over understorey vegetation as well as foraging along the interface of clearings and paddocks with forested areas and along tree-lined creeks (Richards 1988).

The Greater Broad-nosed Bat was recorded to a 'probable' level of certainty within the subject site during recent surveys but also during previous surveys within the study area by *RPS* (2014) and *Abel Ecology* (2017).

It is considered that the subject site provides suitable roosting and breeding habitat for the Greater Broad-nosed Bat based on the presence of hollows of various types and size characteristics. Therefore the assessment outcome for this species will be the same as the East-coast Freetail Bat above and no significant impact is likely to result on a local population, based mainly on the retention of hollows. Mitigation measures are advised to ensure that no impacts on any roosting colonies of microbats occurs in the case that any hollows will be required for removal.



National - Significant Impact Criteria

A4

Under the EPBC Act an action will require approval from the Australian Government Environment Minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance. The following significant impact criteria were sourced from the EPBC Act Policy Statement 1.1 (May 2006):

CRITICALLY ENDANGERED AND ENDANGERED SPECIES

Significant impact criteria

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

- Lead to a long-term decrease in the size of a population;
- Reduce the area of occupancy of the species;
- Fragment an existing population into two or more populations;
- Adversely affect habitat critical to the survival of a species;
- Disrupt the breeding cycle of a population;
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- Introduce disease that may cause the species to decline; or
- Interfere with the recovery of the species.

>> What is a population of a species?

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations; or
- a population, or collection of local populations, that occurs within a particular bioregion.

>> What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to 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; or
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.

VULNERABLE SPECIES

Significant impact criteria

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

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

>> What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal;
- Populations that are necessary for maintaining genetic diversity; and/or
- Populations that are near the limit of the species range.

CRITICALLY ENDANGERED AND ENDANGERED ECOLOGICAL COMMUNITIES

Significant impact criteria

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community;
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;
- Adversely affect habitat critical to the survival of an ecological community;
- 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;
- 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;
- 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; or
- Interfere with the recovery of an ecological community.

MIGRATORY SPECIES

Significant impact criteria

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

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

>> What is important habitat for a migratory species?

An area of 'important habitat' for a migratory species is:

- a) Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- b) Habitat that is of critical importance to the species at particular life-cycle stages; and/or
- c) Habitat utilised by a migratory species which is at the limit of the species range; and/or
- d) Habitat within an area where the species is declining.

>> What is an ecologically significant proportion?

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).

>> What is the population of a migratory species?

'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.



SAIL Impact Assessment Species

A5

The additional impact assessment provisions for threatened species to determine a Serious and Irreversible Impact (SAIL) are outlined under Section 10.2.3 of the BAM (2017) and have been applied to the recorded **Eastern Bentwing-bat** and **Little Bentwing-bat** as follows:

(a) The action and measures taken to avoid the direct and indirect impact on the potential entity for an SAIL

No specific measures are considered necessary to apply to these species given that no important habitat will be likely directly or indirectly impacted.

(b) The size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification

Due to the migratory nature of these two species to breeding caves within inland regions of the state, the local populations are difficult to predict at any time. These species are expected to be well represented in the locality with regular recordings.

(c) The extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact 46 Biodiversity Assessment Method

Within this document both species are *dependent on non-responding attribute (breeding habitat only)*. No breeding habitat will be impacted for these species and no such habitat is present within the remaining study area.

(d) The likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification 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

The habitat for these two species will remain virtually unchanged. Both are known to forage along streetlights and around developed landscapes.

(ii) The proposed loss, modification, destruction or isolation of the available habitat used by the local population, and

The proposal will remove 0.792ha of vegetated habitat which would support prey species lifecycle habitat.

(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. BioNet Atlas records or other documented, quantifiable means must be used by the

assessor to estimate what percentage of the species' population and habitat is likely to be lost in the long term within the IBRA subregion due to the direct and indirect impacts of the development

No habitat important to the life-cycle of these species will be impacted.

