



Catherine McAuley Catholic College, Medowie Biodiversity Development Assessment Report

FINAL REPORT

Prepared for Webber Architects

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Glossary

APZ	Asset Protection Zone
BC Act	NSW <i>Biodiversity Conservation Act 2016</i>
Biosecurity Act	NSW <i>Biosecurity Act 2015</i>
CKPoM	Port Stephens Council Comprehensive Koala Plan of Management
DEE	Commonwealth Department of the Environment and Energy
DCDB	Land and Property Information(LPI) digital cadastral database
DPE	NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
DTDB	Digital topographic databases
Ecosystem credit species	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development.
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
HBT	Hollow-bearing Tree
LEP	Local Environment Plan
Locality	Area located within 10 kilometres radius from the study area
LPI	NSW Land and Property Information
Matters of NES	Matters of National Environmental Significance protected by a provision of Part 3 of the EPBC Act
OEH	NSW Office of Environment and Heritage
Preferred Koala Feed Trees	Tree species used preferentially as forage for Koalas. In the context of the Port Stephens CKPoM these species are; Swamp Mahogany <i>Eucalyptus robusta</i> , Parramatta Red Gum <i>Eucalyptus parramattensis</i> and Forest Red Gum <i>Eucalyptus tereticornis</i> .
PCT	Plant Community Type
RoTAP	Rare or Threatened Australian Plant
SEARs	Secretary's Environmental Assessment Requirements
SEPP 71	NSW State Environmental Planning Policy No. 71 – Coastal Protection
SSD	State Significant Development
Site boundary	The entirety of Lots 412 and 413 of DP 1063902 within which the study area and subject site are located.

Study area	An area within the site boundary which defines the extent of field investigations undertaken to inform the biodiversity assessment.
Subject land	The outer extent of predicted direct impacts associated with construction and operation of the proposed Catherine McAuley Catholic College, located at 507 Medowie Road Medowie (Lot 412 & 413, DP 1063902).
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i>
VIS	NSW Vegetation Information System
WM Act	NSW <i>Water Management Act 2000</i>

Summary

Webber Architects, on behalf of the Trustees of the Roman Catholic Diocese Maitland – Newcastle, proposes the development of Catherine McAuley Catholic College (the development) located at 2 Kingfisher Close, Medowie (hereafter referred to as 'study area') (Figure 1). The development will involve the demolition of an existing dwelling, shed and out buildings, the construction of a 3 stream primary school, 7 stream high school, a Chapel and child care centre, and associated works including a car park, retaining walls and landscaping. It will also involve the establishment and ongoing maintenance of Asset Protection Zones (APZs) necessary to meet bushfire protection requirements. The extent of direct impacts of the development is contained within the 'subject land'.

Due to the scale of the proposed development, the project will be assessed under Part 4 Division 4.1 Section 89C of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as a State Significant Development (SSD). Secretary's Environmental Assessment Requirements (SEARs) were reissued for the development by the NSW Department of Planning and Environment (DPE) on 18 January 2018 and stipulate assessment of impacts to biodiversity is to apply the NSW Biodiversity assessment Method (BAM) (OEH 2017) and Biodiversity Offsets Scheme (BOS) in accordance with the *Biodiversity Conservation Act 2016* (BC Act). The SEARs also identify the need for consideration of potentially significant impacts to biodiversity in accordance with the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Field investigation, undertaken in accordance with the BAM, recorded 12.1 hectares of native vegetation within the study area, representing two threatened ecological communities. No BC Act and/or EPBC Act threatened species were recorded within the subject land, however several threatened species were recorded in adjacent remnant vegetation within the study area and may use the subject land from time to time for foraging and dispersal.

The proposed development footprint has been carefully devised so as to avoid and minimise impacts to native vegetation, threatened ecological communities and threatened species habitat. Impacts to native vegetation and associated threatened species habitat have thereby been restricted to an area of approximately 1.56 hectares.

The residual impact on four plant community types (PCTs), including two BC Act listed threatened ecological communities, and potential Koala habitat identified within the subject land will require retirement of 23 ecosystem credits and 6 Koala species credits under the NSW Biodiversity Offsets Scheme as outlined in Table 22 and Table 23. This offset obligation will be discharged either through the retirement of ecosystem and species credits or through payment of an equivalent amount to the Biodiversity Conservation Fund as set out in Section 7.

Stage 1 – Biodiversity assessment

1 Introduction

Biosis Pty Ltd was commissioned by Webber Architects to undertake a biodiversity assessment of a proposed re-development at 2 Kingfisher Close Medowie.

The purpose of this assessment was to apply the NSW Biodiversity Assessment Method (BAM [OEI 2017a]) to the proposed development in accordance with the *Biodiversity Conservation Act 2016* (BC Act), and provide Webber Architects with a Biodiversity Development Assessment Report (BDAR). The BDAR is to be submitted to the NSW Department of Planning and Environment as the approval authority, as part of a Development Application (DA) for proposed development.

The BDAR also considers potential impacts to Matters of Environmental Significance in accordance with the *Environmental Protection and Biodiversity Conservation Act 2016* (BC Act).

1.1 Project background

The proposed development is to be located at 2 Kingfisher Close Medowie (Figure 1). The development will involve the demolition of the existing dwelling, shed and out buildings, the construction of a 3 stream primary school, 7 stream high school, Chapel and child care centre, and associated works including a car park, retaining walls and landscaping. The proposed development will include construction and operation of stormwater infrastructure designed to ensure post development stormwater volumes and water quality are not substantially different to pre-development values. Furthermore, the proposed development will establish and maintain Asset Protection Zones (APZ) necessary to meet the requirements of s100B of the *Rural Fires Act 1997, Australian Standard 3959 Construction of Buildings in Bushfire Prone Areas* and *Planning for Bushfire Protection* (NSW RFS 2006). These will include establishment of a 40 metre Inner Protection Zone (IPZ) and 10 metre Outer Protection Zone (OPZ).

Due to the scale of the proposed development, the project will be assessed under Part 4 Division 4.1 Section 89C of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as a State Significant Development (SSD). Recent changes to NSW biodiversity legislation have resulted in a change to the SSD project assessment and reporting process, requiring updated biodiversity assessments and potential offset of project impacts. The BC Act requires that all SSD apply the BAM and the Biodiversity Offsets Scheme (BOS) to assess and offset the impacts of developments to biodiversity. A BDAR is required to be submitted to the approval authority.

1.2 Purpose of this assessment

This BDAR will:

- Address the BAM and the Biodiversity Offsets Scheme.
- Identify how the proponent proposes to avoid and minimise impacts to biodiversity.
- Identify any potential impact that could be characterised as prescribed or serious and irreversible in accordance with the BAM.
- Describe the offset obligations required to compensate for any unavoidable biodiversity impacts resulting from the proposed development.
- Describe and assess the significance of potential impacts to Matters of National Environmental Significance (MNES) in accordance with relevant provisions of the EPBC Act.

All biodiversity assessments have been undertaken in accordance with the BAM, and this BDAR has been prepared and reviewed by Accredited Assessor Samuel Luccitti (BAAS17015).

1.3 The study area

The study area is located at 2 Kingfisher Close Medowie, NSW within the Port Stephens Local Government Area (LGA) and the Hunter Local Land Services Region. It is located approximately 4 kilometres south west of the township of Medowie, and approximately 32 kilometres by road north east of Newcastle. The study area is located within Lot 412 and 413 DP 1063902 and covers an area of 21 hectares. The subject land is located within the study area and is defined as the total area of disturbance; including both the construction and operational footprints. The subject land covers a total area of 8.97 hectares and is zoned Large Lot Residential (R5), Low Density Residential (R2) and Rural Landscape (RU2).

The subject land currently contains a single story residential dwelling, shed, tennis court, lawns and scattered landscape plantings as well as native and exotic vegetation (Figure 1). There is a mapped watercourse running east to west 400 metres from the western boundary of the study area. The subject land has a gentle slope with a western aspect that leads to the flat swampy vegetation along the western boundary of the study area.

1.4 Sources of information

Sources of information used in the assessment include relevant databases, spatial data, literature and previous site reports.

In order to provide a context for the subject land, records of flora and fauna from within 5 kilometres (the 'locality') were collated from the following databases and were reviewed:

- Commonwealth Department of the Environment and Energy (DEE) Protected Matters Search Tool for matters protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- NSW Office of Environment and Heritage (OEH) BioNet Atlas of NSW Wildlife, for species, populations and ecological communities listed under the *Biodiversity Conservation Act 2017* (BC Act).
- PlantNET (The Royal Botanic Gardens and Domain Trust).
- BirdLife Australia, the New Atlas of Australian Birds 1998-2015.
- NSW Department of Primary Industry (DPI) Spatial Data Portal.
- Other sources of biodiversity information relevant to the study area were sourced from:
 - The NSW Plant Community Types, as held within the BioNet Vegetation Classification database (OEH 2017).
 - Relevant vegetation mapping, including *Lower Hunter Vegetation Mapping* (Cockerill *et al.* 2013).

Mapping was conducted using hand-held (uncorrected) GPS units (GDA94), mobile tablet computers running Collector for ArcGIS™ and aerial photo interpretation. The accuracy of this mapping is therefore subject to the accuracy of the GPS units (generally ± 5 metres) and dependent on the limitations of aerial photo rectification and registration.

Basemap data was obtained from LPI 1:25,000 digital topographic databases (DTDB), with cadastral data obtained from LPI digital cadastral database (DCDB).

The following spatial datasets were utilised during the development of this report:

- Mitchell Landscapes Version 3.0.
- Interim Biogeographic Regionalisation of Australia (IBRA) Version 7.
- Directory of Important Wetlands (DIWA).
- NSW Soil and Land Information System (SALIS).

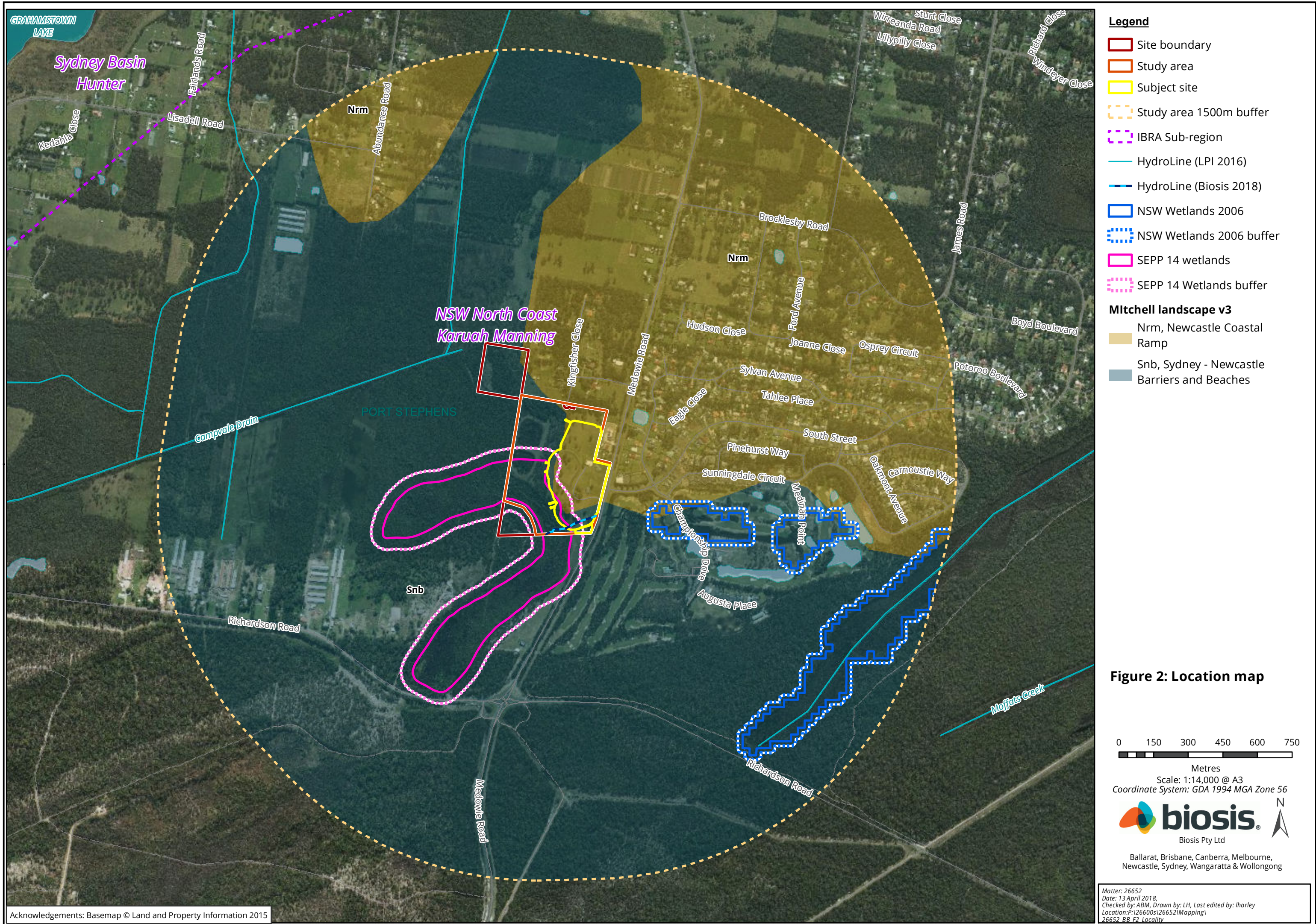
Mapping has been produced using a Geographic Information System (GIS). The following maps and data have been provided:

- Digital mapping with aerial photography showing 1:1000 or finer.
- Site map as described in subsection 4.2.1.1 of the BAM.
- Location Map as described in subsection 4.2.1.2 of the BAM.
- Landscape map with features including 1500 metre buffer, as described in section 4.2.1.3 of the BAM.

1.5 Legislative and policy requirements

The project has been assessed against relevant biodiversity legislation and government policy, including:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Environmental Planning and Assessment Act 1979*
- *Biodiversity Conservation Act 2017*
- *Fisheries Management Act 1994*
- *Water Management Act 2000*
- *Biosecurity Act 2015*
- State Environmental Planning Policy No. 14 (Coastal Wetlands) (SEPP 14)
- State Environmental Planning Policy No. 44 (Koala Habitat Protection) (SEPP 44)
- Port Stephens Comprehensive Koala Plan of Management 2002 (PSCKPoM)
- Port Stephens Local Environmental Plan 2013 (PSC 2013).
- Port Stephens Development Control Plan 2014 (PSC 2014).
- Draft Revised Medowie Planning Strategy (PSC 2016).



2 Landscape Context

This chapter describes the landscape and site context of the subject land, describing the landscape features present within the subject land and within a 1,500 metre buffer to the site, as required by the BAM (OEH 2017a).

2.1 Landscape features

2.1.1 Bioregions

The study area occurs within the NSW North Coast IBRA bioregion and the Karuah Manning IBRA subregion. The North Coast Bioregion runs along the east coast of NSW from just north of Newcastle to just inside the Qld border. The total area of the bioregion is 5,924,130 hectares and the NSW portion accounts for 96.1 per cent of the bioregion.

The Sydney Basin Bioregion bounds the North Coast Bioregion in the south and the Nandewar and New England Tablelands bioregions lie against its western boundary (OEH 2016).

2.1.2 Mitchell Landscape

The study area occurs within both the Sydney Basin Coastal Barriers *Sydney-Newcastle Barriers and Beaches* Mitchell Landscape (west and south side of the site), and the Sydney Basin Hunter *Newcastle Coastal Ramp* Mitchell Landscape (north east corner of the site).

The *Sydney-Newcastle Barriers and Beaches* Mitchell Landscape occurs as quaternary coastal sediments on long recurved quartz sand beaches between rocky headlands backed by sand dunes and intermittently closed and open lagoons. It has a general elevation of between zero to 30 meters with local relief of ten meters. Cliff top dunes may be found as high as 90 meters above sea level.

There is a distinct zonation of vegetation and increasing soil development from the beach to the inland dunes. At the beach *Spinifex Spinifex hirsutus*, Spiky Mat-rush *Lomandra longifolia*, Coast Wattle *Acacia longifolia* ssp. *sophorae* and Coast Tea-tree *Leptospermum laevigatum* colonise the frontal dune. Coast Banksia *Banksia integrifolia* and Old Man Banksia *Banksia serrata* are found on the second dunes and these merge with more complex forest containing Blackbutt *Eucalyptus pilularis*, Red Bloodwood *Corymbia gummifera*, Grass trees *Xanthorrhoea* sp. and numerous understorey shrubs on deep sands that have an organic rich A horizon, a bleached A2 horizon and the initial development of weak iron or organic pans in the sandy subsoil.

Freshwater sedge swamps are found in larger areas of sand. In the lagoons salinity varies depending on tidal flushing and they are often surrounded by Broad-leaved Tea-tree *Melaleuca quinquenervia* and Swamp Oak *Casuarina glauca*. Water margins are occupied by *Juncus* sp. and Common Reed *Phragmites australis* in fresh water areas. Grey Mangrove *Avicennia marina* may occur in some tidal inlets (Mitchell 2002).

The *Newcastle Coastal Ramp* Mitchell Landscape occurs as undulating lowlands and low to steep hills on complex patterns of faulted and gently folded carboniferous conglomerate, lithic sandstone, felspathic sandstone and mudstone. It has a general elevation between 50 to 275 metres with local relief of 40 to 150 metres.

The landscape features a woodland of Spotted Gum *Corymbia maculata*, Forest Red Gum *Eucalyptus tereticornis*, Red Ironbark *Eucalyptus sideroxylon*, White Mahogany *Eucalyptus acmenoides*, Large-fruited Grey Gum *Eucalyptus canaliculata*, with sub-tropical rainforest elements in sheltered gullies.

On lower slopes there are similar eucalypts, with Forest Oak *Allocasuarina torulosa* and grasses, merging to a forest of Smooth-barked Apple *Angophora costata*, Red Bloodwood *Corymbia gummifera*, Blackbutt *Eucalyptus pilularis*, with Bracken *Pteridium esculentum* and grasses nearer the coast (Mitchell 2002).

2.1.3 Soil

The study area is within the Newcastle 1:100k soil landscape (Matthei 1995). The subject land is largely mapped as the Tea Gardens Aeolian soil landscape, consisting of Pleistocene sandsheets of marine and Aeolian quartz sands, wet heath forest (in the south of the subject land, variant 'a'), and wet heath and sedgeland (in the north west of the site, variant 'b').

Dominant soil materials are mapped as sandy peat, loose loamy sand, bleached loose sand, massive organic pan, coarse smelly saturated mottled sand, and saturated brownish black massive coarse light sandy clay loam.

A section in the north east of the site is mapped as the Medowie Residual soil landscape, consisting of deep and well drained red and yellow structured loams on deeply weathered clay deposits, moderately deep and well drained Red Podzolic soils, and some shallow well drained Lithosols on sandy/pebbly deposits with clay lenses.

2.1.4 Native vegetation extent

Vegetation within the study area and within the 1500 metre buffer area was assessed using aerial photographic interpretation, field survey results and existing vegetation mapping (Figure 3). Table 1 provides a list of Plant Community Types (PCTs) identified from existing vegetation mapping, and the current assessment, as occurring within the study area and within the 1500 metre buffer. Conservation status of the communities is also provided.

Table 1 PCTs mapped within the study area and buffer

PCT – (mapped OEH 2016 or Biosis 2018)	Location		
	Subject land	Study area	1500m Buffer
1564: Blackbutt –Rough-barked Apple – Turpentine – ferny tall open forest of the Central Coast	Yes	Yes	Yes
1598: Forest Red Gum grassy open forest on floodplains of the lower Hunter	Yes	Yes	Yes
1619: Smooth-barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands	Yes	Yes	Yes
1646: Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	No	No	Yes
1647: Red Bloodwood - Smooth-barked Apple heathy woodland on coastal sands of the Central and lower North Coast	No	No	Yes
1649: Smooth-barked Apple - Red Mahogany - Swamp Mahogany - Melaleuca sieberi heathy swamp woodland of coastal lowlands	No	No	Yes
1650: Parramatta Red Gum - Rough-barked Apple - Swamp Mahogany - Paperbarks swamp forest on lowlands of the Central Coast	No	No	Yes
1651: Parramatta Red Gum - Fern-leaved Bbanksia - Melaleuca sieberi swamp woodland of the Tomaree Peninsula	No	No	Yes
1704: Fern-leaf Banksia - Prickly-leaved Paperbark-Tantoon - Leptocarpus tenax wet heath on coastal sands of the Central Coast and lower North Coast	No	No	Yes
1706: Leptospermum liversidgei-Callistemon citrinus-Xanthorrhoea fulva wet heath on coastal sands of lower North Coast	No	No	Yes
1718: Swamp Mahogany – Flax-leaved Paperbark swamp forest on coastal lowlands	Yes	Yes	Yes

PCT – (mapped OEH 2016 or Biosis 2018)	Location		
	Subject land	Study area	1500m Buffer
of the Central Coast			
1721: Swamp Mahogany - Broad-leaved Paperbark - Saw Sedge - Yellow Marsh Flower swamp forest of coastal lowlands	No	No	Yes
1727: Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast	No	No	Yes
1734: Wallum Bottlebrush - Leptocarpus tenax - Baloskion pallens Wallum sedge heath of the lower North Coast	No	No	Yes

2.1.5 Exotic grass and cleared areas

Most of the subject land is composed of exotic grass areas under a continual mowing regime. Cleared areas within the study and buffer areas include roads, car parks, a golf course, existing residential and other development, waterbodies (natural and man-made) and vacant land lots.

2.1.6 Differences between mapped vegetation extent and aerial imagery

There were no significant differences between the mapped vegetation extent and that visible on the aerial imagery.

2.1.7 Rivers and streams

The subject land is located within the Hunter Local Land Services Region and the Hunter River catchment. The Williams River is located approximately 10 kilometres west of the study area while the closest major waterbody is Grahamstown Reserve, located approximately 2.8 kilometres to the west.

There is one mapped second order stream, located 400 metres from the western boundary of the study area. The stream runs away from the study area from east to west, where it enters the Grahamstown Reserve (Figure 1). An unmapped watercourse is located in the south of the subject land and appears to connect constructed waterbodies of the golf course east of Medowie Road, with the SEPP 14 wetland to the west of the subject land (Figure 1).

2.1.8 Wetlands

A listed SEPP 14 wetland occurs within the south-west portion of the study area. Under the objectives of the SEPP, impacts to areas of coastal wetlands should be avoided. There are three additional wetlands located to the south east of the study area, within the 1,500 metre buffer area. These are not listed as important wetlands and are located at a distance of 230, 775 and 1,080 metres from the study area respectively. The furthest wetland is named Moffat's Lagoon.

The SEPP 14 wetland within the study area is classified as Highly Sensitive Key Fish Habitat as defined by the NSW Department of Primary Industry (DPI) within the study area (DPI 2013).

2.1.9 Connectivity features

Habitats within the study area are primarily those associated with coastal sclerophyll forests. For highly mobile fauna species and seed/pollen dispersal of some flora species, habitats within the study area are well connected to the vegetation of Tilligerry State Conservation Area to the south and Campvale Swamp to the west. The higher quality habitat connectivity links for fauna and flora occur to the west and south of the subject land, where most of the moderate and good condition vegetation remnant are located and barriers to dispersal are minor.

The subject land is well connected to the larger study area with only minimal disturbances such as vehicle tracks along the western boundary of the subject land, these are not considered to be barriers to species movement within the area. A power easement running from east to west divides vegetation within the study area but is not considered to provide a significant barrier for fauna species.

To the east of the subject land Medowie Road provides a barrier approximately 25 metres wide, this may be significant for less mobile and/or ground-dwelling species.

The subject land is moderately well connected to vegetation in the north of the study area; a smaller strip of vegetation at the northern boundary is connected to the wider landscape through vegetation remnants surrounding rural residential buildings and cleared paddocks (Figure 2 and Figure 3). The subject land and wider study area are highly connected to extensive areas of swamp bushland to the west.

At the site scale and for species more restricted in mobility and dispersal ability, vegetation and habitats located along the eastern boundary are fragmented, with canopy species being separated by at least 25 metres. To the south there is potential for connectivity through the freehold land to vegetation within Tilligerry State Conservation Area (Figure 2 and Figure 3), however, Campvale Road lies between the Conservation area and freehold land and may provide a barrier to dispersal of less mobile and terrestrial species into and from Tilligerry State Conservation Area.

Potential habitat for frogs and other species reliant on waterbodies and watercourses occurs west of the study area within the swamp forest vegetation outside the subject land. Vegetation to the south and west of the study area may provide habitat for dispersal and shelter between potential breeding habitats within the local area. An unmapped waterway to the south of the study area provides potential for dispersal of threatened frog species between habitat to the west and south of the study area to habitat east of Medowie road including Moffats Swamp Nature Reserve.

2.1.10 Areas of geological significance

There were no recorded karst, caves, crevices, cliffs or other areas of geological significance within the subject land or within the 1,500 metre buffer area surrounding the study areas.

2.1.11 Biodiversity Values Map

Parts of the subject land are mapped as containing high biodiversity value on the NSW Government Biodiversity Values map (BV map). Information gathered during field investigations of the current study provided for further refinement of areas mapped as having high biodiversity value.

2.1.12 Soil hazard features

Vegetated parts of the study area are mapped as being Low Risk (2-4 metres) Acid Sulfate Soils. The southern half of the subject land is mapped as Low Risk (above 4 metres) Acid Sulfate Soils (Naylor et al 1998) (Figure 1). Within the broader landscape and within the 1,500 metre buffer Acid Sulfate Soils have been mapped within all Classes (Naylor et al 1998) (Figure 1).

For Low Risk (2-4 metres) lands development consent is required for:

- Works more than two metres below the natural ground surface.
- Works by which the water table is likely to be lowered more than 2 metres below the natural ground surface.

For Low Risk (above 4 metres) lands development consent is required for:

- Works more than four metres below the natural ground surface.

- Works by which the water table is likely to be lowered more than 4 metres below the natural ground surface.

2.2 Site context

The site context was assessed using a site-based method undertaken during the preliminary assessment on 29 May 2017 and during further detail assessment in February 2017. The habitats and vegetation within the subject land are a minor representation of those present within the broader study area and locality.

2.2.1 Native vegetation cover

Native vegetation cover was assessed using GIS based on the most suitable vegetation mapping, in this case *Lower Hunter Vegetation Mapping*. (Cockerill et al 2013).

Native vegetation cover within the 1,500 metre buffer was found to be 67.5%.

2.2.2 Patch size

Patch size was assessed as per the BAM (OEH 2017) using a select process in ArcGIS. All intact vegetation that has a gap of less than 100 metres from the next area of moderate to good condition native vegetation is considered to be of the same patch.

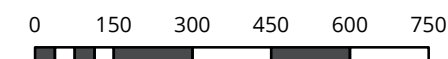
Vegetation within the subject land meeting this criteria was mapped sequentially, it was found to form part of a relatively large patch of connecting vegetation with a patch size larger than 100 hectares.



Legend

- Site boundary
- Study area
- Subject site
- Study area 1500m buffer
- Native vegetation
- HydroLine (LPI 2016)
- HydroLine (Biosis 2018)
- Habitat connectivity

Figure 3: Native vegetation and connectivity



Metres
Scale: 1:14,404 @ A3
Coordinate System: GDA 1994 MGA Zone 56



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

Matter: 26652
Date: 13 April 2018,
Checked by: ABM, Drawn by: LH, Last edited by: lharley
Location: P:\26600s\26652\Mapping\26652_BB_F3_NativeVeg

3 Native vegetation

The extent of native vegetation, threatened ecological communities and vegetation integrity within the study area was determined using the results of site investigations and Chapter 5 and Appendix 6 of the BAM (OEH 2017).

3.1 Methods

3.1.1 Background review

Regional vegetation mapping (Cockerill *et al.* 2013) and database searches (See Section 1.3) were reviewed to inform the site investigations. Based on the results of the background review and the requirements of the BAM with respect to this BDAR, appropriate surveys were designed for the study area and subject land.

3.1.2 Site investigation

A preliminary ecological assessment was undertaken by qualified and experienced Biosis ecologists Alejandro Barreto (Botanist) and Amy Rowles (Zoologist) in May 2017. The study area was surveyed in accordance with the BAM (OEH 2017a), the *NSW Guide to surveying Threatened Plants* (OEH 2016) and random meander methods (Cropper 1993) and involved:

- The identification and mapping of PCTs according to the structural definitions of Lower Hunter Vegetation Mapping (Cockerill *et al.* 2013).
- The identification of native and exotic plant species, according to the Flora of NSW (Harden 1992, 1993, 2000, 2002), with reference to recent taxonomic changes.
- Incidental observations using the “random meander” method (Cropper 1993).
- Identification of fauna habitats and assessment of their condition and value to threatened fauna species.
- Observations of animal activity and searches for indirect evidence of fauna (such as scats, nests, burrows, hollows, tracks, scratches and diggings).
- An assessment of the natural resilience of the vegetation of the site.
- Identification of previous and current factors threatening the ecological function and survival of native vegetation within and adjacent to the study area.