(e) The likely impact on the ecology of the local population. At a minimum, address the following:

(i) for Fauna:

- ***Breeding*** – No breeding habitat will be impacted
- ***Foraging*** – Negligible foraging habitat will be impacted
- ***Roosting, and*** – No likely roosting will be impacted
- ***Dispersal or movement pathways*** – These species are highly mobile over urban landscapes. The proposal will not inhibit or reduce the local movement pathways.

(ii) for Flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available:

- ***Pollination cycle*** – N/A
- ***Seedbanks*** – N/A
- ***Recruitment, and*** – N/A
- ***Interactions with other species*** – N/A
(e.g. pollinators, host species, mycorrhizal associations)

(f) A description of the extent to which the local population will become fragmented or isolated as a result of the proposed development

The proposal will not likely cause any fragmentation or isolation of habitat for the local populations.

(g) 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

All individuals in the locality, region and extending out to this part of the state are part of the same populations for both species.

(h) 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

No such threats are likely to arise from the development.

(i) An estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion

This is not possible to predict for these two species however both disperse from breeding locations within the eastern extent of NSW to the coast and into the ranges (more so for the Eastern Bentwing-bat). Foraging extent is expected to be relatively

evenly represented in the reserves in this part of the state, as well as the associated IBRA regions and subregions.

(j) The measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

- Control foxes and feral cats around roosting sites, particularly maternity caves.
- Retain native vegetation around roost sites, particularly within 300 m of maternity caves.
- Minimise the use of pesticides in foraging areas.
- Protect roosting sites from damage or disturbance.

None of the above measures are considered of relevance to the proposal. No roosting sites have been identified or are expected to occur within the subject site.



SAI Impact Assessment Communities

A6

The additional impact assessment provisions for threatened ecological communities (TECs) to determine a Serious and Irreversible Impact (SAI) are outlined under Section 10.2.2 of the BAM (2017) and have been applied to the recorded **Swamp Oak Floodplain Forest** (SOFF) as follows:

(a) The action and measures taken to avoid the direct and indirect impact on the potential entity for an SAI

The development plan allows for the retention of two (2) patches of SOFF covering 1.164ha within the study area. The proposed development will impact approximately 0.106ha of SOFF. The impacted area is within the proposed APZ and will not be completely removed, but selectively managed to comply with bushfire planning requirements. It is assumed that tree cover will be reduced to 10%, shrub cover to 15%, grasses to 36%, forbs to 1%, ferns to 1%, and other to 4%. In the context of the sites overall managed condition the loss is not significant and not considered to be an SAI.

Mitigation measures include the replanting of these species within the site as part of landscaping works. Residual impacts are to be offset by purchasing and retiring credits through the BOS (see Section 6).

(b) The area (ha) and condition of the TEC to be impacted directly and indirectly by the proposed development. The condition of the TEC is to be represented by the vegetation integrity score for each vegetation zone

Approximately 0.106ha of poor to moderate quality SOFF is to be impacted by the proposed development. The vegetation integrity score has been calculated (see Section 3.1.5) is expected to be reduced by 17.6 points, from 44.3 to 26.7.

(c) A description of the extent to which the impact exceeds the threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact

Thresholds for SOFF have not yet been provided by the OEH.

(d) The extent and overall condition of the potential TEC within an area of 1000ha, and then 10,000ha, surrounding the proposed development footprint

Revised Vegetation mapping of Wyong LGA: Stage 1 - West of F3 Freeway. Report to Wyong Shire Council (Bell & Driscoll 2008). It is assumed that Estuarine Swamp Oak Forest (Map Unit 3) is the equivalent of SOFF.

Table A6.1 – Extant SOFF within 1000ha and 10,000ha

Condition	Extant area within 1000 ha (ha)	Extant area within 10,000 ha (ha)
good	93.48	16.5
poor	21.38	13.45
Total	114.86	29.95

- (e) ***An estimate of the extant area and overall condition of the potential TEC remaining in the IBRA subregion before and after the impact of the proposed development has been taken into consideration***

The following figures are based on the *Revised Vegetation mapping of Wyong LGA: Stage 1 - West of F3 Freeway. Report to Wyong Shire Council* (Bell & Driscoll 2008):

Table A6.2 – Extant SOFF within the Wyong IBRA sub-region

Condition	Extant area - Wyong IBRA sub-region (ha)
good	263.54
poor	72.62
Total	336.16

The proposed development will impact approximately 0.106ha of SOFF, which is 0.0003% of the estimated extant SOFF within the Wyong IBRA sub-region. The proposal is expected to reduce the vegetation integrity of the impacted SOFF by 17.6 points, from 44.3 to 26.7. These impacts can be easily addressed by the revegetation of the removed species within the landscape.

- (f) ***An estimate of the area of the potential TEC that is in the reserve system within the IBRA region and the IBRA subregion***

The following figures are based on the *Revised Vegetation mapping of Wyong LGA: Stage 1 - West of F3 Freeway. Report to Wyong Shire Council* (Bell & Driscoll 2008). Vegetation mapping is not available for all of the Sydney IBRA region so an accurate estimate is not possible.

Table A6.3 – Extant SOFF within the Wyong IBRA sub-region

IBRA region / sub-region	Extant area of SOFF (ha)
Wyong sub-region	57
Sydney region	n/a

(g) The development, clearing or biodiversity certification proposal's impact on:

i. abiotic factors critical to the long-term survival of the potential TEC; for example, how much the impact will lead to a reduction of groundwater levels or the substantial alteration of surface water patterns

Abiotic factors will be impacted at an insignificant level and are not considered likely to be critical to this community's survival. Clearing of vegetation, particularly trees, can raise the level of groundwater. Although this effect is likely to be insignificant within the subject site, minimisation of tree clearing within the proposed APZ should reduce the amount of groundwater rise.

ii. characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants

The proposed development is not considered likely to impact on characteristic and functionally important species.

iii. the quality and integrity of an occurrence of the potential TEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the potential TEC

Establishment of invasive flora and fauna is possible due to the presence of such species. The proposal is expected to reduce the vegetation integrity of the impacted SOFF by 17.6 points, from 44.3 to 26.7. The quality and integrity of the non-impacted SOFF is unlikely to be significantly compromised as the understory is already in a poor condition with high levels of naturalised exotic species. The management of the site as hospital grounds will not result in increased mobilisation of fertilisers, herbicides or other chemicals or pollutants is not likely to become any more frequent than is currently the case.

(h) Direct or indirect fragmentation and isolation of an important area of the potential TEC

The proposed development will reduce the width to, but not completely isolate, a small area of SOFF to the north-west of the subject site. This patch is not considered to be an important area for the long-term survival of the TEC.

(i) The measures proposed to contribute to the recovery of the potential TEC in the IBRA subregion.

Travers bushfire & ecology recommends that an area of SOFF vegetation greater than the 0.106ha impacted be re-established within the study site as an offset to improve the recovery of the TEC within the IBRA subregion.



Plot Datasheets

A7

BAM Site – Field Survey Form						Site Sheet no: 101	
Date		Survey Name		Plot Identifier		Recorders	
10-9-18		18cdL02 F		Q1		GP	
Zone	Datum	IBRA region		Photo #	Zone ID		
				655, 656, 658			
Easting	Northing	Dimensions		Orientation of midline from the 0 m point.		Magnetic	
Vegetation Class						Confidence:	
						H M L	
Plant Community Type						EEC:	Confidence:
							H M L

Record easting and northing from the plot marker. If applicable, orient picket so that perforated rib points along direction of midline.
 Dimensions (Shape) of 0.04 ha base plot inside 0.1 ha FA plot should be identified. magnetic bearing taken along midline.