The conservation significance of plant species and plant communities was determined according to:

- BC Act for significance within NSW.
- EPBC Act for significance within Australia.

Detailed mapping of PCTs was conducted using hand-held (uncorrected) tablet units (Samsung Galaxy Tab 3) using the ArcGIS Collector application and aerial photo interpretation. Areas of native vegetation for which a PCT could validly be assigned were identified and delineated in the field, and their condition determined. Identification of PCTs within the study area was confirmed with reference to the community profile descriptors (and diagnostic species tests) held within the OEH (2016) mapping project and NSW BioNet Vegetation Classification database (OEH 2017b).

The results of the preliminary assessment were used to inform detailed surveys in 30 and 31 January by Samuel Luccitti (Senior Ecologist) and in February 2018 by Alejandro Barreto, Sarah Allison (Zoologist), Carl Corden (Consultant Zoologist).

Detailed surveys included the completion of the requisite number of vegetation integrity survey plots within each broad condition state of each mapped PCT in accordance with the BAM. The locations of surveyed plots are shown in Figure 4. Targeted surveys for candidate species credit flora and fauna species were also undertaken and are described in detail in Section 3.5.

3.2 Results

3.2.1 Vegetation description

The study area supports 12.1 hectares of native vegetation with varying levels of disturbance. Native vegetation within the study area varied in composition and condition as a result of previous land uses. The western boundary of the study area consists mostly of native vegetation, whilst the eastern portion is largely cleared, with scattered remnants.

The subject land is predominately covered by exotic pasture or non-native Slash Pine *Pinus elliottii* over exotic pasture, with native vegetation restricted to small patches of remnant canopy trees over exotic pasture and the edges of larger remnant patches (Figure 4). Shrub and mid layer vegetation strata are mostly absent in the subject land except where the subject land intersects the edge of larger, more intact remnant vegetation patches.

3.2.2 Native vegetation extent

Figure 4 provides a map of the native vegetation extent recorded within the study area and subject land, as assessed during field investigations undertaken in May 2017 and February 2018. The figure includes all areas of native vegetation (native ground cover and areas with canopy) and exotic dominated canopy. Areas not shown as native vegetation cover within Figure 4 are not included for further assessment in accordance with Section 5.1.1.5 of the BAM (OEH 2017).

3.2.3 Plant community types

The following PCTs were assessed as present within the within the subject land:

- PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast.
- PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter.
- PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.
- PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast.

Table 2 to Table 5 provide a detailed description of the four PCTs recorded within the subject land.

Table 2 Vegetation type-Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest.

PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast.	
Vegetation formation	KF_CH2A Wet Sclerophyll Forests (Grassy sub-formation)
Vegetation class	Northern Hinterland Wet Sclerophyll Forest
Extent within subject land	Approximately 0.96 hectares (Figure 4).
Condition	Disturbed. This PCT is in a disturbed condition due to the low abundance of native canopy, lack of midstorey/shrub species and dominance of exotic grasses. Within the subject land the extent of this PCT is regularly mown.
Vegetation zones	1564_Moderate
Description	This PCT was characterised by an open canopy of Blackbutt <i>Eucalyptus pilularis</i> and Rough-barked Apple <i>Angophora floribunda</i> . The understory was dominated by exotic grasses such as Buffalo Grass <i>Stenotaphrum secundatum</i> , Whisky Grass <i>Andropogon virginicus</i> and Kikuyu Grass <i>Pennisetum clandestinum</i> . A low abundance of native groundcover species such as Brown's Lovegrass <i>Eragrostis brownii</i> , Blady Grass <i>Imperata cylindrica</i> and Common Couch <i>Cynodon dactylon</i> were recorded amongst exotic grass sward.
Survey effort	One BAM plot (Q1) was completed within the PCT (Figure 4) which informed the finalised mapping.
Justification of PCT	Floristic composition soil type and landscape position aligns with Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest BioNet conditional benchmarks (OEH 2017b).
TEC Status	Commonwealth EPBC Act: Not listed NSW BC Act: Not listed
Estimate of percent cleared value of PCT in the major catchment area	1%

PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast.

Picture: Blackbutt -
Rough-barked Apple -
Turpentine - ferny tall
open forest within the
subject land



Table 3 Vegetation type- Forest Red Gum grassy open forest

PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter

Vegetation formation	KF_CH9 Forested Wetlands
Vegetation class	Coastal Floodplain Wetlands
Extent within subject land	Approximately 0.17 hectares (Figure 4).
Condition	Moderate. Despite the low abundance of a midstorey and shrub layer, the Hunter Lowland Redgum forest in the subject land was considered to be in moderate condition, given the moderate native species diversity, abundance and relatively low weed cover.
Vegetation zones	1598_Moderate_OPZ 1598_Moderate 1598_Moderate_Stormwater
Description	This PCT is located along the western boundary of the subject land, draining into the swamps on the study area's western section. The canopy is dominated by Red Mahogany <i>Eucalyptus resinifera</i> and Forest Red Gum <i>Eucalyptus tereticornis</i> . The shrub layer is very sparse consisting of Notched Bush-pea <i>Pultanea retusa</i> and Coffee Bush <i>Breynia oblongifolia</i> . The ground cover is dominated by native grasses including Blady Grass <i>Imperata cylindrica</i> , Silvertop Wallaby Grass <i>Rytidosperma pallidum</i> , Smallflower Wallaby Grass <i>Rytidosperma setaceum</i> Common Couch <i>Cynodon dactylon</i> . The most abundant weeds included Buffalo grass, Whisky grass and Paspalum.

PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter


Survey effort	One BAM plot (Q2) was undertaken within the PCT (Figure 4).
Justification of PCT	<p>Floristic composition soil type and landscape position align with the PCT BioNet conditional benchmarks (OEH 2017b) and the Hunter lowland redgum forest in the Sydney Basin and NSW North Coast bioregions final determination (NSW Scientific Committee, 2002) based on the following:</p> <ul style="list-style-type: none"> • Landscape position in gentle slopes arising from depressions and drainage flats on Permian sediments of the Hunter Valley floor in NSW North Coast Bioregion. • Location within the Post Stephens LGA. • The canopy is dominated by Forest Red Gum. • Presence of Coffee Bush, Bushy Hedgehog-grass <i>Echinopogon caespitosus</i> and Wiry Panic <i>Entolasia stricta</i>.
TEC Status	<p>Commonwealth EPBC Act: Not listed</p> <p>NSW BC Act: Endangered</p>
Estimate of percent cleared value of PCT in the major catchment area	0% (Not assessed)
Picture: Forest Red Gum grassy open forest within the subject land	

Table 4 Vegetation type –Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest

PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	
Vegetation formation	KF_CH5B Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation class	Sydney Coastal Dry Sclerophyll Forests
Extent within subject land	Approximately 0.20 hectares (Figure 4).
Condition	<p>Moderate.</p> <p>This PCT is part of the existing road reserve along Medowie Road and despite its fragmentation, historic exposure to edge effects and weed infestation, it was considered to be in moderate condition, given the moderate native species diversity, abundance and relatively low weed cover. A review of Google Street View imagery available for 2010 indicates this vegetation was underscrubbed and maintained through mowing in the past. The understorey vegetation recorded in 2017 and 2-18 therefore represents relatively recent regeneration.</p>
Vegetation zones	1619_Good 1619_Moderate_OPZ 1619_Moderate_IPZ 1619_Moderate
Description	<p>This PCT is located in the south eastern portion of the subject land (Figure 4). Native canopy species recorded within the vegetation include Smooth-barked Apple <i>Angophora costata</i> Swamp Mahogany <i>Eucalyptus robusta</i> Swamp. Coastal Wattle <i>Acacia longifolia subsp. sophorae</i> Lance Leaf Geebung <i>Persoonia lanceolata</i> dominated the mid storey. The ground storey recorded a variety of native sedges and herbs for which included <i>Common Couch</i>, <i>Blue Flax-lily</i> <i>Dianella caerulea</i>, <i>Bushy Hedgehog-grass</i> <i>Echinopogon caespitosus</i>, <i>Tall Saw-sedge</i> <i>Gahnia clarkei</i>, <i>Spiny-headed Mat-rush</i> <i>Lomandra longifolia</i>, <i>Pomax</i> <i>Pomax umbellata</i>, <i>Bracken Fern</i> <i>Pteridium esculentum</i> and <i>Trachymene</i> <i>Trachymene incisa</i>. Exotic species were recorded in low densities. Weed species recorded included Whisky grass, Narrow-leaved Carpet grass, Fleabane <i>Conyza bonariensis</i> and African Lovegrass <i>Eragrostis curvula</i>.</p>
Survey effort	One BAM plot (Q3) was undertaken within the PCT (Figure 4) which informed the finalised mapping.
Justification of PCT	Floristic composition soil type and landscape position aligns with Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest BioNet conditional benchmarks (OEH 2017b). The presence of Swamp Mahogany suggests this vegetation occupies an ecotone at which PCT 1619 transitions to PCT 1718 described in Table 5.
TEC Status	Commonwealth EPBC Act: Not listed NSW TSC Act: Not listed
Estimate of percent cleared value of PCT in the major catchment area	45%

PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands

Picture: Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest within the subject land




Table 5 Vegetation type – Swamp Mahogany – Flax leaved Paperbark swamp forest

PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast

Vegetation formation	KF_CH9 Forested Wetlands
Vegetation class	Coastal Swamp Forests
Extent within subject land	Approximately 0.22 hectares (Figure 4).
Condition	Moderate to Good. This PCT is part of a larger and relatively intact swamp forest patch west of the subject land. This PCT was considered to be in good condition, given its structure, high native species diversity, abundance and relatively low weed cover.
Vegetation zones	1718_Moderate_OPZ 1718_Moderate_IPZ 1718_Moderate_Stormwater 1718_Moderate
Description	This PCT is located along the south west boundary of the subject land and dominates the wetter habitat within the study area (Figure 4). Native species recorded within the vegetation include Swamp Mahogany, Swamp oak <i>Casuarina glauca</i> and Broad-leaved Paperbark <i>Melaleuca quinquenervia</i> . Tall Saw-sedge <i>Gahnia clarkei</i> dominated the mid storey in moist portions of the community and was supported by native shrub species such as Coastal Wattle and Flax-leaved Paperbark <i>Melaleuca linariifolia</i> and climbers such as Dusky Coral Pea <i>Kennedia rubicunda</i> . The ground storey included a variety of native ferns, grasses, rush and forbs such as Gristle Fern <i>Blechnum cartilagineum</i> , Rainbow Fern <i>Calochlaena dubia</i> , Wiry

PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast

	<p><i>Panic Entolasia stricta</i>, <i>Juncus prismatocarpus</i> and Slender Knotweed <i>Persicaria decipiens</i>. Weed species recorded included Blackberry complex <i>Rubus fruticosus</i>, Narrow-leaved Carpet Grass and Crofton Weed <i>Ageratina adenophora</i>.</p>
Survey effort	One BAM plot (Q4) was undertaken within the PCT (Figure 4) which informed the finalised mapping.
Justification of PCT	<p>Floristic composition soil type and landscape position align with the PCT BioNet conditional benchmarks (OEH 2017b) and the Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin final determination (NSW Scientific Committee, 2011) based on the following:</p> <ul style="list-style-type: none"> • The dominance of Swamp Mahogany, Prickly-leaved Tea Tree and Swamp Oak within the canopy. • Association with humic clay loams on waterlogged or periodically inundated alluvial flats and drainage lines in coastal floodplains. • The study area is below 20 metres of elevation. • The study area is located within the NSW North Coast.
TEC Status	<p>Commonwealth EPBC Act: Not listed NSW TSC Act: Endangered</p>
Estimate of percent cleared value of PCT in the major catchment area	74%
Picture: Swamp Mahogany - Flax-leaved Paperbark swamp forest within the subject land	

3.2.4 Threatened ecological communities

Two PCTs within the subject land are consistent with threatened ecological communities (TECs) listed under the NSW BC Act. These include:

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Endangered Ecological Community (Swamp Sclerophyll Forest EEC):
 - Restricted to PCT 1718 and located to the west and north of the subject land. The subject land contains 0.22 hectares of Swamp Sclerophyll Forest EEC.
- Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions (Hunter Lowland Redgum Forest EEC):
 - Restricted to the PCT 1598 and located along the western edge of the subject land. The subject land contains 0.17 hectares of Hunter Lowland Redgum Forest EEC.

Figure 4 illustrates the TECs recorded within the broader study area as detailed in Table 2 to Table 5 above.

3.2.5 Terrestrial Fauna Habitat

The study area supports 12.1 hectares of native vegetation with varying levels of disturbance while the subject land contains 1.55 hectares of native vegetation in relatively disturbed condition. Fauna habitat within the subject land mostly consists of isolated native canopy trees over a mown ground cover of primarily exotic grasses and a narrow strip of Slash Pine along the south-east boundary (Figure 4), under which the understorey has been largely removed. Better quality habitat is associated with larger remnant patches of PCT1718 and PCT 1598 at the western edge of the subject land. APZs associated with the proposed development will impact very narrow strips of this habitat.

Native vegetation within the subject land is considered to be of marginal or low value to threatened species due to the effects of current and historic disturbance such as clearing and regular mowing of the grassy groundcover. These practices have resulted in substantially modified vegetation composition and structure within the subject land and have likely lead to an increase in introduced predator (e.g. European Fox *Vulpes vulpes*, Cat *Felis catus*) pressure.

One ephemeral creek crosses a portion the subject land in the south-east. This creekline may provide some marginal dispersal habitat for threatened frogs and provides connectivity between habitat to the east of the subject land, across Medowie Road and to the west of the subject land. The aquatic habitats associated with this watercourse are further discussed in Section 3.2.6.

Within the subject land there are 11 hollow-bearing trees which may be removed by the development. These trees provide hollows potentially suitable for roosting for threatened microbats but are considered to be unsuitable for breeding by other threatened species due to a variety of factors including aspect, size, position within the tree and position within the landscape.

Habitat within the subject land may provide foraging resources for some threatened species in the form of large flowering eucalypts including Swamp Mahogany, Blackbutt and Rough-barked Apple within PCT 1564 and Red Gum within 1598 (Figure 4). Swamp Mahogany and Forest Red Gum are winter-flowering species and therefore individuals within the subject land likely provide nectar resources for nectivorous birds, including threatened species such as Swift Parrot *Lathamus discolor* and Regent Honeyeater *Anthochaera phrygia*. The subject land and broader study area are not, however, considered 'important habitat' (as per the BAM) for either the Swift Parrot or Regent Honeyeater.

The PCT 1718 and PCT 1598 vegetation adjoining the subject land to the west is well connected to surrounding larger areas of bushland considered to provide higher quality habitat for all threatened species with potential to occur within the subject land.

The study area and surrounding bushland were observed to provide foraging resources for some threatened species during targeted fauna survey (refer Section 3.5).

3.2.6 Aquatic Habitats

One unnamed and unmapped ephemeral waterway traverses the southern section of the subject land (Figure 1). The waterway is moderately modified due to its location within a routinely mown landscape, past canopy clearing and weed infestation. There is an existing culvert structure connecting the subject land with the southern section of the study area. A number of additional small culvert sections provide access across the waterway within the south-western sections of the study area and existing vehicle track crosses near the western boundary of the study area.

The waterway appears to feed the mapped wetlands located across Medowie Road, southeast of the study area. Fringing, or submerged native aquatic plants and instream habitat structures such as logs or rocks were observed within some sections of the stream (Plate 1 and Plate 2). Isolated pools occurring within the waterway are considered to provide limited refuge habitat for aquatic fauna. Several drainage pipes and other infrastructure were found along the waterway (Plate 3).

The stream is not linked to the Strahler stream order system as it is downstream of the waterways on the Pacific Dunes golf course to the east (Personal comm. Ryan Shepherd, Water Regulations Officer, DPI). However, following advice from DPI, the stream is considered to be a first order stream for the purposes of assessment against relevant provision of the WM Act and FM Act (Personal comm. Ryan Shepherd, Water Regulations Officer, DPI).

The unnamed stream is not Key Fish Habitat as defined by DPI (2013) as it is considered to be a first order gaining stream. The stream experiences intermittent flows and offers sporadic refuge, breeding and/or feeding areas for aquatic fauna within semi-permanent pools. The stream is therefore classified as a *Class 3 – Minimal key fish habitat* for fish passage.

The SEPP 14 wetland within the study area is classified as Highly Sensitive Key Fish Habitat within the study area (DPI 2013).



Plate 1 Dry sections of unnamed waterway traversing the southern section of the subject land (February 2018).



Plate 2 Isolated pools of unnamed waterway traversing the southern section of the subject land (May 2017).



Plate 3 Existing infrastructure within unnamed waterway traversing the southern section of the subject land (February 2018).

3.2.7 Groundwater Dependent Ecosystems

The study area sits within the Karuah and Hunter River regions as defined in the Groundwater Dependent Ecosystem (GDE) Atlas (Bureau of Meteorology 2018) and is located within the Hunter Unregulated and Alluvial Groundwater management Area. Vegetation within and adjoining the subject land is identified in the GDE Atlas as moderate or high likelihood of functioning as a terrestrial GDE based on regional studies.

PCTs mapped within the subject land and broader study area that have moderate potential of being GDE include PCT 1564, PCT 1598 and PCT 1619. PCT 1718, which is equivalent to the Swamp Sclerophyll Forest EEC, is considered high potential GDE. The NSW Scientific Committee final determination for Swamp Sclerophyll Forest EEC (NSW Scientific Committee 2011) identifies the Swamp Sclerophyll Forest EEC as forming part of a complex of forested and treeless wetland ecological communities throughout coastal NSW. The Swamp Sclerophyll Forest community occurs on waterlogged or periodically inundated alluvial flats and drainage lines and has been impacted by historic changes to hydrological process across its current and former range.

PCT 1718 within the subject land and broader study area is considered a GDE and may be impacted by the proposed development in the absence of appropriate mitigation and management measures.

3.3 Vegetation integrity assessment

3.3.1 Vegetation zones

PCTs within the subject land were stratified, based on broad condition state, and were further split in to vegetation zones based on the intended vegetation management at construction and operational stages of the proposed development. This resulted in 12 vegetation zones within the subject land (Table 6).

Table 6 Vegetation zones mapped within the subject land

Vegetation zone	Plant community type	Ancillary description	Area (ha)	Patch size class
VZ1	PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter	Moderate_OPZ	0.05	>100ha
VZ2	PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter	Moderate	0.11	>100ha
VZ3	PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Moderate_OPZ	0.10	>100ha
VZ4	PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Moderate_IPZ	0.07	>100ha
VZ5	PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter	Moderate_Stormwater	0.01	>100ha
VZ6	PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast	Moderate	0.97	>100ha
VZ7	PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Moderate_Stormwater	0.01	>100ha
VZ8	PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Good	0.11	>100ha
VZ9	PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Moderate_OPZ	0.05	>100ha
VZ10	PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Moderate_IPZ	0.04	>100ha
VZ11	PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Moderate	0.04	>100ha
VZ12	PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands	Moderate	0.04	>100ha

Vegetation zone	Plant community type	Ancillary description	Area (ha)	Patch size class
	of the Central Coast			

3.3.2 Vegetation integrity

Vegetation integrity was assessed using data obtained from BAM plots completed within each PCT in accordance with the methodology outlined in Section 5.3.4 of the BAM (OEH 2017a). Plot data was collected via:

- A 20 metre x 50 metre quadrat and 50 metre transect for assessment of site attributes and function.
- A 20 metre x 20 metre quadrat, nested within the larger quadrat for full floristic survey to determine composition and structure of the PCT.

The minimum number of BAM plots per vegetation zone was determined through application of Table 4 of the BAM (OEH 2017a) to the total extent of each PCT mapped in the subject land (Table 7). A total of four BAM plots were therefore completed within the subject land. An assessment of vegetation integrity was undertaken using benchmark data collected as outlined in Subsection 5.3.3 of the BAM.

Vegetation integrity plots were not undertaken in each vegetation zone due to the very small area of some vegetation zones mapped within the subject land. Vegetation integrity plots were instead undertaken within representative areas of each PCT with the same plot data applied to multiple vegetation zones within the same PCT.

No additional local data was used for this assessment.

A list of flora species was compiled, and records of all flora species will be submitted to OEH for incorporation into the Atlas of NSW Wildlife.

3.3.3 Vegetation integrity score

Plot data were entered into the BAM calculator to determine vegetation integrity score. Plot data is presented in Appendix 2. Vegetation integrity scores for the vegetation zone in the subject land is provided in Table 7. The number of hollow-bearing trees to be directly impacted by the proposed development are also provided in Table 7. The vegetation integrity score calculated for each

Table 7 Vegetation zone integrity scores

PCT	No. of plots	Applicable vegetation zones	Composition condition score	Structure condition score	Function condition score	Vegetation integrity score	No. of Hollow-bearing Trees
PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast	1	VZ6	12	20.8	66.3	25.5	3
PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter	1	VZ1 VZ2 VZ5	49.1	42.1	59.4	49.7	1

PCT	No. of plots	Applicable vegetation zones	Composition condition score	Structure condition score	Function condition score	Vegetation integrity score	No. of Hollow-bearing Trees
PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	1	VZ8 VZ9 VZ10 VZ11	23.2	38.8	67.4	39.3	1
PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	1	VZ3 VZ4 VZ7 VZ12	51.5	41.6	79.2	55.4	0

As outlined in Section 10.3.1 of the BAM, an offset is required for impacts on native vegetation where the vegetation integrity score is:

- ≥ 15 where the PCT is representative of an endangered or critically endangered ecological community.
- ≥ 17 where the PCT is associated with threatened species habitat (as represented by ecosystem credits), or is representative of a vulnerable ecological community.
- ≥ 20 where the PCT is not representative of a TEC or associated with threatened species habitat.

As shown in Table 7, the integrity score for all vegetation zones is above 20. Therefore, offsets will be required for all impacts to mapped native vegetation within the subject land.



Legend

- Site boundary
 - Study area
 - Subject site
 - HydroLine (Biosis 2018)
 - + Hollow-bearing tree
 - BAM plots
- Vegetation community**
- PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast
 - PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter
 - PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown
 - Stringybark - Hairpin Banksia heathy open forest of coastal lowlands
 - PCT 1718 Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast
 - Exotic vegetation (Slash Pine)
- Threatened Ecological Community**
- Hunter Lowland Redgum Forest EEC
 - Swamp Sclerophyll Forest EEC

Figure 4: Native vegetation within the subject land

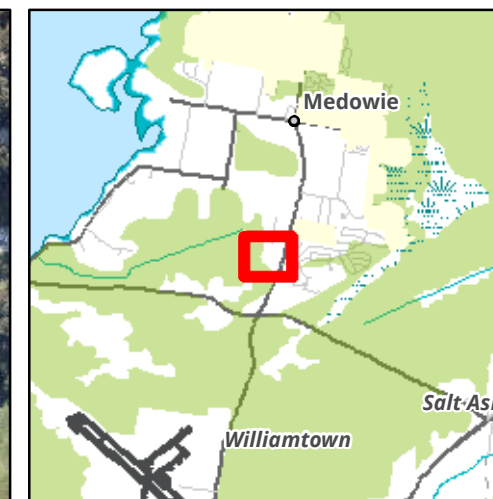
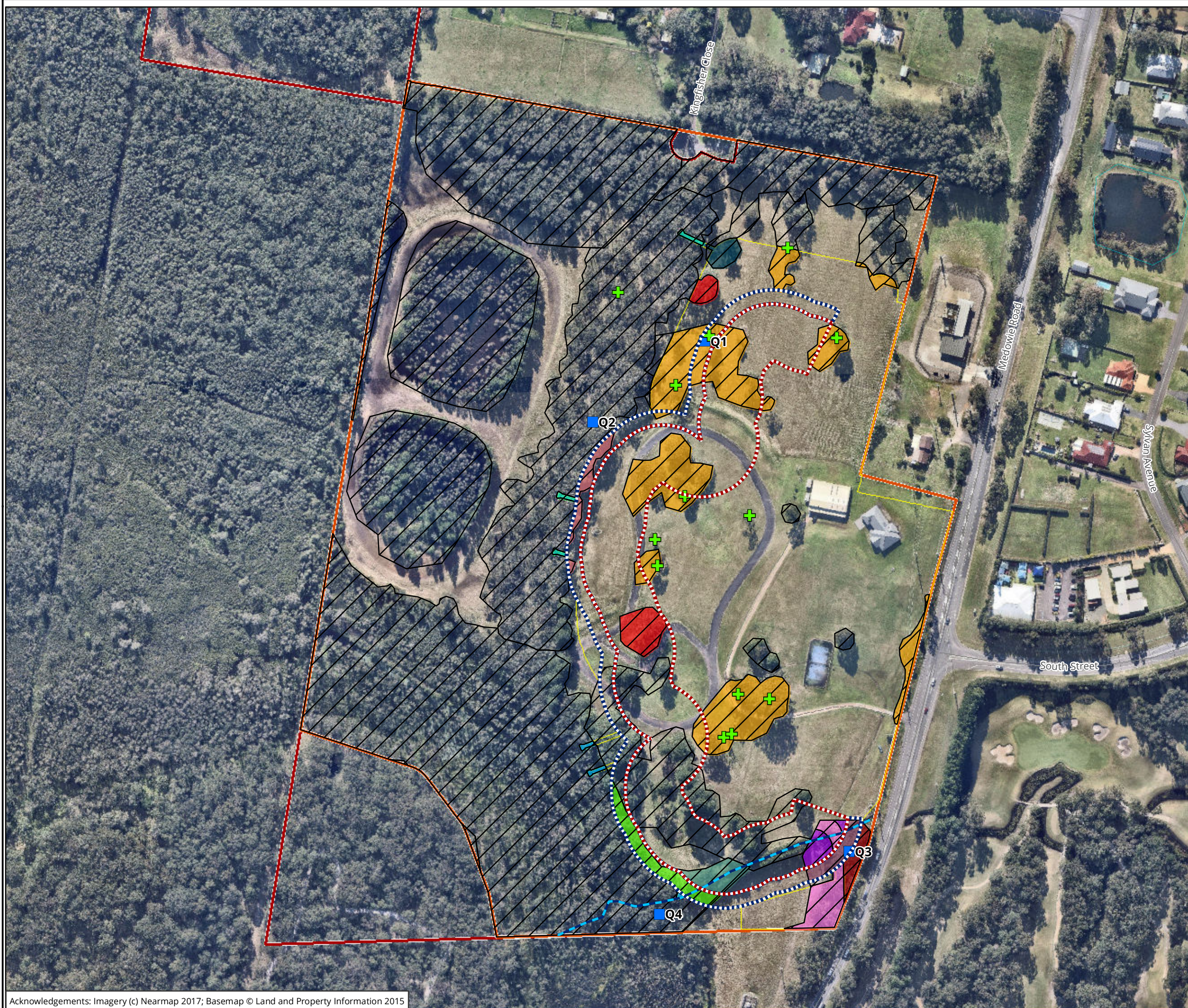
0 25 50 75 100 125
Metres

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



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

Matter: 26652
Date: 13 April 2018
Checked by: ABM, Drawn by: LH, Last edited by: lharley
Location: P:\26600s\26652\Mapping\26652_BB_F4_BiosisVeg



Legend

- Subject site
- Study area
- Site boundary
- Inner protection zone
- Outer protection zone
- HydroLine (Biosis 2018)
- + Hollow-bearing tree
- BAM plots
- Vegetation community

Vegetation zone

- VZ1
- VZ2
- VZ3
- VZ4
- VZ5
- VZ6
- VZ7
- VZ8
- VZ9
- VZ10
- VZ11
- VZ12

Figure 5: Vegetation zones within the subject land

0 25 50 75 100 125
Metres

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



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

Matter: 26652
Date: 13 April 2018
Checked by: ABM, Drawn by: LH, Last edited by: lharley
Location: P:\26600s\26652\Mapping\26652_BB_F5_VegZones

3.4 Ecosystem credit species

Species reliably predicted to occur based on PCTs present within the subject land (i.e. ecosystem credit species) and information obtained from the Threatened Biodiversity Data Collection, were returned from the BAM Offsets Calculator and refined as per Section 6 of the BAM (Table 8). Impacts to these species require further assessment, however targeted survey is not required.