BAM Attribute (400 m ² plot)		Sum values	BAM Attribute (20 x 50 m plot)			# Tree Stems Count		Record number of living eucalypt* (Euc*) and living native non-eucalypt (Non Euc) stems separately * includes all species of Eucalyptus, Corymbia, Angophora, Lophostemon and Syncarpia † Record total number of stems by size class with hollows (including dead stems/trees)
			dbh	Euc*	Non Euc	Hollows†		
Count of Native Richness	Trees	5	large trees for Euc* & Non Euc	80 + cm				
	Shrubs	10						
	Grasses etc.	6						
	Forbs	10						
	Ferns	1						
	Other	5						
Sum of Cover of native vascular plants by growth form group	Trees	43	50 – 79 cm					
	Shrubs	17.8	30 – 49 cm	✓				
	Grasses etc.	64.1	20 – 29 cm	✓				
	Forbs	1	10 – 19 cm	✓				
	Ferns	2	5 – 9 cm	✓			n/a	
	Other	2.9	< 5 cm	✓			n/a	
High Threat Weed cover		1.2	Length of logs (m) (≥10 cm diameter, >50 cm in length)		Total species		total	
							5	

Counts must apply to each size class when the number of living tree stems within the size class is ≤ 10. Estimates can be used when the number of living tree stems within a class is > 10. Estimates should draw from the number series: 10, 20, 30, ..., 100, 200, 300.

For a multi-stemmed tree, only the largest living stem is included in the count/estimate. For hollows count only the presence of a stem containing hollows, not the count of hollows in that stem. Only count as 1 stem per tree where tree is multi-stemmed. The hollow-bearing stem may be a dead stem.

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	65 70 60 85 80	a b n d e	a b n d e	n o o o o
Average of the 5 subplots	72	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots located on alternate sides and 5 m from the plot midline at the locations 5, 15, 25, 35, and 45 m along the midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Within these 1 m x 1 m plots assessors may also record the cover of rock, bare ground and cryptogam soil crusts. Collection of these data is optional - the data do not currently contribute to assessment scores, they hold potential value for future vegetation integrity assessment attributes and benchmarks, and for enhancing PCT description.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type	Landform Element	Landform Pattern	Microrelief
Lithology	Soil Surface Texture	Soil Colour	Soil Depth
Slope	Aspect	Site Drainage	Distance to nearest water and type

Plot Disturbance	Severity code	Age code	Observational evidence:
Clearing (inc. logging)			
Cultivation (inc. pasture)			
Soil erosion			
Firewood / CWD removal			
Grazing (identify native stock)			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

400 m² plot: Sheet of Survey Name Kcalort Plot Identifier Q1 Recorders GP

Date 10/9/18

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	vech
1	<i>Eucalyptus haemastoma</i>	N	20	30		
2	<i>Agaphya cespita</i>	N	15	15		
3	<i>Glochidion teretifolium</i>	N	3	5		
4	<i>Melaleuca nodosa</i>	N	5	4		
5	<i>Acacia longifolia</i>	N	4	10		
6	<i>Persoonia stram.</i>	N	2	20		
7	<i>Dianella caerulea</i>	N	0.1	5		
8	<i>Hibbertia aspera</i>	N	0.1	40		
9	<i>Eutylasia marginata</i>	N	3	200		
10	<i>Leprodia scariosa</i>	N	50	3000		
11	<i>Caughia fil.</i>	N	0.1	20		
12	<i>Prasidium purp.</i>	N	0.1	50		
13	<i>Lambertia torquosa</i>	N	1	5		
14	opp. leaved forb/shrub (s) <i>anacardium micranthum</i>	N	0.1	5		
15	orchid-ph = <i>Villarsia emulata</i>	N	0.1	1		
16	<i>Trachymene inersa</i>	N	0.1	5		
17	Carpet grass - <i>Stenopus fissifolius</i>	HTE	0.1	20		
18	<i>Lipistaria australis</i>	N	0.1	5		
19	<i>Gahnia clarkii</i>	N	7	200		
20	<i>Rubus frut.</i>	HTE	0.1	5		
21	<i>Lambiana</i>	HTE	0.1	3		
22	<i>Acacia suaveolens</i>	N	0.1	1		
23	<i>Antella asiatica</i>	N	0.1	3		
24	toothed, rough sh/forb. (s) <i>anacardium tenaxoides</i>	N	0.1	10		
25	<i>Microseris stipoides</i>	N	2	200		
26	<i>Casuarina glauca</i>	N	2	3		
27	<i>Cinnamomum camphora</i>	HTE	0.1	4		
28	<i>Lepidosperma laterale</i>	N	0.1	5		
29	<i>Leptopogon trimerium</i>	N	5	10		
30	<i>Baronia</i> sp. ? (s) <i>polygalifolia</i>	N	0.1	5		
31	<i>Bombax marginata</i>	N	0.5	2		
32	<i>Cassipoua glabella</i>	N	0.2	16		
33	<i>Bracken</i>	N	0.1	15		
34	<i>Hydrocotyle</i> sp. ? (s)	N	0.1	10		
35	<i>Myrsine</i> shrub - small yellow flower (s)	N	0.1	10		
36	<i>Cryptostylis subulata</i>	N	0.1	8		
37	selge-like tufted leaf	N	2	20		
38	<i>Xanthorrhoea media</i>	N	0.5	3		
39	<i>Persoonia levis</i>	N	1	3		
40	<i>Corymbia gummifera</i>	N	3	1		

GF Code: see Growth Form definitions in Appendix N: native, E: exotic, HTE: high threat exotic GF - circle code if 'top 3'.
 Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ..., 100% (foliage cover); Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ..., 100, 200, ..., 1000

Phl. sp. - Cuscuta
Euc. straggly - Canfieldii?

Printed 31 August 2017

Date		Survey Name		Plot Identifier		Recorders	
10/9/18		18COLLGT		G2		GP	
Zone	Datum	IBRA region	Photo #		Zone ID		
			61, 62				
Easting	Northing	Dimensions		Orientation of midline from the 0 m point		Magnetic	
		20 x 50					
Vegetation Class						Confidence:	
						H M L	
Plant Community Type						EEC:	
						H M L	

Record easting and northing from the plot marker. If applicable, orient picket so that perforated rib points along direction of midline. Dimensions (Shape) of 0.04 ha base plot inside 0.1 ha FA plot should be identified, magnetic bearing taken along midline.

BAM Attribute (400 m ² plot)	Sum values
Count of Native Richness	
Trees	3
Shrubs	7
Grasses etc.	84
Forbs	7
Ferns	4
Other	3
Sum of Cover of native vascular plants by growth form group	
Trees	31
Shrubs	148
Grasses etc.	95
Forbs	12
Ferns	10.6
Other	6.1
High Threat Weed cover	2.7

BAM Attribute (20 x 50 m plot)		# Tree Stems Count		Record number of living eucalypt* (Euc*) and living native non-eucalypt (Non Euc) stems separately
dbh	–Euc*	Non Euc	Hollows†	
large trees for Euc* & Non Euc	80 + cm	Euc	non Euc	
	50 – 79 cm			
	30 – 49 cm	1		
	20 – 29 cm	✓		
	10 – 19 cm	✓		
	5 – 9 cm	✓		n/a
	< 5 cm	✓		n/a
Length of logs (m) (≥10 cm diameter, ≥50 cm in length)		Tally species		total
				0

Counts must apply to each size class when the number of living tree stems within the size class is ≤ 10. Estimates can be used when the number of living tree stems within a class is > 10. Estimates should draw from the number series: 10, 20, 30, ..., 100, 200, 300.

For a multi-stemmed tree, only the largest living stem is included in the count/estimate. For hollows count only the presence of a stem containing hollows, not the count of hollows in that stem. Only count as 1 stem per tree where tree is multi-stemmed. The hollow-bearing stem may be a dead stem.