Table 8 Assessment of ecosystem credit species within the subject land

Common name	Scientific name	Habitat type	Habitat constraint	Geographic limitations	Veg Zone	Sensitivity to gain class	NSW listing status	Comm. listing status.
Barking Owl	<i>Ninox connivens</i>	Foraging	--	--	VZ1, VZ2, VZ3, VZ4	High	V	--
Black Bittern	<i>Ixobrychus flavicollis</i>	--	--	--	VZ4	Moderate	V	--
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis gularis</i>	--	--	--	VZ3	Moderate	V	--
Brown Treecreeper (eastern subspecies)	<i>Climacteris picumnus victoriae</i>	--	--	--	VZ2, VZ3	High	V	--
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	Foraging	--	--	VZ1, VZ3, VZ4	High	V	--
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	--	--	--	VZ1, VZ3, VZ4	High	V	--
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	--	--	--	VZ1, VZ3, VZ4	High	V	--
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	--	--	--	VZ1, VZ3, VZ4	High	V	--
Eastern Osprey	<i>Pandion cristatus</i>	--	--	--	VZ3, VZ4	Moderate	V	--
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Foraging	--	--	VZ1, VZ3	Moderate	V	--
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	Foraging	--	--	VZ1, VZ3	Moderate	V	--
Golden-tipped Bat	<i>Kerivoula papuensis</i>	--	--	--	VZ1, VZ3, VZ4	High	V	--
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	--	--	--	VZ1, VZ3, VZ4	High	V	--

Common name	Scientific name	Habitat type	Habitat constraint	Geographic limitations	Veg Zone	Sensitivity to gain class	NSW listing status	Comm. listing status.
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	--	--	--	VZ3	Moderate	V	--
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	Foraging	--	--	VZ1, VZ3, VZ4	High	V	V
Hooded Robin (south-eastern form)	<i>Melanodryas cucullata cucullata</i>	--	--	--	VZ2, VZ3	Moderate	V	--
Koala	<i>Phascolarctos cinereus</i>	Foraging	--	--	VZ1, VZ3, VZ4	High	V	V
Little Bentwing-bat	<i>Miniopterus australis</i>	Foraging	--	--	VZ1, VZ3, VZ4	High	V	--
Little Eagle	<i>Hieraaetus morphnoides</i>	Foraging	--	--	VZ4	Moderate	V	--
Little Lorikeet	<i>Glossopsitta pusilla</i>	--	--	--	VZ1, VZ2, VZ3, VZ4	High	V	--
Long-nosed Potoroo	<i>Potorous tridactylus</i>	--	--	--	VZ1, VZ4	High	V	V
Masked Owl	<i>Tyto novaehollandiae</i>	Foraging	--	--	VZ1, VZ4	High	V	--
Powerful Owl	<i>Ninox strenua</i>	Foraging	--	--	VZ1, VZ3	High	V	--
Regent Honeyeater	<i>Anthochaera phrygia</i>	Foraging	--	--	VZ4	High	CE	CE
Scarlet Robin	<i>Petroica boodang</i>	--	--	--	VZ2, VZ3	Moderate	V	--
Speckled Warbler	<i>Chthonicola sagittata</i>	--	--	--	VZ2, VZ3	High	V	--
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	--	--	--	VZ1, VZ2, VZ3, VZ4	High	V	E
Square-tailed Kite	<i>Lophoictinia isura</i>	Foraging	--	--	VZ1, VZ3	Moderate	V	--
Swift Parrot	<i>Lathamus discolor</i>	Foraging	--	--	VZ1, VZ3, VZ4	Moderate	E	CE
Turquoise Parrot	<i>Neophema pulchella</i>	--	--	--	VZ3	High	V	--
Varied Sittella	<i>Daphoenositta chrysoptera</i>	--	--	--	VZ1, VZ2, VZ3, VZ4	Moderate	V	--
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	Foraging	--	--	VZ2, VZ3, VZ4	High	V	--

Common name	Scientific name	Habitat type	Habitat constraint	Geographic limitations	Veg Zone	Sensitivity to gain class	NSW listing status	Comm. listing status.
Yellow-bellied Glider	<i>Petaurus australis</i>	--	--	--	VZ1, VZ3	High	V	--
Yellow-bellied Sheathtail-bat	<i>Saccolaimus flaviventris</i>	--	--	--	VZ1, VZ3, VZ4	High	V	--

The presence of these species could not be discounted using the methodology outlined in Step 1 and Step 2 of Section 6.4 of the BAM. It was therefore assumed that these species may occur within the subject land.

3.5 Species credit species

A list of species credit species potentially occurring within the study area was generated in accordance with Section 6.4 of the BAM, including information obtained from the Threatened Biodiversity Data Collection. An assessment of whether suitable habitat occurs within the study area, and therefore whether a species is to be considered a candidate species credit species is also provided. The identification of candidate species credit species was assessed in accordance with Sections 6.3 and 6.4 of the BAM.

Table 9 Candidate species credit species within the subject land

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
Flora									
Dwarf Heath Casuarina <i>Allocasuarina defungens</i>	--	--	North of Bulahdelah	Dwarf Heath Casuarina grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. The species also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains.	High	V	--	No	Subject land does not meet the geographic limitations of the species.
Charmhaven Apple <i>Angophora inopina</i>	--	--	South of Wooton	Grows in woodland with a dense shrubby understorey in a variety of communities including Sydney Coastal Dry Sclerophyll Forests, Coastal Floodplain Wetlands, Eastern Riverine Forests and Sydney Coastal Heaths. Grows on sandstone substrates in deep, white sandy soils.	N/A	V	V	Yes	Marginal habitat exists along vegetation remnants adjacent to the subject land.
Trailing Woodruff <i>Asperula asthenes</i>	--	--	--	Occurs in damp sites, often along river banks.	High	V	V	No.	The species habitat within the subject land is considered to be substantially degraded due to routine mowing of understorey and weed infestation in damp sites within the subject land.
Netted Bottle Brush <i>Callistemon linearifolius</i>	--	--	--	Grows on the coast and adjacent ranges in a variety of communities including Cumberland Dry Sclerophyll Forests, Coastal Floodplain Wetlands, Sydney Coastal Heaths and North Coast Wet Sclerophyll Forests.	High	V	--	Yes	Marginal habitat exists along vegetation remnants adjacent to the subject land.
Red Helmet Orchid <i>Corybas dowlingii</i>	--	--	--	Grows in sheltered gullies and southerly slopes in Northern Hinterland Wet Sclerophyll Forests and North Coast Wet Sclerophyll Forests. Grows in well-drained gravelly soils.	Moderate	E1	--	No.	Marginal species habitat within the subject land is considered to be substantially degraded due to routinely mown understorey.
Leafless Tongue Orchid <i>Cryptostylis hunteriana</i>	--	--	--	Grows in a variety of communities including Sydney Coastal Dry Sclerophyll Forests, Coastal Heath Swamps, New England Dry Sclerophyll Forests and Sydney Coastal Heaths. Grows in sandy soils.	High	V	V	No.	Marginal species habitat within the subject land is considered to be substantially degraded due to routinely mown understorey.
White-flowered Wax Plant <i>Cynanchum elegans</i>	--	--	--	Grows in rainforest gully scrub and steep slope on the edge of dry rainforests in a variety of communities including Coastal Floodplain Wetlands, Maritime Grasslands, Coastal Valley Grassy Woodlands and Northern Hinterland Wet Sclerophyll Forests.	High	V	V	No.	The species habitat within the subject land is considered to be substantially degraded due to shrub layer removal and routinely mown understorey.
Pale Yellow Doubletail <i>Diuris flavescens</i>	--	--	--	Grows in grassy tall eucalypt forest with Kangaroo Grass and Blady Grass on brown clay soil.	Moderate	CE	CE	No.	The species habitat within the subject land is considered to be substantially degraded due to shrub layer removal and routinely mown understorey.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
Rough Doubletail <i>Diuris praecox</i>	--	--	--	Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey.	Moderate	V	V	No.	The subject land is located too far from the typical coastal locations generally considered potential habitat for this species. Furthermore, marginal species habitat within the subject land is considered to be substantially degraded due to routinely mown understorey.
Slaty Red Gum <i>Eucalyptus glaucina</i>	--	--	--	Grows in grassy woodland and dry eucalypt forest. Grows on deep, moderately fertile and well-watered soils.	High	V	V	Yes.	Marginal habitat exists along vegetation remnants adjacent to the subject land.
<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	--	--	--	Grows on wet sites subject to periodic inundation in Coastal Swamp Forests. Grows in deep, low nutrient sandy soils.	High	V	V	Yes.	Marginal habitat exists along vegetation remnants adjacent to the subject land.
<i>Eucalyptus seeana</i> Endangered population	--	--	Within Greater Taree LGA	Occurs as scattered individuals in woodlands and open forests on low, often swampy, sandy soils.	High	E (Pop)	--	No.	Subject land does not meet the geographic limitations of the species.
Guthrie's Grevillea <i>Grevillea guthrieana</i>	--	--	--	Grows along creeks and cliff lines in eucalypt forest, on granitic or sedimentary soil.	High	E	E	No.	There are no local records of this species and available habitats within the subject land is considered to be substantially degraded due to shrub layer removal and routinely mown understorey.
Small-flower Grevillea <i>Grevillea parviflora</i> subsp. <i>parviflora</i>	--	--	--	Grows in sandy or light clay soils including tertiary alluviums over thin shales and lateritic ironstone gravels.	High	V	V	Yes.	Marginal habitat exists along vegetation remnants adjacent to the subject land.
Big Nellie Hakea <i>Hakea archaeoides</i>	--	--	--	Found on steep, rocky, sheltered slopes and in deep gullies in open eucalypt forest. Commonly occurs at the interface of dry eucalypt forest and gully communities.	High	V	V	No.	The subject land does not contain suitable habitat for this species in the form of steep rocky sheltered gullies or interface of such habitat with dry eucalypt forest.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
Noah's False Chickweed <i>Lindernia alsinoides</i>	--	--	--	Grows in swamp forests and wetlands along coastal and hinterland creeks.	High	E	--	Yes.	Swamp forest habitat exists along vegetation remnants adjacent to the subject land.
<i>Maundia triglochinoxoides</i>	--	Swamps and Swamps or shallow fresh water on clay.	--	Grows in shallow freshwater channels, lagoons, creeks, dams or swamps in a variety of communities including Coastal Floodplain Wetlands, Coastal Swamp Forests, Coastal Freshwater Lagoons, Coastal Heath Swamps and Coastal Valley Grassy Woodlands. Grows in heavy clay, low nutrient soils.	High	V	--	Yes.	Swamp forest habitat exists along vegetation remnants adjacent to the subject land.
Biconvex Paperbark <i>Melaleuca biconvexa</i>	--	Swamps and Swamps margins or creek edges.	--	Grows in damp places, often near streams or low lying areas on low slopes or sheltered aspects in a variety of communities including Hunter-Macleay Dry Sclerophyll Forests, Coastal Swamp Forests, Coastal Floodplain Wetlands, Coastal Freshwater Lagoon and North Coast Wet Sclerophyll Forests. Grows in alluvial soils.	High	V	--	Yes.	Swamp forest habitat exists along vegetation remnants adjacent to the subject land.
Grove's Paperbark <i>Melaleuca groveana</i>	--	--	--	Grove's Paperbark grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcropping granite, rhyolite and sandstone on rocky outcrops and cliffs. It also occurs in dry shrubby open forest and woodlands.	High	V	--	No.	The species habitat within the subject land is considered to be substantially degraded due to shrub layer removal and routinely mown understorey.
Tall Knotweed <i>Persicaria elatior</i>	--	--	--	This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	Moderate	V	V	Yes.	Swamp forest habitat exists along vegetation remnants and unnamed drainage identified within the subject land.
Scant Pomaderris <i>Pomaderris queenslandica</i>	--	--	--	Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	High	E	--	No.	The species habitat within the subject land is considered to be substantially degraded due to shrub layer removal and routinely mown understorey.
Eastern Australian Underground Orchid <i>Rhizanthella slateri</i>	--	--	--	Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest. Highly cryptic given that it grows almost completely below the soil surface, with flowers being the only part of the plant that can occur above ground. Therefore usually located only when the soil is disturbed.	High	V	E	No.	The species habitat within the subject land is considered to be substantially degraded due to shrub layer removal and routinely mown understorey.
Black-eyed Susan <i>Tetradlea juncea</i>	--	--	--	Usually found growing in soils from the Awaba soil landscape comprising of low nutrient sandy, skeletal soils, sandy loam soils and clay soils on sandstone or conglomerate substrates.	High	V	V	No.	The species habitat within the subject land is considered to be substantially degraded due to shrub layer removal and routinely mown understorey.
Austral Toadflax <i>Thesium australe</i>	--	--	--	Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass <i>Themeda australis</i> . A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.	Moderate	V	V	Yes.	Marginal habitat exists along vegetation remnants adjacent to the subject land.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
Birds									
Regent Honeyeater (Breeding) <i>Anthochaera phrygia</i>	--	--	--	The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important. Flowering of associated species such as Thin-leaved Stringybark <i>Eucalyptus eugenioides</i> and other Stringybark species, and Broad-leaved Ironbark <i>E. fibrosa</i> can also contribute important nectar flows at times. Nectar and fruit from the mistletoes <i>Amyema miquelii</i> , <i>A. pendula</i> and <i>A. cambagei</i> are also utilised. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria.	High	CE	CE	No.	Species unlikely to breed within the subject land as habitat is not suitable. Breeding records not known from the locality. There are only two previous records of Regent Honeyeater within 5 km of the study area, the most recent of which is 16 years old. The project will not impact on any 'Important Areas' as referred to in the Threatened Species Profile Database for Regent honeyeater.
Bush Stone-curlew <i>Burhinus grallarius</i>	--	Fallen/standing dead timber including logs	--	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Nest on the ground in a scrape or small bare patch.	High	E1	--	No.	Species habitat not present within the subject land.
Gang-gang Cockatoo (Breeding) <i>Callocephalon fimbriatum</i>	--	--	--	In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. May also occur in sub-alpine Snow Gum <i>Eucalyptus pauciflora</i> woodland and occasionally in temperate rainforests. Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 10 cm in diameter or larger and at least 9 m above the ground in eucalypts.	High	V	--	No.	Species breeding habitat not present within the subject land.
Glossy Black-Cockatoo (Breeding) <i>Calyptrorhynchus lathamii</i>	--	--	--	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak <i>Allocasuarina littoralis</i> and Forest Sheoak <i>A. torulosa</i> are important foods. Feeds almost exclusively on the seeds of several species of she-oak <i>Casuarina</i> sp. and <i>Allocasuarina</i> sp., shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.	High	V	--	No.	Species breeding habitat not present within the subject land.
Dromaius novaehollandiae – Endangered population Emu population in the	--	--	--	On the NSW north coast, Emus occur in a range of predominantly open lowland habitats, including grasslands, heathland, shrubland, open and shrubby woodlands, forest, and swamp and sedgeland communities, as well as the ecotones between these habitats. They also occur in plantations of tea-tree and open farmland, and occasionally in littoral	Moderate	E2	--	Yes.	Some marginal habitat within the study area. Last record within the locality is from 1992. Approximately 80 individuals left in this population. It is unknown whether a natural

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
New South Wales North Coast Bioregion and Port Stephens local government area				<p>rainforest.</p> <p>Emus are omnivorous, taking a wide range of seeds and fruits, invertebrates (mainly insects) and foliage and other plant material. They take material directly from plants or bend down to take items from the ground, picking up the food and tossing them back in the throat before swallowing.</p> <p>The population of Emus in the NSW North Coast Bioregion and Port Stephens LGA is of significant conservation value as the last known population in northern coastal NSW, and for the role that birds play in dispersing large seeds of native plant species, and over long distances. Most breeding occurs in late autumn and winter, but better data are needed for the north-eastern NSW population. Eggs are laid on a platform of grass, twigs, leaves and bark on the ground, often at the base of some vegetation and with good views from the nest. Incubation and all parental care is by the male.</p> <p>Young are precocial and covered in down at hatching. They can walk within 5 to 24 hours of hatching.</p>					population survives in Port Stephens LGA.
White-bellied Sea-Eagle (Breeding) <i>Haliaeetus leucogaster</i>	--	--	--	<p>Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea.</p> <p>Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh.</p> <p>Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest).</p> <p>Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Nests are large structures built from sticks and lined with leaves or grass.</p>	High	V	--	No.	Potential breeding habitat not present within the subject land. No foraging habitat.
Little Eagle (Breeding) <i>Hieraetus morphnoides</i>	--	--	--	<p>Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.</p>	Moderate	V	--	No.	Potential breeding habitat not present within the subject land.
Swift Parrot (Breeding) <i>Lathamus discolor</i>	--	--	--	<p>Migrates to the Australian south-east mainland between March and October.</p> <p>On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.</p> <p>Favoured feed trees include winter flowering species such as Swamp Mahogany <i>Eucalyptus robusta</i>, Spotted Gum <i>Corymbia maculata</i>, Red Bloodwood <i>C. gummifera</i>, Mugga Ironbark <i>E. sideroxylon</i>, and White Box <i>E. albens</i>.</p> <p>Commonly used lerp infested trees include Inland Grey Box <i>E. microcarpa</i>, Grey Box <i>E. moluccana</i> and Blackbutt <i>E. pilularis</i>.</p>	Moderate	E1	CE	No.	The project will not impact on any 'Important Areas' as referred to in the Threatened Species Profile Database for Regent honeyeater.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
Square-tailed Kite (Breeding) <i>Lophoictinia isura</i>	--	--	--	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. Appears to occupy large hunting ranges of more than 100km ² . Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.	Moderate	V	--	No.	Potential breeding habitat not present within the subject land.
Barking Owl (Breeding) <i>Ninox connivens</i>	--	--	--	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile soils. Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance. Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g. goannas).	High	V	--	No.	Species breeding habitat not present within the subject land.
Powerful Owl (Breeding) <i>Ninox strenua</i>	--	--	--	The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine <i>Syncarpia glomulifera</i> , Black She-oak <i>Allocasuarina littoralis</i> , Blackwood <i>Acacia melanoxylon</i> , Rough-barked Apple <i>Angophora floribunda</i> , Cherry Ballart <i>Exocarpus cupressiformis</i> and a number of eucalypt species. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him.	High	V	--	No.	Species breeding habitat not present within the subject land.
Eastern Osprey (Breeding) <i>Pandion cristatus</i>	--	--	--	Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed over clear, open water. Nests usually within 1km of the sea.	Moderate	V	--	No.	Potential breeding habitat not present within the subject land.
Masked Owl (Breeding) <i>Tyto novaehollandiae</i>	--	--	--	Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	High	V	--	No.	Species breeding habitat not present within the subject land.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
Mammals									
Eastern Pygmy-possum <i>Cercartetus nanus</i>	--	--	--	Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum <i>Pseudocheirus peregrinus</i> dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.	High	V	--	No.	Suitable habitat not present within the subject land.
Large-eared Pied Bat <i>Chalinolobus dwyeri</i>	--	Cliffs Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels.	--	Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin <i>Petrochelidon ariel</i> , frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies.	Very High	V	V	Yes.	Species roosting or breeding habitat not present within the subject land. Potential to forage over study area.
Parma Wallaby <i>Macropus parma</i>	--	--	--	Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest. Typically feed at night on grasses and herbs in more open eucalypt forest and the edges of nearby grassy areas. During the day they shelter in dense cover.	High	V	--	No.	No habitat present within the subject land. No previous records within locality.
Little Bentwing-bat (Breeding) <i>Miniopterus australis</i>	--	--	--	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	Very High	V	--	No.	Species breeding habitat not present within the subject land.
Eastern Bentwing-bat (Breeding)	--	--	--	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	Very High	V	--	No.	Species breeding habitat not present within the subject land.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
<i>Miniopterus schreibersii oceanensis</i>				Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. At other times of the year, populations disperse within about 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia. Hunt in forested areas, catching moths and other flying insects above the tree tops.					
Southern Myotis <i>Myotis macropus</i>	--	Hollow bearing trees Within 200 m of riparian zone Bridges, caves or artificial structures within 200 m of riparian zone	--	Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	High	V	--	Yes.	Hollow bearing trees within 200m of riparian zone.
Squirrel Glider <i>Petaurus norfolcensis</i>	--	--	--	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Feeds on Acacia gum, eucalypt sap, nectar, honeydew and manna, invertebrates and pollen.	High	V	--	Yes.	Marginal habitat present within the subject land. Higher-quality habitat within study area and locality.
Brush-tailed Rock-wallaby <i>Petrogale penicillata</i>	--	Land within 1km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliffines	--	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15 ha. Live in family groups of 2 to 5 adults and usually one or two juvenile and sub-adult individuals. Dominant males associate and breed with up to four females. 6 Breeding is likely to be continuous, at least in the southern populations, with no apparent seasonal trends in births.	Very High	E1	V	No.	No suitable habitat present within the subject land or study area.
Brush-tailed Phascogale <i>Phascogale tapoatafa</i>	--	Hollow bearing trees	--	Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Agile climber foraging preferentially in rough barked trees of 25 cm DBH or greater. Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Females have exclusive territories of approximately 20 - 40 ha, while males have overlapping territories often greater than 100 ha. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use	High	V	--	Yes.	Habitat exists within subject land but is marginal and degraded.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
				many different hollows over a short time span. Mating occurs May - July; males die soon after the mating season whereas females can live for up to three years but generally only produce one litter.					
Koala <i>Phascolarctos cinereus</i>	--	--	--	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Inactive for most of the day, feeding and moving mostly at night. Spend most of their time in trees, but will descend and traverse open ground to move between trees. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery. Females breed at two years of age and produce one young per year.	High	V	V	Yes.	Habitat within subject land, records within subject land.
Koala – Hawks Nest and Tea Gardens population <i>Phascolarctos cinereus</i> – endangered population	--	--	--	Swamp Mahogany and Tallowwood are of primary importance to this Koala population. Other local native tree species used by Koalas include Broad-leaved Paperbark, Blackbutt, Red Bloodwood, Flooded Gum and Smooth-barked Apple. Koalas in this population are found in a range of Eucalypt forest and woodland communities, including coastal forests, rainforest, riparian areas, swamp sclerophyll forests, heathland and shrubland. The Myall River represents a major barrier between Koalas on the eastern Hawks Nest side of the river and the western Tea Gardens side of the river, although occasional movements between these two locations have been known to occur.	High	E2		No.	Study area is not within the endangered population range.
Common Planigale <i>Planigale maculata</i>	--	--	--	Common Planigales inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water. They are active at night and during the day shelter in saucer-shaped nests built in crevices, hollow logs, beneath bark or under rocks. They are fierce carnivorous hunters and agile climbers, preying on insects and small vertebrates, some nearly their own size. They breed from October to January. The female builds a nest lined with grass, eucalypt leaves or shredded bark.	High	V		No.	Habitat substantially degraded. No suitable habitat within subject land. No previous records within locality.
Grey-headed Flying-fox <i>Pteropus poliocephalus</i>	Breeding	--	--	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	High	V	V	No.	Species breeding habitat not present within the subject land.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
				Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops.					
Reptiles									
Pale-headed Snake <i>Hoplocephalus bitorquatus</i>	--	--	--	The Pale-headed Snake is a highly cryptic species that can spend weeks at a time hidden in tree hollows. Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest. In drier environments, it appears to favour habitats close to riparian areas. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees.	High	V	--	Yes.	Tree hollows present within the subject land. Higher quality habitat within surrounding locality.
Stephens' Banded Snake <i>Hoplocephalus stephensii</i>		Hollow-bearing trees or within 500m of this habitat, within 500m of arboreal vine tangles/ Fallen/standing dead timber including logs or within 500m.		Rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Stephens' Banded Snake is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day. At night it hunts frogs, lizards, birds and small mammals.	High	V	--	Yes.	Hollow-bearing trees present within the study area. Higher-quality habitat occurs outside of subject land.
Amphibians									
Wallum Froglet <i>Crinia tinnula</i>	-	-	-	Wallum Froglets are found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They typically occur in sedgelands and wet heathlands. They can also be found along drainage lines within other vegetation communities and disturbed areas, and occasionally in swamp sclerophyll forests. The species breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches. Breeding can occur throughout the year following rain. Wallum Froglets shelter under leaf litter, vegetation, other debris or in burrows of other species. Shelter sites are wet or very damp and often located near the water's edge. Males may call throughout the year and at any time of day, peaking following rain.	Moderate	V		Yes.	Potential habitat exists within the study area, outside the subject land.
Green and Golden Bell Frog <i>Litoria aurea</i> .	--	<ul style="list-style-type: none"> Semi-permanent ephemeral wet areas Within 1km of wet areas swamps Within 1km of swamp waterbodies 	--	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes <i>Typha</i> spp. or spikerushes <i>Eleocharis</i> spp. Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow <i>Gambusia holbrooki</i> , have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas.	High	E1	V	No.	No suitable habitat within the subject land. One very small patch of potentially marginal habitat is located within the study area and will not be impacted. No previous records from the locality.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
		<ul style="list-style-type: none"> Within 1km of waterbody 							
Green-thighed Frog <i>Litoria brevipalmata</i>	--	--	--	<p>Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. It prefers wetter forests in the south of its range, but extends into drier forests in northern NSW and southern Queensland.</p> <p>Breeding occurs following heavy rainfall from spring to autumn, with larger temporary pools and flooded areas preferred. Frogs may aggregate around breeding sites and eggs are laid in loose clumps among waterplants, including water weeds. The larvae are free swimming. The frogs are thought to forage in leaf-litter.</p>	Moderate	V	--	Yes.	Potential habitat exists within the study area, outside the subject land. No previous records from the locality.
Stuttering Frog <i>Mixophyes balbus</i>	--	--	--	<p>Found in Rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Feed on insects and smaller frogs. Breed in streams during summer after heavy rain. Eggs are laid on rock shelves or shallow riffles in small, flowing streams. As the tadpoles grow they move to deep permanent pools and take approximately 12 months to metamorphose.</p>				No.	No suitable habitat within the study area. No previous records from the locality.
Giant Barred Frog <i>Mixophyes iteratus</i>		Land within 50m of semi-permanent and permanent drainages.		<p>Giant Barred Frogs are found along freshwater streams with permanent or semi-permanent water, generally (but not always) at lower elevation. Moist riparian habitats such as rainforest or wet sclerophyll forest are favoured for the deep leaf litter that they provide for shelter and foraging, as well as open perching sites on the forest floor. However, Giant Barred Frogs will also sometimes occur in other riparian habitats, such as those in drier forest or degraded riparian remnants, and even occasionally around dams.</p> <p>Breeding takes place from late spring to summer. Tadpoles grow to about 11 cm and it may take up to 14 months between egg laying and the completion of metamorphosis.</p> <p>Although generally found within about 20 m of the stream, outside the breeding season, the Giant Barred Frog may disperse away from the stream (e.g. 50 m or further).</p>	Moderate	E1	E	No.	No suitable habitat within the subject land. No previous records from the locality.
Mahony's toadlet <i>Uperoleia mahonyi</i>	--	--	--	<p>Current observations indicate Mahony's Toadlet 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, Mahony's Toadlet also is known to occur in wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney Red Gum woodland. Recent studies suggest intact vegetation adjacent to and within water bodies is an important habitat feature for this species.</p>	High	E1	--	No.	No suitable habitat within the subject land. No previous records from the locality.

Species	Habitat type	Habitat constraints	Geographic limitations	Threatened Biodiversity Data Collection habitats (OEH 2018)	Sensitivity to gain class	NSW listing status	Cwth listing status	Candidate species credit species	Rationale
				<p>Known records are associated with shallow ephemeral/semi-permanent water bodies with limited flow of water. Aquatic vegetation at breeding sites includes sedges (<i>Shoenoplectus</i> sp., <i>Baumea</i> sp. and <i>Lepironia articulata</i>) and Broadleaf Cumbungi <i>Typha orientalis</i>.</p> <p>Females have been recorded up to 400 m from water-bodies indicating moderate dispersal distances and use of multiple habitat types.</p> <p>Tadpoles have been observed using leaf litter in the shallow verges of water bodies on sandy substrate. Rocks, logs and leaf litter may also be used for shelter and provide important foraging areas for invertebrate prey items.</p>					
Insects									
Giant Dragonfly <i>Petalura gigantean</i>	--	Within 500m of swamps	--	<p>Live in permanent swamps and bogs with some free water and open vegetation.</p> <p>Adults emerge from late October and are short-lived, surviving for one summer after emergence.</p> <p>Adults spend most of their time settled on low vegetation on or adjacent to the swamp. They hunt for flying insects over the swamp and along its margins.</p> <p>Adults fly over the swamp and along its margins hunting for flying insects.</p> <p>Males sometimes congregate waiting for females to mate with.</p> <p>Females lay eggs into moss, under other soft ground layer vegetation, and into moist litter and humic soils, often associated with groundwater seepage areas within appropriate swamp and bog habitats. The species does not utilise areas of standing water wetland, although it may utilise suitable boggy areas adjacent to open water wetlands.</p> <p>Larvae dig long branching burrows under the swamp. Larvae are slow growing and the larval stage may last 10 years or more.</p> <p>It is thought that larvae leave their burrows at night and feed on insects and other invertebrates on the surface and also use underwater entrances to hunt for food in the aquatic vegetation.</p>	Very High	E1		No.	Study area does not contain suitable swamp habitat.