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	80 80 70 40 75	0 0 1 8 2	a b c d e	a b c d e
Average of the 5 subplots	69	1.6	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots located on alternate sides and 5 m from the plot midline at the locations 5, 15, 25, 35, and 45 m along the midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Within these 1 m x 1 m plots assessors may also record the cover of rock, bare ground and cryptogam soil crusts. Collection of these data is optional - the data do not currently contribute to assessment scores, they hold potential value for future vegetation integrity assessment attributes and benchmarks, and for enhancing PCT description.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type	Landform Element	Landform Pattern	Microrelief
Lithology	Soil Surface Texture	Soil Colour	Soil Depth
Slope	Aspect	Site Drainage	Distance to nearest water and type

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging)			
Cultivation (inc. pasture)			
Soil erosion			
Firewood / CWD removal			
Grazing (density and season)			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

400 m² plot: Sheet of Survey Name Plot Identifier Recorder(s)
 Date 10/9/18 18COLLGT 02 GP

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	Strat	Yough
1	<i>Leptospermum poly.</i>	2	30	200		
2	<i>Gleichenia ter.</i>	2	15	20		
3	<i>Anaphalis costata</i>	2	4	20		
4	<i>Lambium</i>	HTE	2	10		
5	<i>Gahnia clarkii</i>	2	20	200		
6	<i>Parsonsia stam</i>	2	5	40		
7	<i>Banksia</i>	2	8	50		
8	<i>Gleichenia dicarpa</i>	2	0.5	10		
9	<i>Melaleuca nodosa</i>	2	8	20		
10	<i>Eubalanis merg.</i>	2	4	100		
11	<i>Acacia long.</i>	2	0.5	3		
12	<i>Dianella caerulea</i>	2	0.2	10		
13	<i>Casuarina flauca</i>	2	12	20		
14	<i>Xanthorrhoea media</i>	2	1	10		
15	trilled, sp. <i>Gomocarpus tenuiroles</i>	2	0.5	40		
16	<i>Drosera spatulata</i>	2	0.1	30		
17	<i>Gomocarpus microanthus</i> Fertis (5)	2	0.1	20		
18	club-moss? (5) <i>Selaginella uliginosa</i>	2	0.1	3		
19	<i>Ligustrum sinense</i>	HTE	0.5	10		
20	<i>Trachymene inuisa</i>	2	0.1	5		
21	sedge-like twister	2	1	10		
22	<i>Lepidrodia scarlosa</i>	2	60	500		
23	<i>Leprospermum trinervium</i>	2	10	20		
24	<i>Adiantum pectinopium</i>	2	0.2	200		
25	<i>Carex glabella</i>	2	0.1	10		
26	<i>Carex sericea</i>	2	0.1	5		
27	Whisky grass	HTE	0.1	5		
28	<i>Lambertia formosa</i>	2	0.1	3		
29	<i>Carex asiatica</i>	2	0.1	5		
30	grass (5)	2	0.2	10		
31	soft gramineae (5)	2	0.1	1		
32	<i>Lilium</i> fruit	HTE	0.1	10		
33	<i>Albertya aspera</i>	2	0.1	3		
34						
35						
36						
37						
38						
39						
40						

GF Code: see Growth Form definitions in Appendix 1 N: native, E: exotic, HTE: high threat exotic GF - circle code if 'top 3'.
 Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ..., 100% (foliage cover); Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 6 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ..., 100, 200, ..., 1000, ...

grey bag

Date		Survey Name		Plot Identifier		Recorders	
10/9/18		18CAL02F		G3		GP	
Zone	Datum	IBRA region	Photo #		Zone ID		
Eastings	Northings	Dimensions		Orientation of midline from the 0 m point.		Magnetic decl.	
		20 x 50					
Vegetation Class						Confidence:	
						H	M
Plant Community Type						Confidence:	
						H	M
						L	L

Record easting and northing from the plot marker. If applicable, orient picket so that perforated rib points along direction of midline.
Dimensions (Shape) of 0.04 ha base plot inside 0.1 ha P4 plot should be identified, magnetic bearing taken along midline.