Candidate species credit flora and fauna species considered likely to inhabit the subject land and therefore requiring targeted survey as per Table 9 above include:

- Charmhaven Apple *Angophora inopina*
- Netted Bottle Brush *Callistemon linearifolius*
- Slaty Red Gum *Eucalyptus glaucina*
- *Eucalyptus parramattensis* subsp. *decadens*
- Small-flower Grevillea *Grevillea parviflora* subsp. *parviflora*
- Noah's False Chickweed *Lindernia alsinoides*
- *Maundia triglochinoides*
- Biconvex Paperbark *Melaleuca biconvexa*
- Tall Knotweed *Persicaria elatior*
- Austral Toadflax *Thesium australe*
- Large-eared Pied Bat *Chalinolobus dwyeri*
- Emu *Dromaius novaehollandiae* (Endangered population)
- Southern Myotis *Myotis macropus*
- Squirrel Glider *Ptaurus norfolkensis*
- Brush-tailed Phascogale *Phascogale tapoatafa*
- Koala *Phascolarctos cinereus*
- Pale-headed Snake *Hoplocephalus bitorquatus*
- Stephens' Banded Snake *Hoplocephalus stephensii*
- Wallum Froglet *Crinia tinnula*
- Green-thighed Frog *Litoria brevipalmata*

No additional species listed under the EPBC or BC Act were considered likely to occur within the study area.

3.6 Threatened species surveys

Targeted flora and fauna survey of the study area were undertaken during 30 - 31 January 2018 and 19 - 22 February 2018. Weather observations for each survey date are shown in Table 11.

Table 10 Weather observations during flora and fauna surveys (Medowie, NSW)

Survey undertaken	Survey date	Temperature (°C)		Humidity %	Cloud (eighths)	Moon (eighths)	Wind	Rain (mm)
		Min.	Max.					
Diurnal bird survey	30/1/2018	17.6	31.8	61	0	0	Light	0 (0 over 7 days preceding)
Diurnal bird survey	31/1/2018	19.3	21.5	88	8	0	Moderate	1.8 (0 over 7 days preceding)
Nocturnal frog and mammal survey, diurnal bird survey	19/2/2018	22	28	66	8	0	Light	0 (4.4 mm over 7 days preceding)
Flora surveys, nocturnal frog and mammal survey, diurnal bird survey	20/2/2018	19	22	59	8	0	Light	32.8 (0.4 mm over 7 days preceding)
Nocturnal frog and mammal survey, diurnal bird survey	21/2/2018	16	25	62	1	2	Light	1.6 (32.8mm over 7 days preceding)
Nocturnal frog and mammal survey, diurnal bird survey	22/2/2018	26	25	45	6	2	Light	0 (34.4mm over 5 days preceding)

Information from the Australia Government Bureau of Meteorology website.

3.6.1 Threatened flora habitat and survey

Habitat for threatened flora species within the subject land is considered to be very limited. Historical and ongoing disturbance in the form of vegetation removal, periodical grass mowing and invasion of dense and smothering exotic plant species has significantly degraded the habitats present. However, Marginal habitat can be found along the west and south boundaries adjacent to moderate and good condition vegetation. Candidate species (as listed in Table 9) are low growing ground-cover species, highly sensitive to this form of disturbance. As such, potential occurrence of these species is considered to be low.

Despite the assessed lack of habitat within the subject land, targeted surveys for threatened flora were undertaken in accordance with the *NSW Guide to surveying Threatened Plants* (OEH 2016). This included a

comprehensive survey of all vegetation zones, along the western and south boundaries and the unnamed creekline using parallel line traverses separated by 10 metres.

Targeted surveys using parallel line traverses extended beyond the western boundary of the subject land to adjoining vegetation (Figure 6). This additional survey was undertaken to determine whether threatened flora populations may occur outside the subject land and have potential to be indirectly impacted (e.g. as a result of edge effects) by the proposed development.

All candidate flora species credit species identified in Table 9 were subject of targeted survey.

Targeted surveys did not record any threatened flora species within the subject land or in adjoining native vegetation.

3.6.2 Fauna habitat assessment and field survey

Fauna habitat assessment was undertaken to determine whether the vegetation to be impacted by the proposed development contained microhabitats suitable to support the threatened fauna species outlined in Table 8 and Table 9 above. The habitat assessments focussed on the presence/absence of the following features within the study area:

- Habitat trees including large hollow-bearing trees, availability of flowering shrubs and feed tree species.
- Condition of native vegetation and the presence of exotic species.
- Condition of waterways and associated habitat for aquatic threatened species.
- Quantity of ground litter and logs.
- Searches for indirect evidence of threatened species (e.g. scats, tracks, etc.).
- General degradation of the site as a result of past land management practices and lack of maintenance.

Fauna habitat within the subject land was found to be significantly degraded due to previous disturbance and the lack of understorey and native ground cover for foraging and shelter. As such, the potential presence of the majority of the listed fauna species outlined above is considered to be on a transient basis only, as they fly over the site foraging as part of their larger home range.

Due to the number and proximity of local records, the connectivity of higher quality habitat within the study area and the potential for fauna to move through the subject land while dispersing or foraging as part of a larger home-range, targeted fauna survey was conducted for threatened fauna listed below:

- Large-eared Pied Bat *Chalinolobus dwyeri*
- Emu *Dromaius novaehollandiae* (Endangered population)
- Southern Myotis *Myotis macropus*
- Squirrel Glider *Ptaurus norfolkensis*
- Brush-tailed Phascogale *Phascogale tapoatafa*
- Koala *Phascolarctos cinereus*
- Pale-headed Snake *Hoplocephalus bitorquatus*
- Stephens' Banded Snake *Hoplocephalus stephensii*
- Wallum Froglet *Crinia tinnula*

- Green-thighed Frog *Litoria brevipalmata*

Targeted surveys were conducted in accordance with State and Federal guidelines which include the BAM and Commonwealth guidelines for threatened frogs, birds and mammals.

Habitat values typically increase with improved vegetation condition in the retained vegetation of the wider study area to the west, south and north. These areas have been assessed as holding a higher potential to support threatened fauna and were targeted to ensure indirect impacts and/or potential movement corridors through the subject land were considered.

The remainder of the subject land supports no fauna habitat of significance. The site has been cleared previously, and currently exists as native and exotic vegetation sparsely covering the site, however, this is not considered to support habitat of any significance to species other than those common to urban/disturbed environments.

Table 12 and Figure 6 outline the fauna survey effort undertaken as part of the current assessment.

Table 11 Fauna survey effort details

Survey undertaken	Survey dates	Target species	Survey effort
Diurnal bird survey and searches for tracks, scats, feathers.	30/1/2018 (am) 31/01/2018 (am) 19/02/18 (pm) 20/02/18 (am) 21/02/18 (pm) 22/02/18 (am)	<ul style="list-style-type: none"> • Emu • Koala 	10 hours (1.25 hours per day x 2 persons)
Spotlighting and call-playback	19/02/18 20/02/18 21/02/18 22/02/18	<ul style="list-style-type: none"> • Squirrel Glider • Brush-tailed Phascogale • Koala • Pale-headed Snake • Stephens' Banded Snake • Wallum Froglet • Green-thighed Frog 	13 hours (1.6 hours per night x 2 persons)
Anabat detectors	21/11/17 22/11/17 05/12/17 09/01/18	<ul style="list-style-type: none"> • Southern Myotis • Large-eared Pied Bat 	4 nights

Six threatened fauna species were recorded outside of the subject land but within the study area during detailed field investigations.

One Koala was recorded to the south-west of the impact area within the Swamp Mahogany- paperbark swamp vegetation (PCT 1718) adjacent to the subject land. This area is mapped as preferred koala habitat in the Port Stephens CKPoM due to the presence of important feed tree species and historic Koala records. The preferred koala habitat to the west of the subject land has potential to be utilised as foraging, breeding and dispersal habitat. Some vegetation within the subject land is likely to be used on occasion for foraging and dispersal and historic Koala records are known from within the subject land. Koala habitat mapped within the subject land is shown in Figure 7. The subject land is considered to be of lower importance to the koala as adjacent areas provide higher-quality resources within preferred koala habitat.

One Powerful Owl was recorded within the study area in the southern portion of PCT 1598. The Powerful Owl is a highly mobile species which forages for arboreal mammals across large areas comprising of a range of habitats (OEH 2017g). It is likely the observed individual forages across the study area; preying on the large population of ringtail possums observed during spotlighting. Two Masked Owls were also recorded within vegetation to the south-west of the study area, the individuals responded vocally to call playback and were then observed to land in tall trees adjacent to the study area.

There are no suitable hollow-bearing trees within the subject land for nesting by either Powerful Owl or Masked Owl and the subject land is considered to contain marginal foraging habitat compared to the adjacent open forest in which both species were observed.

A response to call playback for the Wallum Froglet was observed within the south-western corner of the study area within the swamp vegetation. This species is unlikely to occur within the subject land as there is no suitable habitat available. Suitable breeding and foraging habitat exists within PCT 1718 vegetation.

One White-bellied Sea-eagle was observed flying over the study area during diurnal bird survey. This species forages within lakes, estuaries, coastal lagoons, major rivers and off the coast, their primary food resources are fish. Nests of the white-bellied Sea-eagle are large stick-platforms which are used over multiple years. This species is considered unlikely to utilise the subject land or study area as primary characteristics of breeding habitat include forest with tall-emergent eucalypts within close proximity to foraging habitat (OEH 2017h). The White-bellied Sea-eagle is considered unlikely to utilise the study area as the area does not support foraging or breeding habitat, in addition no nests were located during field investigations.

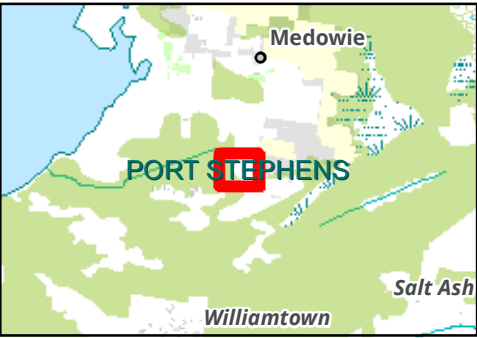
Grey-headed Flying-fox was observed flying over the subject land from the east on all nights of the field investigation and was recorded foraging within Eucalypts spp. and *Melaleuca quinquenervia* within the study area. Individuals flying over and foraging within the study area most likely travel from a small camp located in Moffat's Swamp approximately 3 kilometres north east of the subject land.

Table 10 summarises the results of targeted surveys for candidate species credit species within the subject land.

Table 12 Candidate species credit species Biodiversity Risk Weighting

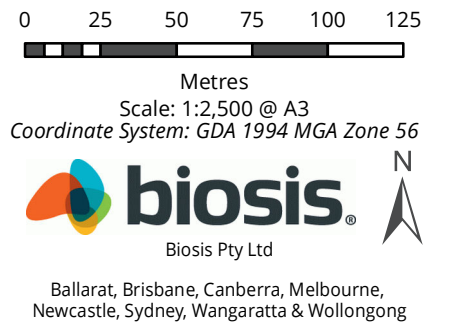
Scientific name	Common name	Presence on site	Habitat feature / component	Biodiversity Risk Weighting
Flora				
<i>Angophora inopina</i>	Charmhaven Apple	No	N/A	1
<i>Callistemon linearifolius</i>	Netted Bottle Brush	No	N/A	2
<i>Eucalyptus glaucina</i>	Slaty Red Gum	No	N/A	2
<i>Eucalyptus parramattensis</i> <i>subsp. decadens</i>	--	No	N/A	2
<i>Thesium australe</i>	Austral Toadflax	No	N/A	1.5
<i>Grevillea parviflora subsp. parviflora</i>	Small-flower Grevillea	No	N/A	2
<i>Maundia triglochinoides</i>	--	No	N/A	2
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	No	N/A	2
<i>Lindernia alsinoides</i>	Noah's False	No	N/A	3

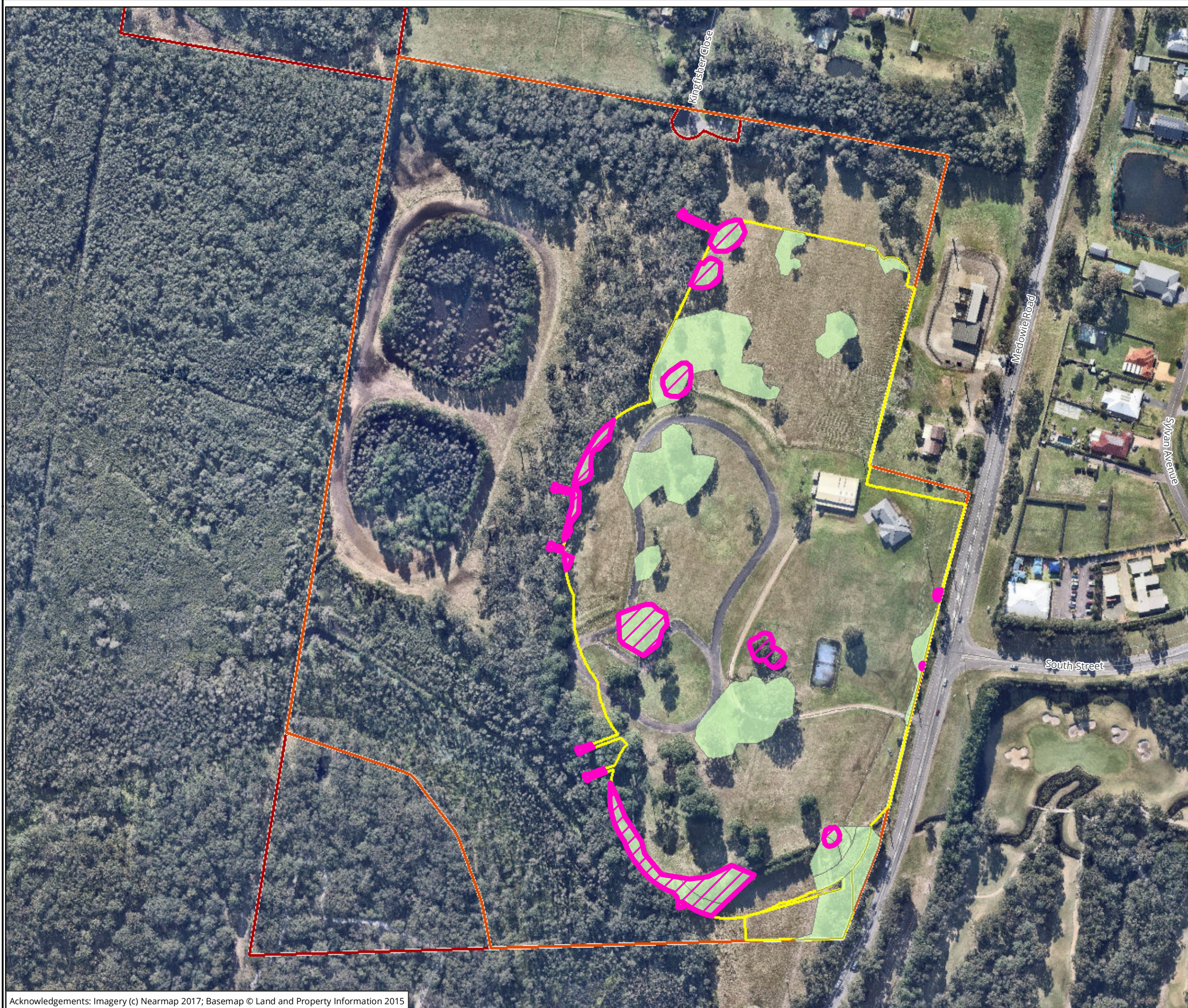
Scientific name	Common name	Presence on site	Habitat feature / component	Biodiversity Risk Weighting
	Chickweed			
<i>Persicaria elatior</i>	Tall Knotweed	No		1.5
Fauna				
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	No	N/A	3
<i>Crinia tinnula</i>	Wallum Froglet	No	N/A	1.5
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	No	N/A	2
<i>Hoplocephalus stephensii</i>	Stephens' Banded Snake	No	N/A	2
<i>Litoria aurea</i>	Green and Golden Bell Frog	No	N/A	2
<i>Litoria brevipalmata</i>	Green-thighed Frog	No	N/A	1.5
<i>Myotis macropus</i>	Southern Myotis	No	N/A	2
<i>Petaurus norfolcensis</i>	Squirrel Glider	No	N/A	2
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	No	N/A	2
<i>Phascolarctos cinereus</i>	Koala	Yes	Preferred koala habitat identified at western edge of subject land as well as isolated feed trees scattered within subject land.	2
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	No	N/A	2



- Legend**
- Subject site
 - Study area
 - Site boundary
 - HydroLine (Biosis 2018)
 - Hollow-bearing tree
 - BAM plots
 - Flora targeted survey tracks
- Fauna survey effort**
- Anabat
 - Call playback
 - Bird survey 1
 - Bird survey 2
 - Bird survey 3
 - Bird survey 4
- Vegetation community**
- PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast
 - PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter
 - PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands
 - PCT 1718 Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast
 - Exotic vegetation (Slash Pine)

Figure 6: Targeted survey effort

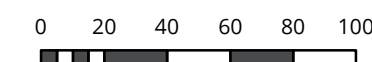




Legend

- Site boundary
- Study area
- Subject site
- Biosis mapped Koala habitat

Figure 7: Koala habitat map



Metres
 Scale: 1:2,400 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



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

Matter: 26652
 Date: 17 April 2018,
 Checked by: ABM, Drawn by: LH, Last edited by: lharley
 Location: P:\26600s\26652\Mapping\
 26652_BB_F7_KoalaHabitat

Stage 2 – Impact assessment (biodiversity values)

4 Avoid and minimise impacts

This section identifies the potential impacts of proposed development on the biodiversity values of the subject land and broader study area and describes measures to avoid and minimise impacts on those biodiversity values.

4.1 Actions to avoid/minimise project impacts

The principal means to reduce impacts on biodiversity values within the study area are to avoid and minimise removal of native vegetation and associated habitat for threatened species. Additionally measures to minimise and mitigate indirect and off-site or downstream impacts during construction and operation of the proposed development have also been identified.

Site selection and planning

The footprint of the subject land has been selected, in part, to minimise impacts to native vegetation and flora and fauna habitats present within the broader study area.

A preliminary assessment undertaken by Biosis in May 2017 identified biodiversity constraints to development across the entirety of Lots 412 and 413 DP1063902. Biodiversity values identified during the preliminary assessment included:

- Vegetation consistent with the Hunter Lowlands Redgum Forest EEC and Swamp Sclerophyll Forest EEC in the western and southern parts of Lot 412 and in the north-eastern of Lot 413 (Figure 4).
- Swamp Mahogany and Forest Red Gum dominated vegetation providing Koala habitat and supporting moderate to high Koala activity (determined on the basis of Koala Spot Assessment Technique survey).
- Presence of preferred Koala habitat, habitat buffers and habitat linking areas within the study area. Remnant vegetation west of the current subject land was identified as Preferred Koala Habitat supporting north / south connectivity of dispersal and foraging habitat for the Koala in the Medowie locality (PSC 2016).
- Potential habitat for several threatened flora species, in particular those associated with waterlogged and/or seasonally inundated swamp and riparian habitats.
- Potential foraging, roosting and breeding habitat for a number of BC Act and EPBC Act listed threatened fauna.
- Presence of a SEPP 14 wetland.

The biodiversity constraints identified during the preliminary assessment were considered in the subsequent concept design and final project design. Key design elements were altered in the early design phase to reduce direct impacts to EEC vegetation and focus impacts within the part of the study area containing non-native vegetation and more heavily disturbed native vegetation.

The subject land is located such that direct impacts to better condition Swamp Sclerophyll Forest EEC and Hunter Lowland Redgum Forest EEC are minimised and the north / south corridor of Preferred Koala Habitat identified in PSC (2016) is maintained. Moreover, indirect impacts to better condition remnant vegetation adjoining the subject land are able to be minimised through careful management of APZ areas which will provide a manageable 'buffer' separating the EEC vegetation from the operational school infrastructure.

The subject lands have been positioned to ensure maintenance of habitat connectivity for Koala and other threatened species by minimising direct impacts to intact remnant vegetation west of the subject land.

By incorporating biodiversity constraints in to the early design phase, the proposed development has been able to restrict direct impacts to:

- Previously cleared Slash Pine and exotic grass dominated non-native vegetation.
- Removal of native vegetation which is heavily disturbed, not consistent with any threatened ecological communities and which provides limited foraging resources for mobile threatened fauna.
- Minor canopy trimming at the edge of better condition Swamp Sclerophyll Forest EEC and Hunter Lowland Red Gum forest EEC.
- Removal of two trees (1 x Rough barked Apple and 1 x Blackbutt) at the edge of the larger patch of better condition Hunter Lowland Red Gum forest EEC west of the subject site.
- Removal of an isolated patch of Hunter Lowland Red Gum forest EEC.

Following the *Controlled activities on waterfront land - guidelines for riparian corridors on waterfront land* (NSW Office of Water, 2012a) a 10 metre vegetated riparian zone (VRZ) should be maintained along either side of the waterway traversing the southern section of the subject land from the top of both banks. Wherever possible works within the VRZ should be avoided so that the existing riparian vegetation is maintained. This recommendation is made in line with the overarching objective of the controlled activity provisions of the WM Act, which is to establish and preserve the integrity of riparian corridors. Further specific recommendations relevant to the proposed development are made, with regards to the specific objectives listed in *Controlled activities on waterfront land - guidelines for riparian corridors on waterfront land* (NSW Office of Water, 2012a) below:

- Road crossings are permitted within the 10 metre VRZ according to the riparian corridor matrix, however the number of access road crossings should be minimised as far as practicable.
- Treat any stormwater run-off prior to discharge into the waterway.
- Locate services and infrastructure outside the VRZ or utilise road crossings wherever practicable.

A range of practical measures to mitigate and manage potential direct and indirect impacts to biodiversity values during the construction and operational phases of the proposed development are described in detail in the following report sections.

Construction

Direct and indirect impacts to biodiversity values retained within the subject land (e.g. winter flowering mature eucalypts and other canopy trees) and adjoining the subject land may occur if adequate mitigation and management measures are not in place during construction of the proposed development.

The following mitigation and management measures are to be implemented in order to mitigate and manage potential direct and indirect impacts during construction:

- Prior to construction, a Construction Environmental Management Plan is to be developed which includes standard measures, including:
 - Installation of appropriate exclusion fencing to the boundary of the retained vegetation and any construction areas where there is some potential for accidental encroachment. This will include appropriate signage such as 'No Go Zone' or 'Environmental Protection Area'. Identification of any 'No Go Zones' in site inductions for all construction personnel.

All site perimeter is to be of a design that excludes terrestrial fauna, in particular Koala, so as to minimise the risk of Koala ingress to the construction site.

Internal fencing / barricades are to be used to establish tree protection zones (TPZs) around retained native trees in accordance with the Standards Australia Committee (2009).

- All material stockpiles, vehicle parking and machinery storage should be located within the areas proposed for clearing, and not in areas of native vegetation that are to be retained.
- Sedimentation and erosion control measures including silt fencing, sediment traps, etc. to prevent sediment-laden stormwater exiting the construction areas and to prevent scouring and erosion of land beyond the development footprint. All erosion and sediment control measures are to be constructed and installed in accordance with relevant guidelines, are to be regularly maintained for the duration of the construction period and are to be carefully removed at completion of works.
- Sediment and erosion control measures should follow recommendations of The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004)
- Dust suppression measures to ensure dust deposition beyond the construction area is minimised.
- Weed and pathogen management including weed hygiene protocols for personnel, machinery and construction materials entering and exiting construction areas to minimise risk of weed and pathogen introduction and spread.
- Waste management is to ensure food scraps and other organic waste that may attract introduced predators (e.g. fox, cats) or other pests (e.g. rats) is not stored for prolonged periods within the construction site.
- Development of an Ecological Management Plan (EMP) for inclusion in the Construction Environmental Management Plan. The EMP will outline measures for staged vegetation clearing to manage fauna species during tree removal, including having a spotter / catcher present. Staged removal involves clearing of understorey vegetation and non-hollow-bearing trees in Stage 1, with removal of hollow-bearing trees in Stage 2. There should be a minimum of 24 to 48 hours between Stage 1 and Stage 2.

Ecologist pre-clearance surveys should including dusk stag watch for microbats with anabat, not greater than one week prior to felling of hollow-bearing trees on site. The project ecologist ecologist is to be present during hollow-bearing trees clearing to manage any microbats or other hollow-dependent fauna that may be present in hollows at time of clearing.

The EMP will detail procedures for dealing with trapped or injured wildlife during the construction period with particular focus on rescue and care of Koalas should an individual gain entrance to the construction site.

- A 10 metre VRZ is to be maintained along either side of the waterway traversing the southern section of the subject land from the top of both banks.
- Road crossings are permitted within the 10 metre VRZ according to the riparian corridor matrix provided in *Controlled activities on waterfront land - guidelines for riparian corridors on waterfront land* (NSW Office of Water, 2012a). The proposed access road crossing is to be constructed with reference to the recommendations made in *Controlled activities on waterfront land - guidelines for watercourse crossings on waterfront land* (NSW Office of Water, 2012b) and the *Policy and Guidelines for Fish Friendly Waterway Crossings* (2003).

- Sediment and silt-screens are to be used to manage instream sedimentation and erosion during construction of the access roads over the unnamed stream in the south of the subject land. Sediment and erosion control measures should follow recommendations of The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004).
- As far as practicable, all construction activities are to undertaken during daylight hours to minimise noise impacts on fauna utilising adjacent habitats.
- Selection and retention of suitable logs (>10 centimetres diameter only) and hollows for placement within retained native vegetation adjoining the subject land.
- Where appropriate native vegetation cleared from the study area should be mulched for re-use on the site, to stabilise bare ground.
- Security lighting within the construction site is to be minimised and where required, is to be oriented such that light spill beyond the subject site and in to patches of retained vegetation is minimised.
- Consideration is to be given to the installation of nest boxes prior to commencement of vegetation clearing for construction. Installation of nest boxes prior to clearing will allow time for microbats and other hollow-dependent fauna to encounter these new resources prior to removal of existing hollows within trees to be removed.
- Establishment of APZs:
 - The establishment of the IPZ surrounding the College will require the removal of non-native trees and shrubs and lopping of some branches of mature native trees in order to achieve the IPZ performance criteria outlined in Newcastle Bushfire Consulting (2018).
 - Establishment of the OPZ will require lopping of canopy branches of some mature native trees within the Swamp Sclerophyll Forest EEC and Hunter Lowland Red Gum forest EEC
 - As far as practicable, establishment of APZs will seek to remove trees not considered Koala feed trees in preference to Koala feed trees.

Operation

- Stormwater generated from roof, hardstand and landscaped areas associated with the college and ancillary areas (e.g. carparks, etc.) is to be detained and treated on-site such that any discharge to the SEPP 14 wetland and associated retained native vegetation west of the subject land is not of substantially different volume relative to the pre-development regime.
- Stormwater infrastructure for the college has been designed to incorporate a mix of Atlantis infiltration tanks and bio filtration detention ponds, gross pollutant traps (GPTs) and pollutant pit inserts (in carpark areas). As such stormwater quality for the existing site will not be compromised by the proposed development. Water quality exiting the subject land will comply with the requirements of the *Protection of the Environment Operations Act 1997* and Port Stephens Council DCP.
- Security lighting for the college is to be located and designed so as to minimise light spill to retained native vegetation and associated habitats beyond the subject land.
- Food waste (e.g. from canteen facilities, playground bins, etc) is to be managed to minimise the availability of this resource to introduced predators such as foxes and cats. Bins are to be of a design that restricts access by introduced pests including introduced predators.

- Regular monitoring and pest treatment of the college and ancillary facilities is to be undertaken to minimise build-up of introduced pest populations within the school boundaries and immediate adjoining areas.
- All perimeter fencing and some internal fencing (e.g. between retained canopy trees) is to be of a 'fauna-friendly' design which minimises potential impacts to gliding arboreal mammals (e.g. sugar gliders) if utilising retained trees within the subject land.
- Lapped and capped timber fencing (or similar) that is impermeable to Koala is to be installed north, west and south of the school to discourage movement of Koalas through the school grounds where they could become trapped. This will encourage Koalas moving east/west through the landscape to use retained habitat north and south of the development.
- Current vehicle speed limits along Medowie Road should be reviewed in consultation with Roads and Maritime Services. It is assumed normal school vehicle speed limit regimes of 40 km/h in the morning and afternoon peak school drop-off / pick-up hours will apply. Retention of the 40 km/h speed limit at all times of day in the vicinity of the college would benefit Koala and other mobile fauna species that occasionally cross Medowie Road and thereby increase the function of the link over cleared land identified in the Port Stephens CKPoM. The speed limit for all internal roads, including the permitter firetrail, is to be 40 kph or lower.
- Appropriate signage warning road users of fauna crossing along internal college access roads and approaches from Medowie Road are to be installed to minimise vehicle – wildlife interactions.
- Landscaping of the college is to use locally native species where practicable to limit the potential spread of weeds in to adjoining retained native vegetation and maximise the foraging resources available for highly mobile species. Where landscaping is undertaken outside the college perimeter fencing, Koala feed trees should be included in landscaping to compensate for loss of Koala feed trees at the locality.
- The presence of Koala and other threatened native fauna within the study area provides exceptional environmental education opportunities for the college which can help to raise awareness of biodiversity and lead to improved biodiversity conservation outcomes. Environmental education could incorporate simple surveys for Koala and other threatened fauna in adjoining bushland as part of the school science curriculum.
- A vegetation Management Plan (VMP) is to be developed to guide the management of retained native vegetation within the College and adjoining APZs. The VMP will describe retention of native vegetation (where appropriate and in accordance with APZ objectives) and the management of weeds, rubbish etc. within APZs, at the boundary between APZs and adjoining native vegetation beyond the subject land and at points of discharge of stormwater infrastructure. The VMP will prescribe measures to minimise fertiliser and herbicide use in situations where chemicals could be transported beyond the subject land.
- A 10 metre VRZ is to be maintained along either side of the waterway traversing the southern section of the subject land from the top of both banks. Wherever possible works within the VRZ should be avoided and the VRZ protected.

4.2 Assessment of unavoidable impacts

Assessment of direct and indirect impacts unable to be avoided has been undertaken in accordance with the BAM (OEH 2017a). The following direct and indirect impacts are unable to be avoided in progressing the proposed development.

4.2.1 Direct impacts

Direct impacts arising from the project include:

- Removal of 0.97 hectares of disturbed *PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast*.
- Removal of 0.11 hectares of moderate condition *PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands*.
- Removal of 0.11 hectares of moderate condition *PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter* consistent with Hunter Lowland Redgum forest EEC listed under the BC Act.
- Removal of 0.04 hectares of moderate to good condition *PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast* consistent with Swamp Sclerophyll forest on coastal floodplains EEC listed under the BC Act.
- Reduction of canopy cover through trimming of canopy tree crowns to achieve APZ objectives across:
 - 0.05 hectares of *PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter* consistent with Hunter Lowland Redgum forest EEC listed under the BC Act (VZ1).
 - 0.17 hectares of *PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast* consistent with Swamp Sclerophyll forest on coastal floodplains EEC listed under the BC Act (VZ3 and VZ4).
 - 0.09 hectares of *PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands* (VZ9 and VZ10).
- Disturbance to understorey and groundcover strata during installation of stormwater outlet pipes across:
 - 0.01 hectares of *PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast* consistent with Swamp Sclerophyll forest on coastal floodplains EEC listed under the BC Act.
 - 0.01 hectares of *PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter* consistent with Hunter Lowland Redgum forest EEC listed under the BC Act.
- Disturbance of 0.34 hectares of land within the mapped boundary of a SEPP 14 Coastal Wetland and 2.1 hectares of land within the buffer to the SEPP 14 Coastal Wetland.
- Removal of 10 Hollow-bearing Trees providing potential roosting for threatened ecosystem credit microbats.
- Removal of a total of 1.55 hectares of native vegetation providing limited foraging resources for threatened fauna.
- Removal of 0.43 hectares of koala habitat predominately within the area mapped within the Port Stephens CKPoM as 100 metres koala habitat buffer and which provides dispersal and shelter habitat. The calculated extent of affected Koala habitat includes all patches of vegetation which contain Koala feed trees and which will be removed as a result of the proposed development.

These impacts will be permanent, will occur from the outset of the development and represent the result of efforts to avoid and minimise impacts at the project design phase. Mitigation measures outlined in Section 4.1 above will help to minimise the potential impacts to biodiversity values that remain present within the study area.

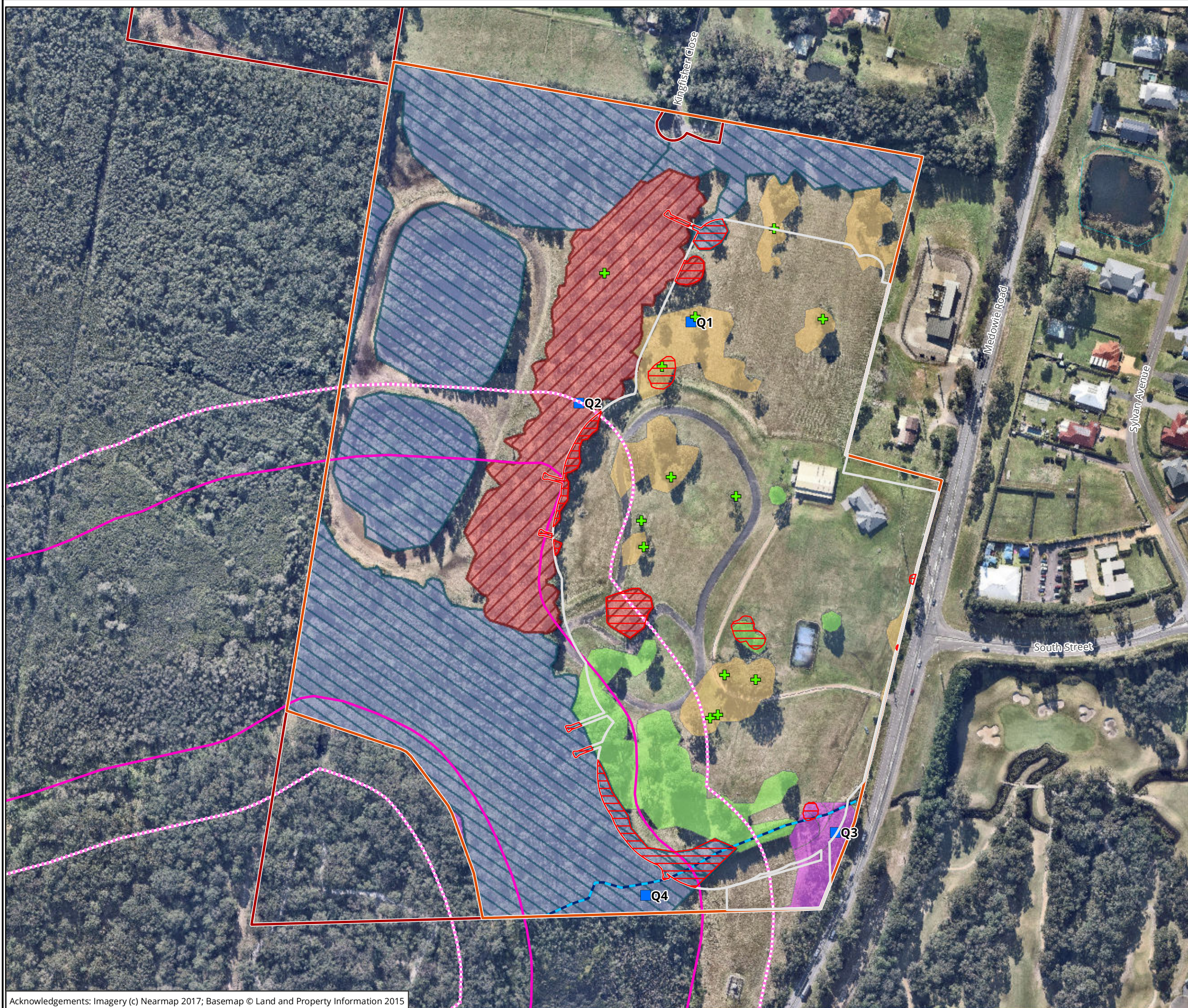
The effect of the above described direct impacts on vegetation integrity of native vegetation within the subject land is summarised in Table 13.

Table 13 Loss in vegetation zone integrity score

PCT	Vegetation Zone	Before development				After development				Change in vegetation integrity	Rationale for change
		Composition	Structure	Function	Vegetation integrity score	Composition	Structure	Function	Vegetation integrity score		
1564	VZ6	12	20.8	66.3	25.5	0	0	0	0	-25.5	Vegetation is to be permanently removed.
1598	VZ1	49.1	42.1	59.4	49.7	49.1	40.5	58.2	48.8	-1	Tree cover decreased from 35% to 20% to account for OPZ requirement of no interlocking canopies. Litter cover reduced from 68% to 30%. All other composition, structure and function values maintained as current shrub cover already low.
	VZ2	49.1	42.1	59.4	49.7	0	0	0	0	-49.7	Vegetation is to be permanently removed.
	VZ5	49.1	42.1	59.4	49.7	7.4	17.4	43.9	17.8	-31.9	Tree richness and cover maintained at 2 and 35% respectively with richness and cover scores for all other strata set to zero to account for clearing of shrub and groundcover during pipe installation. Litter cover and coarse woody debris set to zero to account for removal during pipe installation.
1619	VZ8	23.2	38.8	67.4	39.3	0	0	0	0	-39.3	Vegetation is to be permanently removed.
	VZ9	23.2	38.8	67.4	39.3	23.2	28.4	60.8	34.2	-5.1	Tree cover decreased from 35% to 20% to account for OPZ requirement of no interlocking canopies. Litter cover reduced from 76.6% to 30%. All other composition, structure and function values maintained as

		Before development				After development					
PCT	Vegetation Zone	Composition	Structure	Function	Vegetation integrity score	Composition	Structure	Function	Vegetation integrity score	Change in vegetation integrity	Rationale for change
											current shrub cover already low.
	VZ10	23.2	38.8	67.4	39.3	23.2	21.8	52.2	29.8	-9.5	Tree cover decreased from 45% to 10% to account for IPZ requirement of no interlocking canopies. Litter cover and coarse woody debris reduced to zero. All other composition, structure and function values maintained as current shrub cover already low.
	VZ11	23.2	38.8	67.4	39.3	23.2	38.8	67.4	39.3	0	All scores maintained at pre-development scores as development will not impact vegetation zone.
1718	VZ3	51.5	41.6	79.2	55.4	51.5	21.8	58.3	40.3	-15.1	Tree cover decreased from 45% to 20% to account for OPZ requirement of no interlocking canopies. All other composition, structure and function values maintained as current shrub cover already low.
	VZ4	51.5	41.6	79.2	55.4	51.5	15.9	42.8	32.7	-22.7	Tree cover decreased from 45% to 10% to account for IPZ requirement of no interlocking canopies. Litter cover and coarse woody debris reduced to zero. All other composition, structure and function values maintained as current shrub cover already low.
	VZ7	51.5	41.6	79.2	55.4	10.1	25.6	35	20.9	-34.5	Tree and richness and cover maintained at 2 and 35% respectively with richness and cover

		Before development				After development					
PCT	Vegetation Zone	Composition	Structure	Function	Vegetation integrity score	Composition	Structure	Function	Vegetation integrity score	Change in vegetation integrity	Rationale for change
											scores for all other strata set to zero to account for clearing of shrub and groundcover during pipe installation. Litter cover, coarse woody debris and regenerating stems set to zero/absent to account for removal during pipe installation.
	VZ12	51.5	41.6	79.2	55.4	0	0	0	0	-55.4	Vegetation is to be permanently removed.



Legend

- Site boundary
 - Study area
 - Subject site
 - SEPP 14 Wetlands buffer
 - SEPP 14 wetlands
 - Biosis mapped Koala habitat
 - HydroLine (Biosis 2018)
 - Hollow-bearing tree
 - BAM plots
- Vegetation community**
- PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast
 - PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter
 - PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown
 - Stringybark - Hairpin Banksia heathy open forest of coastal lowlands
 - PCT 1718 Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast
 - Exotic vegetation (Slash Pine)
- Threatened Ecological Community**
- Hunter Lowland Redgum Forest EEC
 - Swamp Sclerophyll Forest EEC

Figure 8: Final project footprint

0 25 50 75 100 125
Metres

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



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

Matter: 26652
Date: 17 April 2018
Checked by: ABM, Drawn by: LH, Last edited by: lharley
Location: P:\26600s\26652\Mapping\26652_BB_F8_FinalFootprint

4.2.2 Indirect impacts

Potential indirect impacts arising from the project are outlined and addressed in Table 14 below. Consideration of indirect impacts was undertaken across an area encompassed by a 1500 metre buffer around the study area and included consideration of the change in land use from the current large lot residential land use to college and associated activities.

Table 14 Assessment of indirect impacts

Indirect impact	Assessment / likelihood of occurrence
Inadvertent impacts on adjacent habitat or vegetation.	The proposed development is unlikely to result in inadvertent impacts on adjacent retained habitat or vegetation. Mitigation measures implemented during the construction and operations phases of the project will ensure no encroachment to adjacent vegetation and habitat by construction workers or students/staff, etc during operation of the college.
Reduced viability of adjacent habitat due to edge effects.	The proposed development will not result in a significant increase in edge effects impacting upon the retained vegetation. The majority of the site has been historically cleared and as such edge effects have been an ongoing impact to the vegetation that is to be retained within the study area. The proposed development will increase edge effects to a small portion of the vegetation present in the southern and western corners of the study area. This vegetation is currently in moderate to good condition and will remain connected to other areas of higher condition vegetation and as such any increased edge effects are expected to result in negligible impacts. The potential for edge effects will be mitigated through implementation of a VMP which will include measures to minimize weed encroachment within APZs bordering adjacent habitat.
Reduced viability of adjacent habitat due to noise, dust or light spill.	Mitigation measures outlined above and standard construction environmental controls will ensure potential impacts are minimised. Light spill from the electrical substation currently occurs within the study area. Security lighting of the construction site and completed college will be designed so as to minimize light spill to adjacent habitat.
Transport of weeds and pathogens from the site to adjacent vegetation.	The potential introduction and spread of weeds and pathogens will be managed through implementation of weed hygiene controls as part of a CEMP during construction. A VMP will be implemented during the operational phase to minimize the risk of weed introduction and spread from the college, associated stormwater infrastructure and APZs to adjacent habitat.
Increased risk of starvation, exposure and loss of shade or shelter.	The proposed development has been carefully positioned away from adjacent habitats and is therefore unlikely to increase the risk of starvation, exposure and loss of shade or shelter.
Loss of breeding habitats.	The proposed development will remove up to 10 hollow-bearing trees. These trees have been assessed as unlikely to be suitable for breeding and as providing only marginal roosting habitat for some threatened species. Two hollow-bearing trees were recorded within the north-western retained vegetation.

Indirect impact	Assessment / likelihood of occurrence
	Potential breeding habitat for the Wallum Froglet occurs within the unnamed stream to the south of the subject land. This habitat will be retained and measures to minimise impacts to the quantity and quality of water within the stream have been outlined in Section 4.1.
Trampling of threatened flora species.	No threatened flora species were recorded within the subject land.
Inhibition of nitrogen fixation and increased soil salinity.	The proposed development will not result in the removal of a substantial area of native vegetation, there is also large patches of vegetation, both within and adjacent to the study area, that will not be impacted. As such it is not considered likely that nitrogen fixation or soil salinity will be impacted such that adjacent habitat will be negatively affected.
Fertiliser drift.	Fertilisers and herbicides are likely to be used during the operational phase to manage landscaped and other open space areas within the College and to manage the APZs surrounding the College. An operational VMP is to be developed which prescribes the types of fertilisers and herbicides permitted for use and the circumstances under which their use is allowed. A key objective of the VMP will be to avoid and minimize the risk of fertilizer and herbicide run-off and drift from the subject land to adjacent vegetation and habitats.
Rubbish dumping.	The CEMP will clearly set out waste management areas and procedures during construction of the College. During the operational phase, the VMP will include measures to monitor and respond to rubbish dumping within the subject land and interface with adjacent vegetation. Construction and operation of the College will increase the security of the study area and likely reduce the potential for rubbish dumping.
Wood collection.	The proposed development is educational in nature and it is considered unlikely those persons who will work at the site will collect wood from the retained vegetation. The heightened security during the construction and operation of the College is likely to deter wood collection activities.
Increase in predatory species populations.	Waste management measures implemented as part of the CEMP and during operation of the College (refer Section 4.1) will mitigate the potential increase in predator species populations.
Increase in pest animal populations.	Rabbits were noted as a pest species within the study area, it is unknown whether this species is currently being controlled within the area however the proposed development is unlikely to result in an increase in the rabbit population on site given it will reduce the extent of open exotic pasture habitat available.
Change in fire regime of native vegetation and associated habitats	The construction and operation of the College is unlikely to lead to a substantial change in the fire regime of adjacent vegetation and habitats. APZs will largely be located within existing highly disturbed areas.
Disturbance to specialist breeding and foraging habitat.	No specialist breeding or foraging habitat occurs within the study area. Foraging habitat exists for Koala, Grey-headed Flying-Fox and Powerful Owl, larger areas of foraging habitat for these species exists outside of the

Indirect impact	Assessment / likelihood of occurrence
	subject land.
Fragmentation of movement corridors.	<p>Vegetation to be removed within the subject land consist of a highly disturbed edge of a fragmented movement corridor linking habitats surrounding the study area to native vegetation to the north and with Tilligerry State Conservation Area to the south. Removal or modification of 1.56 hectares of disturbed vegetation is not considered likely to result in substantial or significant adverse impedance to fauna species that may use the corridor for dispersal.</p> <p>Large areas of better condition vegetation will be retained maintaining the corridor at, or just below, its current width with no expected decrease in overall corridor functionality.</p>
Fencing of the school yard	<p>Fencing surrounding the school will exclude Koala's from the school land to prevent individuals becoming trapped. Boundary fencing to the west, north and south of the College will be of a lapped and capped timber design (or similar) which will effectively exclude Koalas and other terrestrial fauna without posing a risk to fauna. The boundary fencing will mostly follow the outer edge of the perimeter fire trail.</p> <p>All fencing is to be of a fauna-friendly construction such that the risk of entanglement by fauna (e.g. Grey-headed Flying-fox, Sugar Glider, etc.) is minimized.</p>

4.2.3 Prescribed impacts

Assessment of prescribed biodiversity impacts are outlined and addressed in Table 14 below.

Table 15 Assessment of prescribed impacts

Prescribed impact	Assessment / likelihood of occurrence
Impacts of development on the habitat of threatened species or ecological communities associated with karst, caves, crevices, cliffs and other features of geological significance.	No karst, caves, crevices, cliffs and other features of geological significance will be impacted by the proposed works and no threatened species associated with these features were recorded during the assessment.
Impacts of development on the habitat of threatened species or ecological communities associated with rocks.	No bush rock will be impacted by the proposed works and no threatened species associated with this habitat feature were recorded during the assessment.
Impacts of development on the habitat of threatened species or ecological communities associated with human made structures.	No human made structures will be impacted by the proposed works and no threatened species associated with this habitat feature were recorded during the assessment.
Impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation.	<p>0.82 hectares of Slash Pine trees and 6.59 hectares of exotic pasture will be removed or maintained within an APZ as a result of the proposed works. This non-native vegetation within the subject land and broader study area is not associated with habitat of any threatened species known or likely to occur in the locality with the exception of a single Koala feed tree (refer Figure 7). The loss of this tree will result in negligible impacts to the Koala population in the locality.</p> <p>It is possible some highly mobile threatened species including threatened raptors and large forest owls forage in areas of non-native vegetation from time to time however similar habitat is extensive in the locality and subregion. The loss of this non-native vegetation is expected to result in negligible impact to threatened species.</p>
Impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range.	<p>As outlined in Figure 3 an existing movement corridor provides connectivity of habitats occurs within the study area and west of the subject land. This corridor is identified in PSC (2016) as Key Corridor 1 (North – South) and incorporates a majority of connective patches of preferred Koala habitat in the Medowie area (PSC 2016). In addition to its importance to Koala identified in PSC (2016), the majority of threatened species listed in Table 8 and Table 9 likely derive some benefit from this key north – south corridor as it links remnant vegetation north of the study area to bushland within the Tilligerry State Conservation Area. Within the study area, vegetation associated with the corridor is consistent with the Swamp Sclerophyll Forest EEC and Hunter Lowland Redgum Forest EEC.</p> <p>The direct impacts to this movement corridor are restricted to the removal or modification (for APZ establishment and maintenance) of 0.21 hectares of PCT 1718 vegetation and 0.16 hectares of PCT 1598 vegetation contiguous with larger patches of those PCTs to the west of the subject</p>

Prescribed impact	Assessment / likelihood of occurrence
	<p>land. Such an impact is considered negligible when considered at the locality scale and at the bioregional scale.</p> <p>Significant future disruption of this movement corridor may result in severance of connectivity between the habitats within Tilligerry State Conservation and other habitats on the north and west side of the study area, however connectivity will not be severed or substantially impacted by the proposed development.</p> <p>The proposed development will not sever the connectivity present in the broader locality and as such, impacts to species using the corridor is considered negligible.</p>
Impacts of the development on movement of threatened species that maintains their life cycle	<p>The proposed development is not considered to impact on the movement of threatened species that maintains their survival. Species considered likely to utilize the subject land are highly mobile and connectivity will be maintained within remnant vegetation to the north, west and south of the subject land.</p>

Prescribed impact	Assessment / likelihood of occurrence
<p>Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including subsidence or upsidence resulting from underground mining or other development)</p>	<p>The subject land includes approximately 0.34 hectares of a mapped SEPP 14 Coastal Wetland which extends west and south of the subject land and which, based on the results of field survey, provides:</p> <ul style="list-style-type: none"> • Known foraging habitat for Powerful Owl and Masked Owl. • Known foraging and dispersal habitat for Koala. • Known foraging and breeding habitat for Wallum Froglet. • Known habitat for Swamp Sclerophyll Forest EEC and Hunter Lowland Redgum Forest EEC. • Potential habitat for a broad suite of other threatened ecosystem credit fauna species. <p>The wetland is located on waterlogged or periodically inundated alluvial flats associated with coastal floodplain and is sustained by a shallow groundwater regime and surface water inflows from the surrounding landscape. The unnamed stream in the south of the subject land delivers surface flows to the wetland during periods of rainfall.</p> <p>Swamp Sclerophyll Forest EEC is a groundwater dependent ecosystem and is dependent on the groundwater and surface water regime associated with the SEPP 14 wetland. In turn, the Swamp Sclerophyll Forest EEC supports Swamp Mahogany, a preferred Koala feed tree. Field investigations identified dense midstorey and understorey vegetation of the Swamp Sclerophyll Forest EEC within the study area as a key habitat for Ring-tailed Possum <i>Pseudocheirus peregrinus</i> and other arboreal native mammals likely to be important prey species for Powerful Owl and Masked Owl. The Wallum Froglet breeds in swamp habitats such as those available within Swamp Sclerophyll Forest EEC west and south of the subject land.</p> <p>The proposed development is not expected to substantially alter hydrological processes on which the SEPP 14 wetland depends. Construction of the College and associated infrastructure will employ industry standard erosion and sedimentation control measures to mitigate potential for polluted or sediment-laden water to flow beyond the construction area and in to the wetland via the unnamed stream or overland flow. Stormwater infrastructure for the operation of the College has been designed to detain and treat stormwater and other potentially contaminated sources of water on-site, ensuring no substantial change to the quality or quantity of water entering the wetland from the subject land.</p> <p>The construction and operation of the proposed development is not expected to substantially alter the groundwater or surface hydrology that sustains threatened species such as Wallum Froglet and threatened ecological communities such as Swamp Sclerophyll Forest EEC which provides foraging habitat for Koala and large forest owls such as Powerful Owl and Masked Owl.</p>
<p>Impacts of wind turbine strikes on protected animals</p>	<p>The proposed development does not include operation of wind turbines.</p>

Prescribed impact	Assessment / likelihood of occurrence
Impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC	<p>Native vegetation adjacent to the subject land supports foraging and dispersal of Koala. Habitat connectivity for Koala within the study area is mainly north – south via Key Corridor 1 identified in PSC (2016) and discussed in detail above. There is little habitat providing east – west connectivity within the study area, nevertheless, some east – west movement of Koala from the study area east across Medowie Road likely occurs from time to time.</p> <p>The proposed development will increase vehicle movements along Medowie Road during peak school drop-off / pick-up times and therefore may increase the risk of vehicle strikes to Koala. Measures to mitigate the risk of vehicle strike to Koala are to be implemented during construction and operation of the College. These measures will include adequate signage and appropriate speed restrictions in the vicinity of the school as well as increased awareness through construction site inductions and school/community education.</p> <p>Medowie Road is currently an arterial road linking the town of Medowie to other towns such as Raymond Terrace and Wiliamtown and to the city of Newcastle further south. As such, the construction and operation of the College is unlikely to substantially increase the existing risk of vehicle strike to Koala which exists under existing vehicle usage regime. Measures proposed to increase awareness and reduce vehicle speeds in the vicinity of the College are expected to result in an overall negligible increase in risk to Koala from vehicle strike along Medowie Road.</p>

4.3 Adaptive Management Strategy

The proposed development will have only minor direct impacts to biodiversity in the locality and may have some indirect impacts to adjacent habitats. The severity and consequence of direct and indirect impacts are sufficiently well understood that a detailed adaptive management strategy which includes measures to monitor impacts, is not considered necessary. Both the CEMP and VMP will include actions to monitor, assess and adaptively manage the effectiveness of planned mitigation measures.

5 Impact summary

5.1 Thresholds for assessment and offsetting

This section outlines the thresholds for assessment and offsetting in accordance with Section 10 of the BAM.

5.1.1 Serious and irreversible impacts on biodiversity values

No threatened species listed in Appendix 2 or ecological communities listed in Appendix 3 of the *'Guidance to assist a decision-maker to determine a serious and irreversible impact'* (OEH 2017e) have been recorded within the study area or are expected to inhabit the subject land and the proposed development is not considered likely to impact any candidate SAI entity.

5.1.2 Impacts requiring offsets

As outlined in Section 10.3.1 of the BAM, an offset is not required for impacts on native vegetation where the vegetation integrity score is:

- ≥ 15 where the PCT is representative of an endangered or critically endangered ecological community.
- ≥ 17 where the PCT is associated with threatened species habitat (as represented by ecosystem credits), or is representative of a vulnerable ecological community.
- ≥ 20 where the PCT is not representative of a TEC or associated with threatened species habitat.

Impacts native vegetation and threatened species

The proposed development site will result in impacts to:

- 0.97 hectares of PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast.
- 0.17 hectares of the PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter.
- 0.20 hectares of the PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.
- 0.22 hectares PCT 1718 Swamp Mahogany - Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast.
- Impacts to 0.43 hectares of potential Koala habitat.

The vegetation integrity score for all vegetation zones within the subject land is greater than 20 therefore impacts on these four PCTs as well as impacts to Koala habitat will require offsetting. There are no impacts to native vegetation that do not require an offset.

5.1.3 Areas not requiring assessment

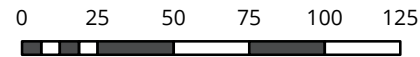
Areas of land not containing native vegetation or threatened species habitat and therefore not requiring assessment are shown in Figure 9.



Legend

- Site boundary
- Study area
- Subject site
- HydroLine (Biosis 2018)
- Areas not assessed
- Impacts requiring offset**
 - Impacts to native vegetation requiring offset
 - Impacts to threatened species requiring offset

Figure 9: Areas requiring offset or not requiring assessment



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

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

Matter: 26652
Date: 17 April 2018
Checked by: ABM, Drawn by: LH, Last edited by: lharley
Location: P:\26600s\26652\Mapping\26652_BB_F10_Offsets

6 Biodiversity credits

This section provides a summary of biodiversity credits required for impacts on the biodiversity values within the development site, following consideration of measures to avoid, minimise and mitigate impacts.

Table 16 and Table 17 provide a summary of ecosystem credit and species credit requirements respectively resulting from the proposed development. The full credit profile is provided in Appendix 3.

Table 16 Summary of ecosystem credits for all vegetation zones.

Vegetation zone	Plant community type	Ancillary description	Area (ha)	Vegetation integrity Loss	Biodiversity Risk Weighting	Candidate SAI	Ecosystem credits required
VZ1	PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter	Moderate_OPZ	0.05	-1	2	No	1
VZ2	PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter	Moderate	0.11	-49.7	2	No	3
VZ3	PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Moderate_OPZ	0.10	-15.1	2	No	1
VZ4	PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Moderate_IPZ	0.07	-22.7	2	No	1
VZ5	PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter	Moderate_Stormwater	0.01	-31.9	2	No	1
VZ6	PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast	Moderate	0.97	-25.5	1.5	No	9
VZ7	PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Moderate_Stormwater	0.01	-34.5	2	No	1
VZ8	PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Good	0.11	-39.3	1.5	No	2
VZ9	PCT 1619 Smooth-barked Apple - Red	Moderate_OPZ	0.05	-5.1	1.5	No	1

Vegetation zone	Plant community type	Ancillary description	Area (ha)	Vegetation integrity Loss	Biodiversity Risk Weighting	Candidate SAI	Ecosystem credits required
	Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands						
VZ10	PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Moderate_IPZ	0.04	-9.5	1.5	No	1
VZ11	PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Moderate	0.04	0	1.5	No	1
VZ12	PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Moderate	0.04	-55.4	2	No	1
Total							23

Table 17 Summary of species credits for all vegetation zones.

Species Credit Species	Vegetation Zone	Area of habitat	Habitat Loss (Vegetation integrity loss)	Biodiversity Risk Weighting	Candidate SAI	Species credits required
Koala <i>Phascolarctos cinereus</i>	VZ1	0.05	-1	2	No	0
	VZ2	0.11	-49.7			3
	VZ3	0.1	-15.1			1
	VZ4	0.07	-22.7			1

Species Credit Species	Vegetation Zone	Area of habitat	Habitat Loss (Vegetation integrity loss)	Biodiversity Risk Weighting	Candidate SAI	Species credits required
	VZ5	0.01	-31.9			0
	VZ6	0.03	-25.5			0
	VZ7	0.01	-34.5			0
	VZ8	0.01	-39.3			0
	VZ12	0.04	-55.4			1
Total						6

7 Strategy to meet biodiversity offset requirements

The total number and classes of biodiversity credits required to be retired for the project are summarised in Table 18 and Table 19 together with the like-for-like credit options as identified through application of the BAM Offsets Calculator.