BAM Attribute (400 m ² plot)	Sum values
Trees	2
Shrubs	—
Grasses etc.	3
Forbs	1
Ferns	1
Other	1
Count of Native Richness	
Trees	42
Shrubs	—
Grasses etc.	26
Forbs	0.1
Ferns	0.1
Other	5
Sum of Cover of native vascular plants by growth form group	
High Threat Weed cover	25.5

BAM Attribute (20 x 50 m plot)		# Tree Stems Count		Record number of living eucalypti* (Euc*) and living native non-eucalypti (Non Euc) stems separately
dbh	— Euc* — Non-Euc	Hollows [†]		
large trees for Euc* & Non Euc	80 + cm	—	—	
	50 – 79 cm	11		
	30 – 49 cm	1		
	20 – 29 cm	1		
	10 – 19 cm			
	5 – 9 cm	1	n/a	
	< 5 cm	1	n/a	
Length of logs (m) (≥10 cm diameter, >50 cm in length)		1 only specimen		total 56 m

Counts must apply to each size class when the number of living tree stems within the size class is ≤ 10. Estimates can be used when the number of living tree stems within a class is > 10. Estimates should draw from the number series: 10, 20, 30 ..., 100, 200, 300.

For a multi-stemmed tree, only the largest living stem is included in the count/estimate. For hollows count only the presence of a stem containing hollows, not the count of hollows in that stem. Only count as 1 stem per tree where tree is multi-stemmed. The hollow-bearing stem may be a dead stem.

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	85 100 80 85 100	0 5 0 2 0	0 0 0 0 0	0 0 0 0 0
Average of the 5 subplots	90	1.4	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots located on alternate sides and 5 m from the plot midline at the locations 5, 15, 25, 35, and 45 m along the midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Within these 1 m x 1 m plots assessors may also record the cover of rock, bare ground and cryptogam soil crusts. Collection of these data is optional - the data do not currently contribute to assessment scores, they hold potential value for future vegetation integrity assessment attributes and benchmarks, and for enhancing PCT description.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type	Landform Element	Landform Pattern	Microrelief
Lithology	Soil Surface Texture	Soil Colour	Soil Depth
Slope	Aspect	Site Drainage	Distance to nearest water and type

Plot Disturbance	Severity code	Age code	Observational evidence:
Clearing (inc. logging)			
Cultivation (inc. pasture)			
Soil erosion			
Firewood / CWD removal			
Grazing (identify native stock)			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

400 m ² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	10/9/18	18calort	Q3	GP

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	vouch or
1	<i>Caesalpinia glauca</i>	N	40	50		
2	<i>Eutelsia marginata</i>	N	20	200		
3	<i>Lantana</i>	HTE	10	100		
4	<i>Ligustrum sinense</i>	HTE	12	150		
5	<i>Passerina stanleya</i>	N	5	50		
6	<i>Craibia clarkii</i>	N	5	50		
7	<i>Centella asiatica</i>	N	0.1	10		
8	<i>Asparagus aparagoides</i>	HTE	1	20		
9	<i>Opismenus aemulus</i>	N	1	50		
10	<i>Solanum nigrum</i>	E	0.2	10		
11	<i>Asparagus aethiopicum</i>	HTE	2	5		
12	<i>Ipomoea indica</i>	HTE	0.1	5		
13	<i>Senna pendula</i>	HTE	0.2	10		
14	<i>Platycentrum bifurcatum</i>	N	0.1	3		
15	<i>Phoenix canariensis</i>	HTE	0.2	1		
16	<i>Eucalyptus laetifolia</i>	N	7	0		
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Abundance: 1, 2, 3, ..., 10, 20, 30, ..., 100, 200, ..., 1000, ...