The Trustees of the Roman Catholic Diocese Maitland – Newcastle propose to discharge the biodiversity offset obligations of the project through the retirement of the full number of like-for-like credits and/or payment in to the Biodiversity Conservation Fund of an equivalent amount calculated using the BAM Offsets Payment Calculator.

Table 18 Summary of like-for-like ecosystem credits required to offset impacts of the project.

PCT code	PCT Name	TEC	Ecosystem credits required	Vegetation Class	Offset trading group	Containing HBTs	IBRA subregions	PCTs
1564	Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast		9	Northern Hinterland Wet Sclerophyll Forests	Tier 7 or higher	Yes	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	690, 697, 698, 755, 1092, 1262, 1267, 1268, 1281, 1385, 1548, 1549, 1550, 1556, 1557, 1558, 1564, 1565, 1580, 1582, 1584, 1585, 1845, 1846, 1847, 1914
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	5	Any PCT of the Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	Tier 3 - Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	Yes		42, 1591, 1598, 1603, 1605, 1691, 1692, 1749.
1619	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands		5	Sydney Coastal Dry Sclerophyll Forests	Tier 7 or higher	Yes		1083, 1138, 1156, 1181,1183, 1250, 1253, 1619, 1620, 1621, 1623,1624, 1625, 1627, 1632, 1636, 1638, 1642,1643, 1681, 1776, 1777, 1778, 1780, 1782,1783, 1785, 1786, 1787
1718	Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	4	Any PCT of the Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Tier 3 - Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Yes		837, 839, 971, 1064, 1092, 1227, 1230, 1231, 1232, 1235, 1649, 1715, 1716, 1717, 1718, 1719, 1721, 1722, 1723, 1724, 1725, 1730, 1795, 1798

Table 19 Summary of like-for-like species credits required to offset impacts of the project.

Threatened Species	Species credits required	Credit class
Koala <i>Phascolarctos cinereus</i>	6	Koala

8 Assessment against biodiversity legislation and policies

8.1 Environment Protection and Biodiversity Conservation Act 1999

An assessment of the impacts of the proposed development on Matters of NES, against heads of consideration outlined in Commonwealth of Australia (2013) was prepared to determine whether referral of the project to the Commonwealth Minister for the Environment is required. Matters of NES relevant to the project are summarised in Table 20.

Table 20 Assessment of the project against the EPBC Act

Matter of NES	Project specifics	Potential for significant impact
Threatened species	12 threatened flora and 20 threatened fauna species have been recorded or are predicted to occur in the locality. As no impacts to significant flora or fauna habitats will result from the proposed development, and no listed species were recorded within the subject land, no impacts to threatened species will result from the project. Significant impact criteria (SIC) assessments have been prepared for two fauna species recorded within the study area; the Grey-headed Flying-fox and the Koala.	Significant impact unlikely to result from the proposed development as per SIC assessments provided in Appendix 4.
Threatened ecological communities	No Threatened Ecological Community listed under the EPBC Act were mapped in the study area.	Significant impact unlikely to result from the proposed development.
Migratory species	21 migratory bird species have been recorded or are predicted to occur in the locality. The study area does not provide important habitat for any of these species.	Significant impact unlikely to result from the proposed development.
Wetlands of international importance (Ramsar sites)	The study area does not flow directly into a Ramsar site and the development is not likely to result in a significant impact.	The proposed development will not result in changes to the ecological character of any Ramsar site.

On this basis, the Matters of National Environmental Significance listed under EPBC Act are not considered to be subject to significant impacts and referral of the proposed development to the Minister for the Environment and Energy will not be required.

8.2 Fisheries Management Act 1994

The proposed development will directly impact 0.34 hectares of the mapped extent of a SEPP 14 Coastal Wetland which is considered Highly Sensitive Key Fish Habitat. None of the directly impacted 0.34 hectares of the mapped wetland supports freshwater or marine aquatic vegetation and the proposed development will

not require the removal of snags. Therefore the proposed development is not considered 'dredging' under the relevant provisions of the FM Act.

Database searches of a 5 kilometre radius surrounding the study area did not return any records of FM Act or EPBC Act listed threatened fish or other aquatic species and none are considered likely to occur within the subject land given the limited and mostly disturbed nature of aquatic habitats available. The unnamed stream provides only *Class 3 – Minimal key fish habitat* for fish passage and is not considered habitat for threatened aquatic species.

The proposed development includes the construction of a single carriageway access road from Medowie Road across the unnamed stream in the southern part of the subject land. The access road is to be constructed at a section of the stream which is already culverted. As such, the proposed access road is not expected to create, or exacerbate existing barriers to fish passage along the unnamed stream.

Mitigation and management measures detailed in Section 4 include measures to minimise sediment and pollutant transport to the SEPP 14 wetland and unnamed stream during construction and operation of the College and associated infrastructure. Provided all measures are implemented in full, the proposed development is unlikely to significantly impact any threatened species, populations or ecological communities listed under the FM Act.

8.3 Water Management Act 2000

The WM Act provides for the sustainable and integrated management of the state's water for the benefit of both present and future generations based on the concept of ecologically sustainable development. Under the WM Act an approval is required to undertake controlled activities on waterfront land, unless that activity is otherwise exempt under Section 91E. Waterfront land is defined within the Act as the bed of any river, lake or estuary and any land within 40 meters of the river banks, lake shore or estuary mean high water mark. One unnamed and unmapped ephemeral waterway traverses the southern section of the subject land. Consultation with DPI Water has clarified that as the waterway is not mapped on the 1:25,000 topographic map for the region, a controlled activity permit for works within waterfront land is not required in this instance.

The WM Act is supported by a series of interpretation guidelines including *Controlled activities on waterfront land - guidelines for riparian corridors on waterfront land* (NSW Office of Water, 2012a). This guideline defines a riparian management envelope referred to as the vegetated riparian zone (VRZ). The width of the VRZ within a riparian corridor has been pre-determined and standardised for first, second, third and fourth order and greater watercourses according to the Strahler System of ordering watercourses and is measured from the top of the highest bank on both sides of the watercourse. This guideline also presents the riparian corridor matrix that assists applicants for controlled activity approvals to identify certain works and activities that can occur on waterfront land and in riparian corridors. The guideline includes overarching management measures for works on waterfront land. Consultation with DPI Water has clarified that while the waterway is not mapped on the 1:25,000 topographic map for the region, DPI Water expects that an appropriate VRZ be maintained along the waterway and the overarching objective of the controlled activity provisions of the WM Act and objectives for riparian corridor management (NSW Office of Water, 2012) be met. Recommendations to ensure that the proposed development meets these criteria have been made in section 4.1.

8.4 Port Stephens Local Environmental Plan (2013)

The project has minimised impacts to native vegetation and flora and fauna habitats and is therefore consistent with the environmental (biodiversity) related objectives of Large Lot Residential (R5), Low Density

Residential (R2) and Rural Landscape (RU2) zoning in the Port Stephens LEP (2013). The proposed activities are listed as Permitted with Consent.

8.5 SEPP No. 14 Coastal Wetlands

The aim of SEPP 14 Coastal Wetland is to ensure that the coastal wetlands of NSW are preserved and protected in the environmental and economic interests of the State. In order to preserve and protect wetlands, the SEPP restricts clearing and other activities within land mapped as SEPP 14 Coastal Wetland where the clearing will be at odds with the stated SEPP objectives.

The subject land contains 0.34 hectares of land mapped SEPP 14 Coastal Wetland including approximately:

- 0.14 hectares of PCT 1718 and PCT 1598 vegetation, and
- 0.20 hectares of non-native, highly disturbed vegetation.

The proposed development will therefore require removal or modification of approximately 0.14 hectares of native vegetation within the mapped extent of the SEPP 14 Coastal Wetland within the study area. The proposed development footprint has been sited so as to avoid and minimise direct impacts to the mapped wetland. Moreover, mitigation measures are to be implemented during construction and operation of the proposed College and associated infrastructure such that the environmental effects of the proposed development are likely to be negligible (refer Section 4).

Taking in to consideration the small area of mapped wetland to be impacted, the predominance of high disturbed non-native vegetation within the mapped extent of SEPP 14 wetland in the subject land and the measures proposed to mitigate potential indirect impacts, the proposed development is not considered to be inconsistent with the aims and objectives of SEPP 14 Coastal Wetlands.

8.6 SEPP No. 44 – Koala Habitat Protection and Port Stephens Council CKPoM

The subject land supports known and/or potential habitat for Koalas. The development is therefore required to demonstrate compliance with SEPP No. 44. As advised by DPE in a response to the SEARS for the project, compliance of the development with the provisions of Appendix 4 of the Port Stephens Council Comprehensive Koala Plan of Management (CKPoM) constitutes compliance with SEPP No. 44.

Koala habitat assessment was undertaken for the development in accordance with the guidelines provided in Appendix 6 of the CKPoM. The results of the habitat assessment are summarised in Table 21 below.

Table 21 Koala habitat assessment

Appendix 6 – Guidelines for Koala Habitat Assessment	Comments	Compliance y/n
Qualifications	Koala habitat assessment for the development was carried out by suitably qualified personnel with experience in tree species identification, biological science, fauna survey and management. Brief curricula vitae for relevant personnel are provided in Appendix 5	Y
Preliminary assessment	Presence of preferred Koala habitat, habitat buffers and habitat linking areas were confirmed as per Koala Habitat Planning Map. Presence of individual preferred Koala feed trees was confirmed within habitat buffers.	Y

Appendix 6 – Guidelines for Koala Habitat Assessment	Comments	Compliance y/n
Vegetation mapping	Vegetation mapping undertaken for the development is provided in Figure 7. LGA vegetation mapping of the site was confirmed to be accurate.	Y
Preferred Koala feed trees	The location of all individual preferred Koala feed trees was mapped where these occurred outside of Preferred Koala Habitat (i.e. within the habitat buffers and habitat linking areas.	Y
Koala habitat mapping	Figure 7 shows Koala habitat mapping in the context of the development.	Y
Koala habitat utilisation	<p>Habitat utilisation within the Preferred Koala Habitat adjacent to the development was assumed to be at >30% given Koalas were recorded in these areas during the surveys and a SAT survey within intact native vegetation of the study area identified moderate to high Koala activity.</p> <p>An adapted SAT methodology was employed within the subject land (i.e. habitat buffer and habitat linking areas) for the development. Minimum density for plots as per the Appendix 6 guidelines (i.e. 1 plot per 1,000m²) could not be achieved given the sparse density of trees present. SAT surveys (including searches for faecal pellets, scratches and presence of Koalas) were therefore undertaken beneath all scattered trees within the subject land for the development. No signs of Koala activity were recorded in any areas of the development footprint. Habitat utilisation within these areas is therefore calculated to be at <30%.</p>	Y

Using the results of the Koala habitat assessment the development was assessed against the performance criteria outlined in Appendix 4 of the CKPoM. The results of this assessment are provided in Table 22 below.

Table 22 Performance criteria assessment

Appendix 4 – Performance criteria	Comments	Compliance y/n
1. Development works cannot be located to avoid removal of koala habitat	Habitat utilisation throughout the current development footprint was calculated to be at <30%. These results could therefore not be used to refine the development layout.	Y
2. Development aims to minimise removal of Koala habitat	Overall the development has been designed to avoid removal of native vegetation, including Preferred Koala Habitat. Where possible, scattered trees within the development footprint will be retained.	Y

Appendix 4 – Performance criteria	Comments	Compliance y/n
4. Koala habitat assessment used to determine development footprint	<p>Koala habitat assessment was undertaken to define Preferred Koala Habitat areas, to identify and map locations of preferred Koala feed trees within habitat buffer and habitat linking areas and to determine Koala habitat utilisation within the project area.</p> <p>The results of the Koala habitat assessment were used to refine the development layout as per points 1 and 2 above.</p>	Y
a. Must minimise removal of vegetation within Preferred Koala Habitat or Habitat Buffers	Vegetation removal within the Preferred Koala Habitat has been avoided. Vegetation removal within the habitat buffer cannot be avoided, therefore request Port Stephens waive this provision given compliance with 1, 2 and 4 above	N
b. Maximise retention and minimise degradation of vegetation within Habitat Linking Areas	Habitat Linking Areas will be maintained north and south of the proposed development. Vegetation removal within the habitat linking area cannot be avoided, therefore some loss of relatively poor quality Habitat Linking Areas will occur.	Y
c. Minimise removal of Koala feed trees	Where possible Koala feed trees will be retained within the development footprint and the proposed development has been designed so as to minimise impacts to preferred Koala habitat.	Y
d. Make provision for restoration of Koala Habitat within Habitat Buffers and Habitat Linking Areas	Weed management and control within APZs as part of a VMP will minimise edge effects on adjacent Preferred Koala Habitat.	Y
e. Make provision for long term Koala habitat management.	A VMP will guide management of native vegetation within the subject land and the interface of the subject land and preferred Koala habitat.	Y
f. Avoid compromising safe Koala movement across the site.	Koala feed trees will be retained as far as practicable and appropriate boundary and internal fencing will be installed to facilitate Koala movement or to safely exclude Koalas where required.	Y
g. Vegetation clearing restricted to building envelopes, infrastructure and fire fuel reduction.	Clearing will be restricted to identified envelopes for buildings and infrastructure and fire fuel reduction zones.	Y
h. Minimise threats from dogs, motor vehicles and swimming pools.	The development will exclude dogs and provide strict speed limits and fencing excluding access to retention basins to avoid danger to children and staff. These measures will also be effective for Koalas.	Y

The development was also assessed for compliance against additional considerations of the CKPoM as well as the Draft Revised Medowie Planning Strategy (PSC 2016). The results of this assessment are provided in Table 23 below.

Table 23 Additional considerations

Provisions	Comments	Compliance y/n
Development application requirements	<p>Koala habitat assessment has been undertaken by suitably qualified personnel in accordance with the guidelines provided in Appendix 6.</p> <p>Clear details of vegetation removal and retention, and the development footprint are provided in the relevant sections of this report.</p> <p>Proposed measures to manage Koala habitat, impacts of dogs and roads and appropriate fencing are outlined in Table 18. Details of these measures will be provided in relevant Landscape Design Plans, Vegetation Management Plans and/or Biodiversity Management Plans for the project.</p> <p>Koala monitoring programs are not required, given the development is not a subdivision.</p>	y
Koala Management Unit requirements	<p>The subject land is located within the Medowie Koala Management Unit (KMU) as mapped in the CKPoM. As per the CKPoM, habitat restoration within the Medowie KMU is recommended 'pending the effective abatement of the threat posed by dogs and traffic'.</p> <p>Restoration of Koala habitat within the development footprint is not recommended as is likely to increase the potential for Koala mortality from traffic collision, given this would restore habitat immediately adjacent to Medowie Road to the east. Further, restoration of koala habitat within the development footprint is unlikely to restore or enhance habitat linkage to the Tomago Sandbeds KMU given the existing threat posed by traffic associated with Richardson Road to the south.</p>	
Draft Revised Medowie Planning Strategy	<p>This provides mapping of Key Koala corridors. The subject land is located adjacent to Corridor 1 (North-South). This corridor links major connective patches of preferred Koala habitat as the 'primary' habitat corridor within Medowie. The development footprint has been located to avoid removal of Preferred Koala Habitat to the west which forms a component of Corridor 1. The development will therefore not result in any severance or reduction to Corridor 1.</p>	y

The results of these assessments have determined that the development will be consistent with the objectives of the Port Stephens Council CKPoM and therefore with SEPP No. 44 provided the recommended safeguards are implemented.

8.7 Biosecurity Act 2015

The Biosecurity Act was enacted to provide for the identification, classification and control of Priority Weeds with the purpose of determining if a biosecurity risk is likely to occur, i.e.:

- The introduction, presence, spread or increase of a pest into or within the State or any part of the State.
- A pest plant has the potential to; harm or reduce biodiversity or out-compete other organisms for resources, including food, water, nutrients, habitat and sunlight.

One Priority Weed for Greater Sydney Region (which includes the Port Stephens LGA) was recorded in the subject land Table 20.

Table 24 Priority Weeds recorded within the subject land

Scientific Name	Common Name	General Biosecurity Duty
<i>Rubus fruticosus</i> species aggregate	Blackberry	<i>Prohibition on dealings</i> <i>Must not be imported into the State or sold</i> All species in the <i>Rubus fruticosus</i> species aggregate have this requirement, except for the varieties Black Satin, Chehalem, Chester Thornless, Dirksen Thornless, Loch Ness, Murrindindi, Silvan, Smooth Stem, and Thornfree.

9 Conclusion

This assessment has been completed in accordance with the BAM methodology on behalf of Webber Architects.

The site assessment identified areas of the following PCTs within the Subject land:

- *PCT 1564 Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast.*
- *PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter.*
- *PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.*
- *PCT 1718 Swamp Mahogany – Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast.*

Two of these PCTs are associated with the following EEC listed under the NSW BC Act:

- PCT 1598 is consistent with the Hunter Lowland Redgum Forest EEC.
- PCT 1718 is consistent with Swamp Sclerophyll Forest EEC.

A total of 12.1 hectares of native vegetation was recorded within the study area; mostly represented by the Hunter Lowland Redgum Forest EEC and Swamp Sclerophyll Forest EEC. Through an iterative design process, which considered the biodiversity values known and likely to occur within the study area, a subject land was identified for the proposed development and ancillary infrastructure that minimises biodiversity impacts to the removal or modification of 1.55 hectares of native vegetation and associated habitat and removal of 10 isolated hollow-bearing trees.

The subject land includes approximately 0.34 hectares of a mapped SEPP 14 Coastal Wetland which includes approximately 0.14 hectares of native terrestrial vegetation and 0.20 hectares of non-native vegetation.

No threatened flora species were recorded within the subject land during field investigation undertaken in accordance with the BAM. Six threatened fauna species were recorded within the study area during field assessment including; Koala, Grey-headed Flying-fox, Powerful Owl, Masked Owl, White-bellied Sea-eagle and Wallum Froglet. No threatened fauna were recorded within the subject land. The subject land is therefore considered likely to provide only marginal foraging habitat for these highly mobile threatened species. No breeding habitat for Grey-headed Flying-fox, Powerful Owl, Masked Owl, White-bellied Sea-eagle and Wallum Froglet occurs within the subject land.

Koala are expected to forage occasionally on feed tree species within the subject land and may disperse across the subject land from Preferred Koala habitat immediately west of the subject land. The proposed development will result in removal of approximately 0.43 hectares of foraging habitat but will not impact habitat connectivity for Koala in the locality.

Measures to avoid and minimise impacts to biodiversity values of the study area were considered during the design and planning stage of the proposed development, resulting in substantial minimisation of direct impacts on native vegetation, especially identified EECs, SEPP 14 Wetlands and Preferred Koala Habitat. Measures to mitigate potential indirect impacts to biodiversity values are detailed in Section 4.

A Significant Impact Criteria assessments in accordance with Commonwealth of Australia (2013) was completed for the Koala and Grey-headed Flying-fox within the subject land. These assessments concluded the project is unlikely to result in any significant residual impacts on EPBC Act listed fauna species provided

appropriate measures to avoid, minimise and mitigate impacts are implemented effectively. Given the proposal is unlikely to have a significant residual impact on any EPBC Act listed fauna species, referral to the Commonwealth Minister of the Environment is not deemed necessary for the current proposal.

Given the minimisation of direct impacts to the mapped extent of the SEPP 14 coastal wetland and Preferred Koala Habitat and given a range of measures will be implemented to ensure indirect impacts are minimised, the proposed development is not considered to be in opposition to the aims and objectives of SEPP 14 - Coastal Wetlands or SEPP 44 - Koala Habitat Protection. Moreover, the proposed development is not expected to significantly impact any freshwater or marine aquatic values listed under the FM Act.

The proposed development will not impact any candidate species or ecological communities at risk of *Serious and Irreversible Impact* as outlined in Section 10.2 of the BAM.

Residual impacts to native vegetation will require retirement of 23 ecosystem credits and 6 Koala species credits in accordance with the Biodiversity Offsets Scheme, as outlined in Table 25 and Table 26.

Table 25 Summary of ecosystem credits.

PCT code	Plant community type name	Ecosystem credits required
1564	Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast	9
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	5
1619	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	5
1718	Swamp Mahogany - Flax leaved Paperbark swamp forest on coastal lowlands of the Central Coast	4
Total		23

Table 26 Summary of species credits.

Species Credit Species	Species credits required
Koala <i>Phascolarctos cinereus</i>	6
Total	6

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Appendices

Appendix 1 Survey methods

A1.1 Nomenclature

The flora taxonomy (classification) used in this report follows the most recent Flora of NSW (Harden 1992, Harden 1993, Harden 2002). All doubtful species names were verified with the on-line Australian Plant Name Index (Australian National Botanic Gardens 2007). Flora species, including threatened species and introduced flora species, are referred to by both their common and then scientific names when first mentioned. Subsequent references to flora species cite the common names only, unless there is no common name, for which scientific name will be used. Common names, where available, have been included in threatened species tables and the complete flora list in Appendix 2.

Names of vertebrates follow the Census of Australian Vertebrates (CAVs) maintained by the Commonwealth Department of the Environment and Energy (DEE) (Commonwealth of Australia 2009). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only.

A1.1 Permits and licences

The flora and fauna assessment was conducted under the terms of Biosis' Scientific Licence issued by the Office of Environment and Heritage under the *National Parks and Wildlife Act 1974* (SL100758, expiry date 31 March 2018). Fauna survey was conducted under approval 11/355 from the NSW Animal Care and Ethics Committee (expiry date 31 January 2019). The BAM Assessment was carried out by Accredited Assessor Sam Luccitti (BAAS17015).

A1.2 Limitations

Ecological surveys provide a sampling of flora and fauna at a given time and season. Factors influencing detectability of species during survey include species dormancy, seasonal conditions, ephemeral status of waterbodies, and migration and breeding behaviours of some fauna. In many cases, these factors do not present a significant limitation to assessing the overall biodiversity values of a site.

The field survey was conducted in summer during warm and variable weather, which is a suitable time to determine the presence of most threatened species. However, specific requirements for heavy rain in detecting Green and Golden Bell Frog were not met due to a lack of rain over the months of November to mid-January 2018, through surveys were timed to follow rain events.

Surveys undertaken, combined with habitat assessments and desktop analysis are considered sufficient to reach the conclusions herein in regards to this and all other species' likelihood of occurrence within the study area.

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

Appendix 2 Native vegetation data (BAM)

A2.1 BAM plot field data

Table A1 BAM plots flora species recorded within the subject land

Family	Scientific Name	Common Name	Quadrat one				Quadrat 2				Quadrat 3				Quadrat 4			
			Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum
Amaranthaceae	<i>Alternanthera denticulata</i>	Lesser Joyweed													HTE	1%	6	GC
Apiaceae	<i>Hydrocotyle bonariensis</i>														E	1%	20	GC
	<i>Trachymene incisa</i>	Trachymene									N	4%	50	GC				
Asteraceae	<i>Ageratina adenophora</i>	Crofton Weed													HTE	1%	2	GC
	<i>Conyza bonariensis</i>	Fleabane									E	1%	1	GC				
	<i>Hypochaeris glabra</i>	Smooth Catsear	E	1%	5	GC												
	<i>Hypochaeris radicata</i>	Catsear									E	1%	3	GC				
Blechnaceae	<i>Blechnum cartilagineum</i>	Gristle Fern													N	10%	50	GC
Commelinaceae	<i>Commelina cyanea</i>	Native Wandering Jew													N	1%	20	GC
Cyperaceae	<i>Gahnia clarkei</i>	Tall Saw-sedge									N	2%	3	GC	10%	N	10	GC

Family	Scientific Name	Common Name	Quadrat one				Quadrat 2				Quadrat 3				Quadrat 4			
			Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum
	<i>Isolepis prolifera</i>														1%	N	20	GC
	<i>Schoenoplectus mucronatus</i>														1%	N	4	GC
	<i>Schoenoplectus mucronatus</i>														1%	N	4	GC
Dennstaedtiaceae	<i>Histiopteris incisa</i>	Bat's Wing Fern													2%	N	10	GC
	<i>Pteridium esculentum</i>	Bracken					1%	N	6	GC	3%	N	9	GC	10%	N	20	GC
Dicksoniaceae	<i>Calochlaena dubia</i>	Rainbow Fern													5%	N	20	GC
Fabaceae (Faboideae)	<i>Kennedia rubicunda</i>	Dusky Coral Pea													5%	N	50	GC
	<i>Pultenaea retusa</i>						1%	N	1	GC								
Fabaceae (Mimosoideae)	<i>Acacia longifolia subsp. sophorae</i>	Coastal Wattle									2%	N	1	S	1%	N	2	S
Goodeniaceae	<i>Dampiera sp</i>	Purple Beauty Bush													1%	N	20	GC
Juncaceae	<i>Juncus prismatocarpus</i>														1%	N	20	GC

Family	Scientific Name	Common Name	Quadrat one				Quadrat 2				Quadrat 3				Quadrat 4			
			Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot	1%	N	1	GC												
Lomandraceae	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush									4%	N	8	GC				
Myrtaceae	<i>Angophora costata</i>	Sydney Red Gum									25%	N	3	OS				
	<i>Angophora floribunda</i>	Rough-barked Apple	25%	N	2	OS												
	<i>Eucalyptus resinifera</i>	Red Mahogany					15%	N	3	OS								
	<i>Eucalyptus robusta</i>	Swamp Mahogany									5%	N	1	OS	30%	N	6	OS
	<i>Eucalyptus tereticornis</i>	Forest Red Gum					20%	N	1	20%								
	<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark													2%	N	6	S
	<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark													5%	N	5	OS
Onagraceae	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Water Primrose													1%	E	6	GC

Family	Scientific Name	Common Name	Quadrat one				Quadrat 2				Quadrat 3				Quadrat 4			
			Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum
Phormiaceae	<i>Dianella caerulea</i>	Blue Flax-lily					1%	N	3	GC	5%	N	20	GC				
	<i>Dianella caerulea</i> var. <i>producta</i>						1%	N	2	GC								
Phyllanthaceae	<i>Breynia oblongifolia</i>	Coffee Bush					1%	N	1	GC								
Pinaceae	<i>Pinus elliotii</i>	Slash Pine									2%	HTE	6	GC				
Plantaginaceae	<i>Plantago lanceolata</i>	Lamb's Tongues	5%	E	100	GC	3%	E	50	GC								
Poaceae	<i>Andropogon virginicus</i>	Whisky Grass	10%	HTE	50	GC	2%	HTE	9	GC	4%	HTE	50	GC				
	<i>Aristida ramosa</i>	Purple Wiregrass					4%	N	50	GC								
	<i>Aristida vagans</i>	Threeawn Speargrass	5%	N	50	GC												
	<i>Axonopus fissifolius</i>	Narrow-leafed Carpet Grass	20%	HTE	500	GC					2%	HTE	50	GC	3%	HTE	50	GC
	<i>Bothriochloa macra</i>	Red Grass	1%	N	1	GC												
	<i>Briza minor</i>	Shivery Grass									1%	E	5	GC				

Family	Scientific Name	Common Name	Quadrat one				Quadrat 2				Quadrat 3				Quadrat 4			
			Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum
	<i>Casuarina glauca</i>	Swamp Oak													10%	N	8	O
	<i>Cynodon dactylon</i>	Common Couch	9%	N	500	GC	5%	N	100	GC	10%	N	500	GC				
	<i>Echinochloa colona</i>	Awnless Barnyard Grass													1%	N	2	GC
	<i>Echinopogon caespitosus</i>	Bushy Hedgehog-grass					1%	N	3	GC	1%	N	8	GC - Ground Cover				
	<i>Entolasia stricta</i>	Wiry Panic					1%	N	3	GC					4%	N	500	GC
	<i>Eragrostis brownii</i>	Brown's Lovegrass	1%	N	7	GC					5%	N	50	GC				
	<i>Eragrostis curvula</i>	African Lovegrass									1%	HTE	4	GC				
	<i>Imperata cylindrica</i>	Blady Grass	5%	N	50	GC	10%	N	50	GC								
	<i>Oplismenus imbecillis</i>						1%	N	5	GC								
	<i>Paspalum dilatatum</i>	Paspalum	15%	HTE	100	GC	5%	HTE	50	GC	2%	HTE	20	GC				

Family	Scientific Name	Common Name	Quadrat one				Quadrat 2				Quadrat 3				Quadrat 4			
			Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum	Cover	N. E or HTE	Abundance	Stratum
	<i>Paspalum urvillei</i>	Vasey Grass													1%	E	3	GC
	<i>Pennisetum clandestinum</i>	Kikuyu Grass	10%	E	100	GC												
	<i>Rytidosperma setaceum</i>	Smallflower Wallaby Grass					5%	N	20	GC								
	<i>Rytidosperma sp</i>	Alpine Grass					10%	N	20	GC								
	<i>Setaria parviflora</i>		8%	E	100	GC												
	<i>Sporobolus africanus</i>	Parramatta Grass	2%	E	20	GC					1%	E	7	GC				
	<i>Stenotaphrum secundatum</i>	Buffalo Grass	5%	HTE	50	GC	1%	HTE	20	GC					3%	HTE	20	GC
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed													2%	N	20	GC
Proteaceae	<i>Persoonia lanceolata</i>	Lance Leaf Geebung									1%	N	3	S				

Family	Scientific Name	Common Name	Quadrat one				Quadrat 2				Quadrat 3				Quadrat 4			
			Cover	N, E or HTE	Abundance	Stratum	Cover	N, E or HTE	Abundance	Stratum	Cover	N, E or HTE	Abundance	Stratum	Cover	N, E or HTE	Abundance	Stratum
Restionaceae	<i>Baloskion tetraphyllum subsp. meioestachyum</i>	Plume Rush									3%	N	10	GC				
Rosaceae	<i>Rubus fruticosus</i>	Blackberry complex					1%	E	2	GC					15%	E	100	GC
Rubiaceae	<i>Pomax umbellata</i>	Pomax									2%	N	100	GC				
Verbenaceae	<i>Verbena bonariensis</i>	Purpletop													1%	E	3	GC
Violaceae	<i>Viola hederacea</i>	Ivy-leaved Violet					1%	N	6	GC								

Notes to table: N: Native, E: Exotic, HTE: High threat exotic. OS: overstorey, S: Shrub layer, GC: groundcover.

A2.2 BAM plot data sheets

BAM Site - Field Survey Form

Site Sheet no: 1 of

Date		Survey Name	Plot Identifier	Recorders	
20/02/18		26652	Q1	ABM	
Zone	Datum	IBRA region	Zone ID		
		NSW NORTH COAST			
Easting	Northing	Dimensions	Orientation of midline		Magnetic °
		20 x 50	110		
Vegetation Class		Northern Hinterland wet sclerophyll Forest			Confidence: H M L
Plant Community Type		1564 Blackbutt - Roughbarked Apple-Turpentine			Confidence: H M L
		EEC: No			

Record easting and northing from the plot marker. If applicable, orient picket so that perforated rib points along direction of midline. *Fairy fern forest*
 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 non-eucalypt (Non Euc) stems separately	
			dbh	Euc*	Non Euc	Hollows†		
Richness of	Trees	1	Mark large tree threshold for Euc* & Non Euc		80 + cm	17	3	* includes all species of Eucalyptus, Corymbia, Angophora, Lophostemon and Syncarpia † Record total number of stems by size class with hollows (including dead stems/trees)
	Shrubs	0	50 - 79 cm	0				
	Grasses etc.	5	30 - 49 cm	✓		0		
	Forbs	1	20 - 29 cm	-		-		
	Ferns	0	10 - 19 cm	-		-		
	Other	0	5 - 9 cm	-		n/a		
Cover of	Trees	25	< 5 cm	✓		n/a	total 2	
	Shrubs	0	Length of logs (m) (≥10 cm diameter, >50 cm in length)		2 m	Tally space		
	Grasses etc.	21						
	Forbs	1						
	Ferns	0						
	Other	0						
High Threat Weed cover		50						

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.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each)	70	75	55	50	25	5	7	10	6	45	0	0	0	0	0	0	0	0		
Average of the 5 subplots	55					14.6					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	FLATPLAIN	Microrelief	
Lithology		Soil Surface Texture	Slaty loam	Soil Colour	BROWN	Soil Depth	
Slope	Gentle	Aspect	WEST	Site Drainage		Distance to nearest water and type	100m

Plot Disturbance	Severity code	Age code	Observational evidence:
Clearing (inc. logging)	3	0	Removal of midstorey and canopy, mown lawn.
Cultivation (inc. pasture)	0		
Soil erosion	0		
Firewood collection	0		
Grazing	0		
Fire damage	0		
Storm damage	0		
Weediness	3	0	High weed cover in the groundcover
Other			

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

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

BAM Site – Field Survey Form

Site Sheet no: 1 of

Date: 20/02/18		Survey Name: 26652	Plot Identifier: Q2	Recorders: A3m	
Zone	Datum	IBRA region: NSW NORTH COAST	Zone ID		
Easting	Northing	Dimensions: 20 x 50	Orientation of midline: 200		Magnetic °
Vegetation Class: SYDNEY COASTAL DRY SUBTROPICAL FOREST		Confidence: (H) M L			
Plant Community Type: 1598 Forest Red gum grassy open Forest		EEC: YES			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
Richness of	
Trees	2
Shrubs	2
Grasses etc.	9
Forbs	3
Ferns	1
Other	0
Cover of	
Trees	35
Shrubs	2
Grasses etc.	38
Forbs	3
Ferns	1
Other	0
High Threat Weed cover	12

BAM Attribute (20 x 50 m plot)	# Tree Stems Count	Record number of living eucalypt* (Euc*) and living non-eucalypt (Non Euc) stems separately
dbh	Euc* Non Euc Hollows†	
Mark large tree threshold for Euc* & Non Euc	80 + cm 1 1 Non Euc Hollows 1	
50 – 79 cm	6	0
30 – 49 cm	✓	0
20 – 29 cm	✓	0
10 – 19 cm	–	–
5 – 9 cm	–	n/a
< 5 cm	–	n/a
Length of logs (m) (≥10 cm diameter, >50 cm. In length)	Tally space	total 1.5

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.

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	80 70 65 75 50	10 15 6 10 5	0 0 0 0 0	0 0 0 0 0
Average of the 5 subplots	68	9.2	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	FLAT PLAIN	Landform Pattern		Microrelief	
Lithology	Soil Surface Texture	CLAY LOAM	Soil Colour	DARK BROWN	Soil Depth	
Slope	Aspect	WEST	Site Drainage		Distance to nearest water and type	50m

Plot Disturbance	Severity code	Age code	Observational evidence:
Clearing (inc. logging)	3	D	MAJOR GRASS
Cultivation (inc. pasture)	0		
Soil erosion	1	NR	BRICK GRASS PATCHES
Firewood collection	0		
Grazing	0		
Fire damage	0		
Storm damage	1	R	SMALL FALLER BRANCHES
Weediness	2	NR	GROUND COVER DOMINANT BY WEEDS
Other	0		

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

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

BAM Site – Field Survey Form

Site Sheet no: 1 of

Date		Survey Name	Plot Identifier	Recorders	
20/02/18		26652	Q3	ABM	
Zone	Datum	IBRA region	Zone ID		
		NSW NORTH COAST			
Easting	Northing	Dimensions	Orientation of midline		
		20x50m	190 Magnetic °		
Vegetation Class		SYDNEY COASTAL DRY SCLEROPHYLL FOREST			Confidence: M L
Plant Community Type		1619 Smooth-barked Apple-Red Bloodwood heathy			Confidence: M L

Record easting and northing from the plot marker. If applicable, orient picket so that perforated rib points along direction of midline. *OPW Forest*
 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
Trees	2
Shrubs	2
Grasses etc.	6
Forbs	3
Ferns	1
Other	0
Cover of	
Trees	30
Shrubs	3
Grasses etc.	25
Forbs	11
Ferns	3
Other	0
High Threat Weed cover	9

BAM Attribute (20 x 50 m plot)		# Tree Stems Count			Record number of living eucalypt* (Euc*) and living non-eucalypt (Non Euc) stems separately * includes all species of <i>Eucalyptus</i> , <i>Corymbia</i> , <i>Angophora</i> , <i>Lophostemon</i> and <i>Syncarpia</i> † Record total number of stems by size class with hollows (including dead stems/trees)
dbh	Euc*	Non Euc		Hollows†	
Mark large tree threshold for Euc* & Non Euc	80 + cm	Euc*	Non Euc	Hollows†	
50 – 79 cm	0 = 4			1	
30 – 49 cm	✓			0	
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 space			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.

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	90 98 95 55 45	15 1 0 0 0	0 0 0 0 0	0 0 0 0 0
Average of the 5 subplots	76.6	2.2	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
	FLAT	FLAT	10m

Plot Disturbance	Severity code	Age code	Observational evidence:
Clearing (inc. logging)	1	0	
Cultivation (inc. pasture)	0		
Soil erosion	1	0	Bare ground patches
Firewood collection	0		
Grazing	0		
Fire damage	2	0	EVIDENCE OF FIRE
Storm damage	2	NR	LARGE FALLEN BRANCHES
Weediness	2	NR	STRONG WEED PRESENCE
Other			

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

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

BAM Site – Field Survey Form

Site Sheet no: 1 of

Date		Survey Name	Plot Identifier	Recorders	
20/02/18		26652	Q4	A3m	
Zone	Datum	IBRA region	Zone ID		
		NSW North Coast			
Easting	Northing	Dimensions	Orientation of midline		
		20x50	30 Magnetic °		
Vegetation Class		Coastal Swamp Forest			
Plant Community Type		1718 Swamp Mahogany-Flax-Logged Paperbark Swamp Forest			
		EEC: YBS			
		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
Richness of	Trees	3
	Shrubs	2
	Grasses etc.	6
	Forbs	3
	Ferns	4
	Other	1
Cover of	Trees	45
	Shrubs	3
	Grasses etc.	18
	Forbs	4
	Ferns	27
	Other	5
High Threat Weed cover		6

BAM Attribute (20 x 50 m plot)		# Tree Stems Count	
dbh	Euc*	Non Euc.	Hollows†
Mark large tree threshold for Euc* & Non Euc	80 + cm	1	1
50 – 79 cm	5		0
30 – 49 cm	✓		0
20 – 29 cm	–		–
10 – 19 cm	✓		–
5 – 9 cm	✓		n/a
< 5 cm	✓		n/a
Length of logs (m) (≥10 cm diameter, >60 cm in length)		Tally space	
		total 5m	

Record number of living eucalypt* (Euc*) and living 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)

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.

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	98 85 90 25 75	2 0 4 0 2	0 0 0 0 0	0 0 0 0 0
Average of the 5 subplots	74.6	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
	FLAT	Clay/humic	Dark Brown
			Poor
			0

Plot Disturbance	Severity code	Age code	Observational evidence:
Clearing (inc. logging)	1	NR	
Cultivation (inc. pasture)	0		
Soil erosion	2	R	Drainage cuts through plots showing signs of erosion
Firewood collection	0		
Grazing	0		
Fire damage	2	R	Tree trunks burnt out
Storm damage	1	R	Fallen branches
Weediness	2	NR	Blackberry dominates some areas
Other			

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

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

Appendix 3 Full Credit Profile



BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id

00009667/BAAS17015/18/00010084

Assessor Name

Alejandro Barreto

Proponent Names

Proposal Name

Medowie Catholic College

Assessor Number

0

Report Created

20/04/2018

Candidate Serious and Irreversible Impacts

No Data

No Data

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

Predicted Threatened Species Not On Site

BAM Biodiversity Credit Report (Like for like)

No Changes

Ecosystem Credit Summary

PCT	TEC	Area	Credits
1598-Forest Red Gum grassy open forest on floodplains of the lower Hunter	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	0.2	5.00
1718-Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.2	4.00
1564-Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast	Not a TEC	1.0	9.00
1619-Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Not a TEC	0.2	5.00

Credit classes for 1564	Like-for-like options			
	Any PCT in the below Class	And in any of below trading groups	Containing HBT	In the below IBRA subregions

BAM Biodiversity Credit Report (Like for like)

	Northern Hinterland Wet Sclerophyll Forests (including PCT's 690, 697, 698, 755, 1092, 1262, 1267, 1268, 1281, 1385, 1548, 1549, 1550, 1556, 1557, 1558, 1564, 1565, 1580, 1582, 1584, 1585, 1845, 1846, 1847, 1914)	Northern Hinterland Wet Sclerophyll Forests - < 50% cleared group (including Tier 7 or higher).	Yes	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Credit classes for 1598	Like-for-like options			
	Any PCT with the below TEC	Containing HBT	In the below IBRA subregions	
	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions (including PCT's 42, 1591, 1598, 1603, 1605, 1691, 1692, 1749)	Yes	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	
Credit classes for 1619	Like-for-like options			
	Any PCT in the below Class	And in any of below trading groups	Containing HBT	In the below IBRA subregions

BAM Biodiversity Credit Report (Like for like)

	Sydney Coastal Dry Sclerophyll Forests (including PCT's 1083, 1138, 1156, 1181, 1183, 1250, 1253, 1619, 1620, 1621, 1623, 1624, 1625, 1627, 1632, 1636, 1638, 1642, 1643, 1681, 1776, 1777, 1778, 1780, 1782, 1783, 1785, 1786, 1787)	Sydney Coastal Dry Sclerophyll Forests - < 50% cleared group (including Tier 7 or higher).	Yes	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Credit classes for 1718	Like-for-like options			
	Any PCT with the below TEC	Containing HBT	In the below IBRA subregions	
	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (including PCT's 837, 839, 971, 1064, 1092, 1227, 1230, 1231, 1232, 1235, 1649, 1715, 1716, 1717, 1718, 1719, 1721, 1722, 1723, 1724, 1725, 1730, 1795, 1798)	Yes	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	

Species Credit Summary

BAM Biodiversity Credit Report (Like for like)

Species	Area	Credits
Phascolarctos cinereus / Koala	0.4	6.00

Phascolarctos cinereus / Koala	1564_Moderate	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus /Koala	Any in NSW
	1598_Moderate	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus /Koala	Any in NSW
	1598_Moderate_OPZ	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus /Koala	Any in NSW

BAM Biodiversity Credit Report (Like for like)

Phascolarctos cinereus/ Koala	1598_Moderate_OPZ		
	1598_Moderate_Stormwater	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus/Koala	Any in NSW
	1619_Good	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus/Koala	Any in NSW
	1619_Moderate	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus/Koala	Any in NSW

BAM Biodiversity Credit Report (Like for like)

Phascolarctos cinereus/ Koala	1619_Moderate_IPZ	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus/Koala	Any in NSW
	1619_Moderate_OPZ	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus/Koala	Any in NSW
	1718_Moderate	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus/Koala	Any in NSW
	1718_Moderate_IPZ	Like-for-like options	
		Only the below Spp	In the below IBRA subregions

BAM Biodiversity Credit Report (Like for like)

		Phascolarctos cinereus/Koala	Any in NSW
	1718_Moderate_OPZ	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus/Koala	Any in NSW
	1718_Moderate_Stor mwater	Like-for-like options	
		Only the below Spp	In the below IBRA subregions
		Phascolarctos cinereus/Koala	Any in NSW

Appendix 4 Significant Impact Criteria assessments

Koala, *Phascolarctos cinereus*

Species background

Koala populations in QLD, NSW and ACT are listed as vulnerable under the EPBC Act. Koalas occupy a range of eucalypt-dominated forest and woodland types throughout their range, but favour habitats that support key forage species in more mesic microhabitats. Altitude (<800m ASL) and temperature restrict the koalas distribution, as does leaf moisture at the western and northern ends of the range (Department of Sustainability, Environment, Water, Population and Communities, 2012).

Key threats to Koala include habitat fragmentation, predation by dogs, vehicle strikes and disease. Climate change may also be affecting Koala populations through increased temperatures causing heat stress and a reduction in the level of moisture within the leaves of browse trees.

Occurrence in the study area

Previous records of Koala's exist within the study area and surrounding locality. Koala habitat has been identified as occurring within the study area and subject land. One Koala was recorded within the study area during habitat assessment and diurnal bird survey.

The study area encompasses 21 hectares of predominantly native vegetation, the subject land is an area of 8.97 hectares comprised of 1.56 hectares of native vegetation predominantly in the form of isolated paddock trees, previously cleared paddock with exotic grasses and an area of pine trees in the south. Koala habitat occurs within the study area in the form of Coastal Swamp Forest (PCT 1718) and Coastal Floodplain Wetlands (PCT 1598). Within the subject land there is a small amount of this habitat located along the western and southern boundary, this comprises 0.22 hectares of PCT 1718, 0.17 hectares of PCT 1598, 0.03 hectares of PCT 1564 and 0.01 hectares of PCT 1619. In addition, scattered paddock trees comprising of known koala feed tree species, exotic trees and trees not known as koala feed tree species occur within the subject land. A total of 0.43 hectares of Koala habitat has been mapped by Biosis within the subject land to be impacted by the proposed development.

An adapted Koala Spot Assessment Technique (SAT) survey was undertaken within the subject land, the SAT technique was applied beneath all scattered trees within the subject land to ascertain Koala activity across the subject land. One additional Koala SAT survey plot was surveyed within the adjacent Preferred Koala Habitat for comparative activity data.

No Koalas or signs of Koala activity were recorded from the SAT surveys, diurnal or nocturnal searches within the subject land. One Koala was recorded during surveys within the study area in land outside of the subject land. The results of SAT surveys indicate that Koala activity within the Preferred Koala habitat adjacent to the subject land was 30%. This suggests that activity within the study area occurs primarily within the higher-quality habitat outside of the subject land.

Habitat to the west of the subject land is mapped as a preferred Koala habitat by the Port Stephens Koala Plan of Management. This corridor links major connective patches of preferred Koala habitat as the 'primary' habitat corridor within Medowie.

Significant impact assessment

An assessment of whether the project impacts are likely to lead to a significant impact on this species is provided below. The significant impact assessment presented below has been undertaken with reference to the avoidance measures already pursued and further impact minimisation and mitigation measures available to the project.

The project footprint has been sited to avoid core areas of remnant native vegetation, which are expected to provide the higher quality habitat for Koala. While the project will remove 0.43 hectares of Koala habitat, this loss has been minimised wherever possible and the overall area of occupancy for the species will remain unchanged. The project will not limit the ability of Koalas to move between habitat patches, does not constitute a barrier to movement and will not fragment populations. It is unlikely that habitat within the subject land constitutes habitat critical to the survival of the species and this habitat will not be adversely affected to the extent that it would result in a substantial decline in the species. The project will not interfere substantially with the recovery of the Koala.

This assessment has determined that a referral to the Australian Government Minister for Environment is not recommended.

Koala, (*Phascolarctos cinereus*), vulnerable species - assessment against Significant Impact Criteria (CoA 2013)

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
Lead to a long-term decrease in the size of an important population of a species	Unlikely	While the proposal will result in the removal of potential foraging and breeding habitat for Koala, the total area of habitat being removed is small in relation to the amount of retained, and non-impacted habitat. The subject land has been aligned to avoid areas of high-quality koala habitat and movement corridors where Koalas are more likely to occur. Given the scale of the impact in the context of available habitat in the region, and the retention of vegetation to the west of the subject land to maintain habitat corridors it is unlikely that the proposed development will lead to a long-term decrease in the size of an important Koala population.
Reduce the area of occupancy of an important population	Unlikely	The species is likely to be relatively widespread, but patchily distributed in larger consolidated blocks of remnant native vegetation within the locality. Due to the relatively localised and limited amount of habitat affected by the proposal, the overall area of occupancy for Koala is likely to remain unchanged. The species will continue to forage and breed in retained habitat either side of the cleared construction footprint and the completed construction will not represent a barrier to the movement of individuals.
Fragment an existing important population into two or more populations	Unlikely	The koala occurs from Queensland through to the Victorian boarder, the proposed construction is not at the limit of the species range. The local population is not part of an endangered population. The subject land is well connected to preferred koala habitat to the south and west, to the east of the subject land is Medowie

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
		<p>Road and to the north are residential dwellings with cleared paddocks and patches of remnant vegetation. Koalas are capable of moving large distances between preferred feeding locations.</p> <p>The construction footprint is largely sited within previously cleared areas and will remove a small area of foraging and dispersal habitat. The proposed development will avoid areas of good connectivity within high-quality habitat to the west of the subject land. The development will not limit the ability of the species to move through the landscape from north to south. Medowie road is an existing barrier to dispersal however some movement across Medowie Road likely occurs from time to time. The proposed development will not substantially reduced east west movement of Koalas across Medowie Road.</p> <p>Taking the above in to consideration, the local koala population will not be fragmented or isolated as a result of the proposed development.</p>
Adversely affect habitat critical to the survival of the species	Unlikely	<p>Approximately 0.2 hectares of preferred koala habitat mapped within the subject land as defined by the Port Stephens KPOM. Habitat critical to the survival of the Koala as defined in <i>EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)</i> (Commonwealth of Australia, 2014) occurs within the study area. Using the koala habitat assessment tool in Table 4 of the referral guidelines, it is considered likely some remnant vegetation within the subject land would constitute habitat critical to the survival of Koala.</p> <p>Using the criteria in Figure 2 of Commonwealth of Australia (2014) the project is considered to adversely affect Koala habitat for the following reasons:</p> <ul style="list-style-type: none"> • The impact area contains habitat critical to the survival of the koala. • The area to be cleared contains known koala feed trees. • Less than 2 hectares of habitat (0.43 hectares) will be cleared. <p>The project area has been sited to avoid as far as possible key areas of Koala habitat in the consolidated blocks of preferred koala habitat to the south and west.</p> <p>0.43 hectares of Koala habitat will be affected by the project, the impacts associated with the clearing will not significantly increase the level of fragmentation.</p> <p>Given the above information and using Figure 2 of Commonwealth of Australia (2014) a referral is not</p>

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
		recommended.
Disrupt the breeding cycle of an important population	Unlikely	While the project may result in the removal of vegetation occupied by the species, including individuals that are breeding, the project will not result in the disruption to the breeding cycle of any local koala population or the species as a whole. It is unlikely that disturbance from noise or lighting associated with the construction and operation of the school will substantially interfere with the species' ability to reproduce successfully. Koalas will continue to breed in areas unaffected by vegetation loss and as a result the breeding cycle of an important population will not be disrupted.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely	<p>Koalas are assumed to be present at low densities within the subject land. The project will only impact a 0.43 hectares of mostly disturbed habitat with larger areas of better condition habitat available in the broader landscape.</p> <p>The project is not likely to isolate populations as the development will not significantly impact on the koala corridor and is not likely to constitute a barrier to movement. While the project will result in the removal of scattered trees, some of which are likely to be used by the species, this level of loss is not likely to result in the decline of the species at a national scale.</p>
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely	Feral animals, including introduced predators, and plants are known or likely to be well established in the project area. Some of these are known to negatively impact koalas including dogs and foxes. However it is unlikely that the project would result in the establishment of new species. The proposed action is unlikely to exacerbate the current level of invasive species threat operating within the project area. Industry standard weed and pathogen hygiene procedures will prevent the spread of pathogens such as <i>Phytophthora cinnamomi</i> .
Introduce disease that may cause the species to decline	Unlikely	The project is unlikely to result in the introduction of a disease (e.g. Clamydia) that could reduce the reproductive output of Koala populations in or near the project area.
Interfere substantially with the recovery of a species	Unlikely	<p>Actions considered likely to substantially interfere with the recovery of Koala are defined in <i>EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)</i> (Commonwealth of Australia, 2014) as follows:</p> <ul style="list-style-type: none"> Increasing koala fatalities in habitat critical to the survival of the koala due to dog attacks to a level that is likely to result in multiple, ongoing mortalities. Increasing koala fatalities in habitat critical to the survival of the koala due to vehicle-strikes to a level that

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
		<p>is likely to result in multiple, ongoing mortalities.</p> <ul style="list-style-type: none"> Facilitating the introduction or spread of disease or pathogens for example <i>Clamydia</i> or <i>Phytophthora cinnamomi</i> to habitat critical to the survival of the koala, that are likely to reduce the carrying capacity of the habitat. Creating a barrier to movement to, between or within habitat critical to the survival of the koala that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala. Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term. <p>The project will not result in increased dog attacks, which are primarily an issue where new urban development encroaches upon Koala habitat. While the project can be expected to result in an increase in traffic in some areas during the construction and operational phases, mitigation measures will be implemented such that sustained increases in Koala road mortalities is unlikely. The project will also result in higher level of traffic after completion during school times (8am-10am, 2pm-4pm). As this will occur during the day and result in reduced speed limits around the school zone this is unlikely to constitute an increased threat to Koalas. The project is unlikely to result in the introduction of a disease (e.g. <i>Clamydia</i>) that could reduce the reproductive output of Koala populations in or near the project area. Similarly, the project is unlikely to exacerbate the current level of invasive species threat operating within the project area. High standards of machinery wash-down will prevent the spread of pathogens such as <i>Phytophthora cinnamomi</i>. The development will not constitute a barrier to the movement of Koalas between habitat patches and therefore will not restrict the species' ability to disperse or carry out normal demographic processes. The project is not expected to result in substantial changes to hydrology which would result in degradation of any critical habitat to the extent that the carrying capacity of that habitat is reduced.</p> <p>The project is therefore unlikely to substantially interfere with the recovery of the Koala.</p>

Grey-headed Flying-fox, *Pteropus poliocephalus*

Species background

Grey-headed Flying-foxes are listed as Vulnerable under the EPBC Act and as Vulnerable under the BC Act in NSW. They occur within 200km of the eastern coast of Australia from Rockhampton in Queensland to Adelaide in South Australia (OEH, 2017f).

Adult Grey-headed Flying-foxes forage over a large area and can travel up to 50km in one night (OEH, 2017f) but more often forage within 20km of their roost site (CoA, 2017). They feed on blossom and fruit of primarily canopy vegetation including Eucalyptus, Corymbia, Angophora, Melaleuca, Banksia and Ficus species. Adults may migrate in response to changes in the amount and location of food as these resources are not annually reliable and may occur at different times in different locations (CoA, 2017). The Grey-headed Flying-fox roost most often in communal camps which are generally located within 20km of regular foraging resources and are often located along water-courses, mating and breeding occurs within these camps with conception occurring in April or May and young born in October or November.

Although separate camps exist and the species is spatially structured into colonies, the Grey-headed Flying-fox is a highly mobile species with genetic exchange occurring between camps, this species is considered as one continuous population (Department of the Environment, 2018).

Nationally significant camps are defined as camps occupied by >10,000 Grey-headed Flying-foxes in more than one year in the last 10 years or occupied by 2,500 Grey-headed Flying-foxes permanently or seasonally every year for the last 10 years (CoA, 2015).

Key threats to the Grey-headed Flying-fox include Habitat loss and fragmentation (loss of roosting and foraging sites), exploitation (culling of individuals due to conflict with farmers), electrocution on power lines and entanglement in netting and barbed wire, heat stress, and a lack of knowledge of the species (DoE 2018, OEH 2017f).

Occurrence in the study area

The study area encompasses 21 hectares of predominantly native vegetation, the subject land is an area of 8.97 hectares comprised of 1.56 hectares of native vegetation predominantly in the form of isolated paddock trees, previously cleared paddock with exotic grasses and an area of pine trees in the south. Two Grey-headed Flying-fox camps are located within 10km of the subject land, one in Raymond Terrace to the west and one at Moffats Swamp to the east. The camp located at Raymond Terrace is a nationally significant Flying-fox camp.

Within the study area potentially significant winter foraging resources exist in the form of Swamp Mahogany and Melaleuca species. These resources are unlikely to be significantly impacted by the proposed development as they occur largely outside of the development footprint with only 0.22 hectares occurring on the subject land to be removed or modified.

Grey-headed Flying-foxes were recorded flying over the study area from the east to the west, they were not recorded foraging within the study area. Foraging Grey-headed Flying-foxes were located to the south-west of the study area within private bushland. These animals were noted to be foraging on flowering eucalyptus species over four nights during targeted fauna survey.

Significant impact assessment

An assessment of whether the project impacts are likely to lead to a significant impact on this species is provided below. The significant impact assessment presented below has been undertaken with reference to the mitigation and management measures already pursued.

Although only observed flying over during the current assessment, foraging may occasionally occur within the subject land. The subject land has been selected to avoid areas of core, in-tact remnant vegetation which are expected to provide the higher quality habitat for Grey-headed Flying-fox. The project will remove a very small area of potential habitat and the overall area of occupancy of this species will remain unchanged. The project will not interfere substantially with the recovery of the Grey-headed Flying-fox.

Grey-headed Flying-fox, (*Pteropus poliocephalus*), vulnerable species - assessment against Significant Impact Criteria (CoA 2013)

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
Lead to a long-term decrease in the size of an important population of a species	Unlikely	While the proposal will result in the removal of potential foraging resources for Grey-headed Flying-fox, the total area of habitat being removed is small in relation to the amount of retained, and non-impacted habitat. Also, the subject land has been sited to avoid large areas of consolidated forest and woodland which the species prefers and where more significant foraging resources occur. Given the scale of the impact in the context of available habitat in the region, it is unlikely that it will lead to a long-term decrease in the size of an important Grey-headed Flying-fox population.
Reduce the area of occupancy of an important population	Unlikely	<p>The species is highly mobile and relatively widespread, roosting and maternity sites are well documented and conspicuous. No roosting or breeding habitat was recorded during field assessment.</p> <p>Due to the small area and limited number of potential feed trees to be removed, and the higher-quality habitat which was observed to be in use by foraging Grey-headed Flying-fox during field survey, the overall area of occupancy of the species will remain unchanged.</p> <p>The species will continue to forage in retained habitat either side of the construction footprint and the development will not represent a barrier to the movement of individuals.</p>
Fragment an existing important population into two or more populations	Unlikely	<p>The national population of the Grey-headed Flying-fox is considered a single population as it is a highly mobile species. The subject land is a small area of previously modified and cleared land surrounded by higher-quality habitat. It is surrounded to the south and west by more in-tact remnant forest and swamp vegetation including protected land of the Tilligerry State Conservation Area, and by rural residences with relatively scattered clumps of remnant vegetation to the north. Areas to the east include a golf course and Moffats Swamp Nature reserve.</p> <p>The proposed development will not impact on the nationally significant flying-fox camp located approximately 9km west in the town of Raymond Terrace.</p> <p>The proposed development will remove 1.56 hectares of native vegetation and will not fragment the population.</p>

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
Adversely affect habitat critical to the survival of the species	Unlikely	<p>Habitat critical to the survival of the Grey-headed Flying-fox includes important breeding and foraging resources. Breeding occurs within camps, two camps are located within 10km of the study area. One of these is a nationally significant camp located within 10km to the west of the study area, the other camp is located approximately 2km to the east. Limiting foraging resources may constitute habitat critical for the survival of Grey-headed Flying-fox and may include areas with highly productive winter flowering tree species.</p> <p>It is considered unlikely that remnant vegetation within the subject land would constitute habitat critical to the survival of the Grey-headed Flying-fox for the following reasons:</p> <ul style="list-style-type: none"> • No camps will be impacted by the proposed development. • Remnant vegetation within the subject land is considered unlikely to be selected as a roosting site in the future as vegetation occurs at the edge of a clearing and consists of relatively isolated paddock trees. • The subject land has been selected to avoid identified areas of potentially important foraging resources for the Grey-headed Flying-fox including Swamp Mahogany and Melaleuca species.
Disrupt the breeding cycle of an important population	Unlikely	<p>While the project may result in the removal of vegetation utilised for foraging by the species, including individuals that are breeding, the project will not result in the disruption to the breeding cycle of any local Grey-headed Flying-fox population or the species as a whole. It is unlikely that disturbance from noise or lighting associated with the construction and operation of the College will substantially interfere with the species' ability to reproduce successfully as the subject land is not within close proximity to breeding areas. Grey-headed Flying-foxes will continue to breed in camps unaffected by vegetation loss and as a result the breeding cycle of the population will not be disrupted.</p>
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely	<p>Grey-headed Flying-foxes are assumed to utilise the study area on occasion for foraging. The project will only impact a small number of trees which may provide foraging resources at certain times of the year. The proposed development will not impact on any existing camps and is unlikely to have an impact on the nationally significant camp located at Raymond Terrace as this small patch is unlikely to produce sufficient foraging resources to support a large number of Flying-foxes. There exists higher-quality resources within in-tact native vegetation to be retained surrounding the subject land, therefore the project will only impact a very small number of resources within the</p>

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
		<p>broader landscape.</p> <p>The subject land is considered unlikely to be suitable for future use as a camp as it does not support habitat features associated with Flying-fox camps.</p> <p>The proposed development will remove 1.56 hectares of native vegetation, this will not fragment or isolate the population as it is a small area, surrounding vegetation to be retained is well-connected to large areas of native bushland including protected reserves and due to the highly mobile nature of the species.</p> <p>While the project will result in the removal of scattered trees, some of which may be used by the species, this level of loss is not likely to result in the decline of the species at a national scale.</p>
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely	<p>There are a large number of feral animals and plants that are known or likely to be well established in the study area. Some of these have potential to negatively impact Grey-headed Flying-fox including foxes and dogs. However it is unlikely that the project would result in the establishment of new species. The proposed action is unlikely to exacerbate the current level of invasive species threat operating within the project area.</p>
Introduce disease that may cause the species to decline	Unlikely	<p>The project is unlikely to result in the introduction of a disease that could reduce the reproductive output of Grey-headed Flying-foxes in or near the project area.</p>
Interfere substantially with the recovery of a species	Unlikely	<p>Actions considered likely to substantially interfere with the recovery of the Grey-headed Flying-fox as determined by key threats to the species (DoE, 2017) are as follows:</p> <ul style="list-style-type: none"> Habitat loss and fragmentation including important foraging species such as Melaleuca species, Forest Redgum and Swamp Mahogany. <ul style="list-style-type: none"> Winter Foraging resources are limited to a narrow coastal strip in QLD and northern NSW. Spring foraging resources are considered critical to the survival of the species. Exploitation – shooting of Grey-Headed Flying-foxes to protect fruit crops involves death of the individual and indirect death as a result of shooting of pregnant and lactating females. Competition and hybridisation – indirect competition by Black Flying-fox which has had a range expansion in the past. Pollutants, electrocution and pathogens. A disproportionately higher number of lactating females are killed by electrocution on power lines.

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
		<p>The project will not fragment habitat for the Grey-headed Flying-fox and will not significantly contribute to the loss of habitat as it will result in the removal of only 1.56 hectares of native vegetation. Vegetation to be removed is not considered to comprise of significant foraging resources. Vegetation to be retained in the surrounding area comprises of species considered as potentially important spring and winter foraging resources including Melaleuca species, Swamp Mahogany and Red Gum species.</p> <p>The proposed development will not result in activities likely to result in exploitation of the species as the development is a College. The proposed development is not likely to increase incidence of competition or hybridisation.</p> <p>The project is therefore unlikely to substantially interfere with the recovery of the Grey-headed Flying-fox.</p>

Appendix 5 Curricula vitae for relevant personnel

Position

Senior Botanist

Qualifications

BEnvSc (Hons)

NSW BioBanking Assessor No. 0237



Professional experience

Samuel has over 10 years of experience as a field botanist and ecological advisor, which was gained while working within the environmental consulting and mining sectors. He is skilled in the design and execution of targeted threatened flora surveys, vegetation mapping and threatened fauna habitat assessment both in New South Wales and Western Australia. Samuel has a deep knowledge of the biodiversity legislation with extensive experience implementing the biodiversity assessment methodology, preparing biodiversity assessment reports under both the previous and current legislation and developing biobanking sites.

Samuel is also experienced in the design and implementation of ecological monitoring programmes for a variety of significant environmental features such as conservation of significant flora, fauna and ecological communities and groundwater dependent vegetation, as well as the design of appropriate biodiversity offset programmes to meet state and federal requirements. Samuel provides technical direction and advice on key biodiversity issues relevant to infrastructure and mining project approvals and operations and has established a strong link with external technical experts and regulatory agencies to ensure a best practice approach to all work.

Key project experience

Project Manager/Ecologist

Biosis is currently undertaking detailed biodiversity assessments in accordance with the NSW Framework for Biodiversity Assessment (OEH) and Major Projects offset policy to support an Environmental Impact Assessment of the approximately 15 km long proposed Coffs Harbour Bypass route. The project is a declared State Significant Development under Section 115U of the Environmental Planning and Assessment Act 1979. The project includes the compilation of a comprehensive set of management plans for key biodiversity elements potentially impacted by the proposal.

Project Manager/Ecologist

Targeted survey for the threatened Leafless Tongue Orchid within known and potential habitat at a location in Warnervale on the NSW Central Coast. The project included a review of literature pertaining to the Leafless Tongue Orchid and its wasp pollinator and the

development of recommendations to Central Coast Council to guide future management of known and potential habitat in the context of planned residential and industrial development of the locality.

Project Manager

BioBanking Statement for a Development site at Eleebana and BioBanking Agreement for a Biobank site at Valentine for Lake Macquarie City Council.

Project Manager/Ecologist

Biosis was engaged by Hill View Property Development to source Cumberland Plain Land Snail (CPLS) species credits under the NSW Biobanking Scheme. Biosis identified an existing Biobank site at which snail credits could be generated and undertook necessary desktop assessment and field survey to support an application to the NSW Office of Environment and Heritage to vary the existing Biobanking Agreement and generate CPLS species credits.

Ecologist

Conducting biodiversity assessment including utilizing the new biodiversity assessment methodology and including plant identification, plant community type identification and searches for threatened flora for a large-scale project in western NSW.

Project Manager

Completion of a flora and fauna assessment for the proposed soil remediation of a future Town Centre in West Dapto, south west of Wollongong. The assessment included targeted survey of abandoned buildings identified as providing potential habitat for several microbat species. The flora and fauna assessment report incorporated recommendations to mitigate potential impacts to microbats through the provision of alternative roosting habitat on and off site.

Project Manager/Ecologist

Biosis was engaged by Doma Group to complete targeted surveys for the Golden Sun Moth (GSM), Perunga Grasshopper and Hoary Sunray and to update vegetation surveys of natural Temperate Grassland at the former CSIRO headquarters in Campbell, ACT. The field survey supplemented a desktop review of existing information pertaining to the site and will be used to complete documentation for assessment of a proposed residential development under the Commonwealth EPBC Act.

Project Manager

Biosis was engaged by Doma Group to complete targeted surveys for the Golden Sun Moth in areas of known and potential habitat within the Canberra Brickworks site, Yarralumla, ACT.

Project Manager/Ecologist

Development of a conservation management plan for an urban remnant patch of the NSW and Commonwealth listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland critically endangered ecological community in Goulburn, NSW. The conservation management plan will direct on-going management of remnant vegetation and was praised by Goulburn Mulwaree Council for its high standard and comprehensiveness.

Project Manager/Ecologist

Flora and fauna assessment and analysis of ecological constraints to inform the design of a Neighborhood Plan within the West Dapto Release Area. Ecological constraints to development including the

presence of endangered ecological communities, threatened species habitats and local and regional biodiversity corridors were identified and communicated to the project team through the provision of detailed and accurate maps and GIS-integrated spatial data as well as concise written reports.

Project Manager/Botanist	Application of the NSW Biodiversity Banking Assessment Methodology to develop a Biodiversity Assessment Report in support of a Biobanking Statement for residential subdivision of a 6 hectare parcel of land in the south west of Sydney. The project included negotiations with Wollondilly Shire Council and the Office of Environment and Heritage in order to refine the scope of the assessment and subsequent Biobanking Statement.
Project Manager	Terrestrial flora and fauna monitoring of potential subsidence impacts due to longwall mining in the Southern Coal Fields of the Illawarra. Provided management oversight and technical input into the design, implementation and reporting of an ecological monitoring required to meet key environmental compliance requirements.
Project Manager/Ecologist	Development and implementation of a 5 year Commonwealth biodiversity offset plan for the Yandicoogina Iron Ore Project Expansion to offset impacts to Northern Quoll and Pilbara Olive Python. A partnership was established with the WA Department of Environment and Conservation to deliver feral predator control and threatened species monitoring over 140,000 ha in the western Pilbara bioregion of Western Australia.
Project Manager/Ecologist	Management of an arid zone riparian ecosystem monitoring program across the Fortescue and Hamersley subregions of the Pilbara bioregion in order to detect and monitor mining-related hydrological and hydrogeological impacts to groundwater dependent ecosystems. A Digital Cover Photography technique was used to monitor changes in riparian eucalypt health over time in response to seasonal, and mining-induced changes in surface and groundwater availability. The monitoring program was a key component of ecological monitoring for regulatory compliance of several large iron ore mines.
Ecologist	Technical advice into the development of an ecosystem monitoring program for a highly restricted, purportedly groundwater dependent priority ecological community in the central Hamersley Ranges of Western Australia. Established a tree health monitoring program for the dominant, assumed groundwater dependent tree species characteristic of the ecological community. A comprehensive ecosystem health monitoring program was established in collaboration with the University of Western Australia's Ecosystem Research Group.
Senior Advisor	Provided technical direction and advice to the Rio Tinto Iron Ore (WA) Environmental Approvals team and other internal stakeholders on key biodiversity issues relevant to mining and infrastructure project approvals and operations.

Specialist Advisor

Critically reviewed biodiversity and ecosystem services components of the Oyu Tolgoi Copper Mine Environmental & Social Impact Assessment to ensure compliance with Performance Standard 6 of the International Finance Corporation. Liaised with senior management, expert biodiversity consultants and international lending institutions (IFC, EBRD, EDC) to deliver a set of agreed project commitments on biodiversity impact mitigation.

Publications

Page G, **Luccitti S**, English J, Archibald R, Grierson P (in prep.). Seasonal and daily cycles of stem radial variation of *Eucalyptus victrix* in a boom-bust environment. Symposium presentation to the 2014 Ecological Society of Australia Annual Conference, Alice Springs, Northern Territory.

Grierson P, O'Donnell A, Page G, Sadler R, Bowler K & **Luccitti S** (2012). Dynamics of tussock grasslands in semi-arid northwest Australia – insights from long-term ecological research. Poster presentation to the 17th Biennial Australian Rangelands Society Conference, Kununurra, Australia.

Professional affiliations and memberships

Ecological Society of Australia

Position

Botanist

Qualifications

BBiotech Bot

DipCALM

**Professional experience**

Alejandro has a background in plant tissue culture, including research and development, micro propagation techniques and laboratory procedures. For the last three years, Alejandro has acquired experience in flora/fauna surveying and assessment, environmental restoration, bio banking assessments, vegetation management and project management. Alejandro commenced his career with Biosis in March 2016 as an Ecologist in our Newcastle office.

Alejandro has been involved in a wide range of projects throughout NSW, which have included ecological assessments, biodiversity assessments (BioBanking), floristic surveys, vegetation mapping, targeted threatened flora surveys, review of environmental factors, offset strategies, vegetation management plans, and monitoring plans.

His key experience consists of ecological investigations projects that include reporting, project management and client liaison. Alejandro also has experience in report writing such as review of environmental factors and monitoring reports.

Key project experience

Botanist	Biodiversity Assessment including targeted surveys for threatened species for the proposed Goonumbla Solar Farm at Parkes for Geolyse on behalf of Renewable Energy Consultancy.
Ecologist/Botanist	Coffs Harbour Bypass Biodiversity threatened species Survey and BioBanking Assessment for ARUP on behalf of Roads and Maritime Services (2016-2017)
Botanist	Biodiversity Assessment including targeted surveys for threatened species for the proposed Walgett Solar Farm at Walgett for Geolyse on behalf of Epuron Island GP Management Pty Ltd.
Botanist	Targeted Biodiversity surveys for Nyngan In Ground Storage project for Bogan Shire Council.

Botanist	BioBanking Assessment of wetland communities (Yamba, NSW). This project involved the development of an accurate vegetation community map for the area. Over 5 vegetation communities were identified and described within 5 ha area.
Botanist	Monitoring of the Vegetation Rehabilitation at Tanilba Northern Dune for Sibelco Australia, Oyster Cove, NSW. This project involved the biannual monitoring of the mine rehabilitation areas over a period of ten years reporting on the growth, species richness and floristic structure within these communities.
Botanist	Annual Monitoring of Native Rainforest communities around Donaldson Coal mine (Ashtonfield, NSW). This project involves flora monitoring of the offset areas around the mine site, and reporting on the growth, species richness and floristic structure within these communities.
Project Manager/Ecologist	Wetland studies and vegetation mapping for the proposed precast workshop and 39 Old Punt Road, Tomago NSW for Stephen Rose Architects on behalf of Civmec.
Project Manager/Botanist	Flora and Fauna Assessment for the proposed Medical Centre at 275 Vincent Street Cessnock, NSW for Archadia Projects Pty Ltd.
Project Manager/Botanist	Flora and Fauna Assessment for the proposed raw material storage, car park at 50 Gardiner Street Rutherford, NSW for Fulton Hogan Industries Pty Ltd.
Project Manager/Botanist	<i>Tetratheca juncea</i> survey and mapping, Eraring Power Station, NSW. Targeted surveys of <i>Tetratheca juncea</i> (Black-eyed Susan).
Project Manager/Botanist	Biodiversity Assessment in support of the Environmental Impact Statement (EIS) for the proposed Yarraman Abattoir at Wybong, NSW for KMH on behalf of FJT Australia Pty Ltd.

Other project experience

Project Manager	Weed control of Mine Rehabilitation areas (Denman, NSW). This project involved selective control of Galenia weed within the Rehabilitation area, works mapping and progress report for Mangoola Coal Glencore
Ecologist	Aquatic ecological impact assessment to inform the preparation of a remedial action plan at a former landfill site, Milperra NSW for Environmental Earth sciences.
Project Manager/Ecologist	Review of Environmental Factors (REF) Rusty Lane Road Upgrade (Branxton, NSW). This project involved the preparation of an REF report for Singleton Council NSW.
Project Manager/Ecologist	Vegetation Management Plan (VMP) for 52 Harris Street (Cameron Park, NSW). This project involved the preparation of a VMP report prior development for Palmer Bruyn Pty Ltd.
Project Manager/Botanist	Weed Action Plan 2016 (WAP) for Oceanic Coal Australia Limited (OCAL) landholdings and buffer lands at West Wallsend and Teralba (NSW). This project involved the mapping of weeds of national significance and noxious weeds within OCAL lands and preparation of a WAP to manage and prioritize weed control strategies for 2016.
Ecologist	Green and Golden Bell Frog Compensatory Habitat Construction Supervision at Kooragang Island (NSW). This project involved the capture, identification and relocation of fauna affected by the earthworks activities during the project for the Newcastle Coal Infrastructure Group.

Other qualifications and training

Advanced Plant Identification skills for Research and Environmental Assessment, University of New South Wales

Derived Grassland Workshop (Teresa James)

Diploma in Information Technology, Kent Institute Sydney

Eucalypt, Grasses and Sedges/Rushes Identification (Van Klaphake)

Landscape Function Analysis (David Tongway)

Working Safely at Heights (Life & Rescue International)

Australian Defence Security Clearance

Fauna Spotter Catcher Training (Risk Response + Rescue NSW)

Senior First Aid

4WD driving and vehicle recovery

Occupational Health and Safety General Induction for Construction Work in NSW, Work Cover

Professional affiliations and memberships

Ecological Consultants Association of New South Wales (ECANSW)

Position

Zoologist

Qualifications

BEnvMgt



Professional experience

Carl has 15 years' experience as a consulting ecologist and zoologist working throughout New South Wales, Queensland and Tasmania. Carl commenced working as a consultant ecologist in 2002 and has since gained extensive experience conducting flora and fauna surveys, and preparing impact assessments, management and monitoring plans for a wide range of residential, infrastructure, renewable energy and extractive industries projects.

Carl prides himself on his identification skills and knowledge of Australian fauna, based on a life long passion for observing and studying wildlife spanning over 40 years. His strengths are in fauna survey and management, having undertaken numerous field surveys employing a wide range of methods in the course of his career.

Carl has extensive experience in New South Wales including the Sydney Metropolitan Area, Hunter, Illawarra, central-west, south-west and northern New South Wales. Carl also has extensive experience working in south-east Queensland, the Bowen and Galilee Basins of central and western Queensland and the Mt Isa region of north-west Queensland. Carl has also worked on fauna monitoring programs in north-eastern Tasmania.

Carl has completed training as a BioBanking Assessor and has experience facilitating a number of conservation offset arrangements in NSW with the application of BioBanking Assessment Methodology.

Key project experience

Zoologist

Preclearance assessments and advice, clearing supervision, monitoring, and preparation of biodiversity, microbat and nest box management and habitat connectivity plans for the NorthConnex project for Lend Lease Bouygues Joint Venture on behalf of Roads and Maritime, Sydney, NSW.

Zoologist

Preclearance assessments and advice, clearing supervision, monitoring, and preparation of fauna and nest box management plans for the Northern Beaches Hospital Connectivity and Network Enhancement project for Ferrovial York Joint Venture on behalf of Roads and Maritime, Sydney, NSW.

Zoologist	Preclearance assessments and advice and clearing supervision for Stage 1 of the Narellan Road Upgrade project for Seymour Whyte on behalf of Roads and Maritime, Sydney, NSW.
Project Manager / Zoologist	Preclearance assessments and advice and clearing supervision for the Brighton Lakes development project for Mirvac.
Project Manager / Zoologist	Preparation of nest box management plan, and installation and monitoring of nest boxes for the Sydney Metro Northwest skytrain project for Impregilo-Salini Joint Venture on behalf of Transport for NSW.
Zoologist	Preclearance assessments and advice and clearing supervision for the Tuggerah Intersection Upgrade project for Seymour Whyte on behalf of Roads and Maritime, Sydney, NSW.
Project Manager / Zoologist	Vegetation Management Plan and Revegetation Compensation Package for the C.B.D. to south east light rail project for KHM Environmental on behalf of Transport for NSW.
Project Manager / Zoologist	Biodiversity Constraints and Opportunities assessment for the proposed Ultimo School project for NSW Public Works.
Zoologist	Fauna assessment and EPBC Act Referral (Koalas) for Brandy Hill Quarry expansion SSD. Biosis has completed an assessment in accordance with the Framework for Biodiversity Offsets (FBA) and has determined offset requirements using the credit calculator.
Zoologist	Flora and fauna survey and reporting to support an Environmental Impact Statement for proposed upgrade works and alterations, proposed for the Kurnell Refinery Conversion, Botany Bay for Caltex Pty Ltd via URS Pty Ltd.
Zoologist	Conducting bird monitoring for Musselroe Wind Farm, Tasmania.
Zoologist	Conducting fauna surveys for the Nimmie Caira Project, south-western NSW.
Zoologist	Fauna habitat surveys and nest box management plan for the Woolgoolga to Ballina Pacific Highway upgrade.
Project Manager / Zoologist	Development of a Fauna Monitoring Program for Liverpool City Council to be implemented throughout council reserves within the Liverpool LGA.
Zoologist	Flora and fauna assessment of slope stabilization works along the Bells Line of Road at Mt Tomah
Project Manager / Zoologist	Pre-clearing fauna assessment of proposed construction site at Anzac Parade, Moore Park

Other qualifications and training

BioBanking Assessor Accreditation Training Course
EPBC Act Environmental Offsets Policy and Offsets Assessment Tool Training Course
Wildlife identification and handling
Grasses Identification (Van Klaphake)
Senior First Aid
Rail Industry Worker Induction Card
Advanced 4WD driving and vehicle recovery
Work Safely at Heights Training
Occupational Health and Safety General Induction for Construction Work in NSW, Work Cover

Publications

Richard, J. and **Corden, C.** 2005. Notes on terrestrial shelter sites selected by Green-striped Frog *Litoria alboguttata* on Curtis Island, central coastal Queensland. *Herpetofauna* **35**(2).

Professional affiliations and memberships

Ecological Consultants Association of New South Wales (ECANSW)
Southern Ocean Seabird Study Association (SOSSA)

Position

Field zoologist

Qualifications

BSc (Hons)

**Professional experience**

Sarah joined Biosis in July 2016, with 2 years of experience in the Ecology sector. Sarah is experienced in fauna surveys, small scale removal and reintroduction of fauna and assessments of vegetation community structure. Sarah's key tasks include management of small projects, field survey, preparation and writing of proposals and reports, survey planning and organisational support. Sarah also has a strong skills in background research, data entry and data analysis.

Sarah's project experience includes targeted surveys for mammals, birds, frogs and orchids, throughout New South Wales and parts of South Australia, Northern Territory and Western Australia. Sarah has also recently assisted with fieldwork for biobanking projects. Her previous experience as a research assistant have built strong data entry and management skills in addition to fauna-based field skills including DNA sampling, pit-tagging, euthanasia, radio tracking and animal husbandry.

Prior to working with Biosis Sarah completed an Internship assisting in the long term monitoring of an endangered population of long-nosed bandicoots and re-introductions of bush rats following the removal of black rats. Sarah has further experience in conducting behaviour experiments with the use of giving up densities, infra-red cameras and the JWatcher program for the analysis of footage.

Key project experience

Field Zoologist	Brookfield tunnel inspection and microbat report to Hunter Water Corporation.
Field Zoologist	Targeted fauna survey at Taylor Bay for Port Stephens Council.
Field Zoologist	Targeted fauna survey at Warners Bay for De Witt consulting.
Field Zoologist	Project management and report production for the Investigation of two White-bellied Sea-eagle nests at Wadalba over the 2017 breeding season for Central Coast Council.

Field Zoologist	Report production and assistance with field investigations for the 2016-2017 Wadalba Wildlife Corridor fauna survey for Central Coast Council.
Research assistant	Nest Box monitoring for Kimbriki Environmental Enterprises.
Research assistant	Targeted Cryptostylis hunteriana survey for Central Coast Council.
Research assistant	Targeted survey for Squirrel Glider, Grey-crowned Babbler and Brush-tailed Phascogale for R. W. Corkery & Co Pty. Ltd.
Research assistant	Coffs Harbour Bypass targeted fauna surveys including bat, frog and mammal survey for Arup Pty Ltd.
Research assistant	Nocturnal fauna survey and data collation for Kimbriki Environmental Enterprises.
Research assistant	Biobanking field data collection and collation for Kimbriki Environmental Enterprises.
Research assistant	Targeted Orchid survey for Biobanking project in Valentine and Eleebana for Lake Macquarie City Council.
Research assistant	Desktop research for Flora and Fauna Assessments for proposed Yarraman Abattoir and Feedlot for KMH Environmental.
Research assistant	Proposal, desktop research and report writing for an asset protection zone for the proposed Chisholm Childcare Centre for Quinn O'Hanlon Architects Pty Ltd.
Research assistant	Completed assessments of significance (TSC Act) for proposed in-ground storage tanks at Nyngan for NSW Public Works Department of Finance and Services.
Research assistant	Desktop research for Flora and Fauna Assessments for Lots 1-12 Forster, Butmaroo, King and Majura Streets, Bungendore, NSW for Fraish Consulting.
Research assistant	Desktop research for proposed Northwood Retirement Village in Tenambit for De Witt Consulting.
Research assistant	Desktop research, field assessment and report writing including assessments of significance (TSC Act) and significant impact assessment (EPBC Act) for the proposed medical center in Cessnock, NSW for Archadia Projects.
Research assistant	Land access management (ongoing) for Ecology and Heritage field investigations for the proposed Coffs Harbour Bypass for NSW Roads and Maritime Services.
Research assistant	Field assessment and data collation of hollow bearing trees for Kimbriki Environmental Enterprises.

Research assistant	Desktop research for proposed Leachate Treatment Plant and rising main to sewer for Kimbriki Environmental Enterprises.
Research assistant	Desktop research for Balranald solar site project for Overland Sun Farming.
Research assistant	Background research and White-Bellied Sea Eagle monitoring for Central Coast Council.
Other project experience	
Intern Ecologist	Long-nosed Bandicoot monitoring including genetic sampling and pit-tag insertion, for Australian Wildlife Conservancy.
Intern Ecologist	Secondary Bush-rat re-introduction and black-rat removal at North Head Sanctuary for Australian Wildlife Conservancy.
Research Assistant	Assisting with field fauna and flora surveys and behavioral experiments including equipment maintenance and volunteer training for multiple projects with the University of New South Wales.

Other qualifications and training

Wildlife identification and handling
Remote Area First Aid

Professional affiliations and memberships

Hunter Bird Observers Club

Position

Field zoologist

Qualifications

BSc (Hons1)

Ph.D Biology

Professional experience

Samantha has four years of experience in the Ecology sector. She is experienced in targeted fauna surveys, habitat assessments and fauna handling. Samantha's key tasks include management of small projects, field survey, preparation and writing of proposals and reports.

Prior to working with Biosis Samantha completed her Ph.D on using chemical cues to control invasive cane toad *Rhinella marina* tadpoles in Australia. She also worked on a remote Red Collared Brown lemur *Eulemur collaris* tracking and behaviour survey, in southern Madagascar, and assisted on the Wingecarribee Koala Survey for Office of Environment and Heritage.

Samantha's most recent fieldwork experience, involves habitat assessments for threatened fauna, and targeted surveys for threatened frogs, mammals and reptiles.

Key project experience

Field Zoologist	Biodiversity Constraints Assessment for RW Corkery & Co Pty Ltd in Sutton Forest.
Field Zoologist	Brookfield Tunnel Microbat assessment, for Hunter Water.
Field Zoologist	Biodiversity Assessment, Lindsey Noonan Drive, for Lateral Brookfield Bat Tunnel, Engineering and Management.
Field Zoologist	Targeted Red-crowned Toadlet Surveys, Northern Beaches Hospital.
Field Zoologist	Pre-clearance surveys, Berrima, for Roads and Maritime Services
Field Zoologist	Green and Golden Bell Frog targeted surveys, Illawarra Retirement Trust, Culburra.
Field Zoologist	Flora and Fauna Assessment, Brighton Lakes Golf Course.
Field Zoologist	Cumberland Plain Land Snail Management Plan, M4 Smart Motorway, for Roads and Maritime Services.

Field Zoologist	Nest Box Monitoring, Northern Beaches Hospital.
Field Zoologist	Targeted Threatened Frog surveys, Illawarra Coal.
Field Zoologist	Ecological Assessment, Londonderry Road for Sydney Water.
Field Zoologist	Koala Habitat Mapping, Wingecarribee LGA.

Other qualifications and training

General Construction Induction Card (White Card)

First Aid & CPR