North Manyana Subdivision

Biodiversity Development Assessment Report

Heir Asquith Pty Ltd

27 October 2023

→ The Power of Commitment

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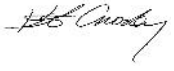
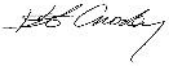
Final	1	K Chesnut, B Harrington	K Crosby		K Crosby		13/10/2023
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Certification under Section 6.15 of the *Biodiversity Conservation Act 2016*

I, Ben Harrington (accredited assessor number BAAS17023) certify that this Biodiversity Development Assessment Report and the accompanying finalised credit report dated 27 / 10 / 2023 has been prepared in accordance with the requirements of (and information provided under) the Biodiversity Assessment Method.

_____ _____

Ben Harrington – BAAS17023
27 / 10 / 2023

Executive summary

Heir Asquith Pty Ltd (Heir Asquith) propose to develop a 65-lot residential subdivision at Lot 106 DP 755923 and Lot 2 DP 1161638, at Manyana on the south coast of NSW. ('the proposed subdivision' or 'the proposal'). A large, community title conservation lot will be established incorporating land outside of the proposed residential subdivision lots and the adjacent Lot 2 DP 1121854. The conservation lot will be managed under a vegetation management plan (VMP) until such time that any Biodiversity Stewardship Agreement (BSA) under the NSW *Biodiversity Conservation Act 2016* (BC Act) comes into force over the land.

This Biodiversity Development Assessment Report (BDAR) has been prepared by GHD Pty Ltd (GHD) to identify the potential impacts on biodiversity values associated with the proposal. The BDAR has been prepared an accredited assessor in accordance with the Biodiversity Assessment Method (BAM) 2020, and includes:

– Desktop assessment to describe the existing environment and landscape features of the development footprint and to identify the suite of threatened species and communities potentially affected by the proposal
– Field survey in accordance with the BAM to describe the biodiversity values of the development footprint and surrounding study area and confirm the quantum of impact to native vegetation and threatened species habitat
– Discussion of measures to avoid and minimise impacts to biodiversity values including iterative changes to the proposal
– BAM credit calculations to determine the number and type of biodiversity credits that would be required to offset impacts of the proposal following implementation of measures to avoid and minimise impacts.

Field surveys have been conducted to identify and map plant community types (PCTs) and condition classes, threatened ecological communities and habitat for threatened species according to the BAM and associated guidelines. Multiple rounds of targeted seasonal surveys have been conducted from 2018 to present including supplementary surveys after September 2021 that were designed to address potential limitations in survey results as a result of prior drought conditions or bushfire.

Section 6.4 of the BC Act establishes a requirement to take all feasible steps to avoid or minimise impacts on biodiversity values and to offset residual impacts. The proposal has aimed to avoid and minimise impacts to native vegetation and habitat values by amending the original subdivision layout for the development. Various iterations of the subdivision layout have been developed and then amended in response to detailed understanding of the site's biodiversity values and offset requirements as the BDAR and a previous biocertification proposal and development applications were prepared.

The discussion of measures to avoid impacts should be mainly based on the 'readily developable area', noting that if land use zoning or other environmental planning instruments restricts development in an area then there can be no genuine avoidance of an impact of a development that could not otherwise be carried out. The current subdivision proposal would remove 17.95 ha of native vegetation for a 19.58 ha subdivision containing 65 residential lots within the total readily developable area of 36.54 hectares. The proposed subdivision includes a conservation lot around 57.25 ha in area over the remainder of the study area, including 17.98 ha of the readily developable area. Figure 1 shows the proposed, reduced impact subdivision development footprint along with the 2021 DA development footprint and previous development proposals for context.

The biodiversity survey and assessment commenced prior to the Black Summer fires of 2019/2020, which severely burnt much of the eastern portion of the study area. Much of the vegetation in the eastern portion of the study area that was severely burnt was relatively intact and in high condition, while the proposal footprint aligns with vegetation that had been exposed to regular disturbance, and which was not severely burnt. The layout of the development has also taken into consideration the retention of connectivity associated with the proposed conservation lands. Mitigation measures are proposed that will minimise some of the impacts of the proposal on biodiversity values associated with the site, including the following that would be implemented as part of the construction environmental management plan for the site. These include measures relating to:

– Standard Construction Environmental Management Plan protocols– including site inductions and dust suppression measures.

– Vegetation protection – including protective fencing to prevent impacts to surrounding retained vegetation, vehicle washing to avoid spread of pathogens/weeds, appropriate locations of stockpiles during construction and installation of sediment fences.
– Weeds – including weed management actions/planning, weed propagule spread control measures and sediment control.
– Fauna habitat management – including hygiene protocol implementation, presence of an ecologist during clearing, staged vegetation clearing, protocols for the removal of hollow-bearing trees and other habitat features.
– Water quality and aquatic habitats – including erosion and sediment control measures, plans and surface stabilisation, dust control, spill kits and protocols.

The proposal would result in residual direct impacts within a 19.58 hectare development footprint including:

– removal of 17.95 hectares of native PCT's and associated threatened ecological communities in the development footprint as summarised in Table 9.1
– removal of up to 17.88 hectares of known habitat for the threatened fauna species Eastern Pygmy Possum (*Cercartetus nanus*) requiring calculation of species credits as well as other threatened or migratory fauna associated with the PCTs in the development footprint
– removal of up to 1.38 ha of PCT 1326 – Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, which is part of a local occurrence of a threatened ecological community listed under the BC Act and EPBC Act, as well as an entity at risk of a potential Serious and Irreversible Impact (SAII)
– Removal of a further 1.64 ha of non-native vegetation and cleared land in the development footprint with negligible value for threatened species that do not require further assessment under the BAM.

The proposal would not impact any threatened biota listed under the *Fisheries Management Act 1994* (FM Act).

– Once the subdivision has been established there is potential for the proposal to impact surrounding vegetation and habitat values through effects such as:

– Generation of additional light and noise
– Erosion and sedimentation as a result of runoff from hard stand areas
– Introduction of weed propagules by vehicle and/or residents
– Fauna mortality as a result of vehicle strike or attacks by domesticated animals
– Increased risk of fire
– Rubbish dumping.

Mitigation measures would be implemented to minimise potential indirect or operational impacts. These would include:

– Implementation of a vegetation management plan (VMP) over the conservation lot until such time that any BSA comes into force over the land including measures to:
  - mitigate potential indirect impacts of the proposal
  - manage unauthorised landuses, environmental weeds and other threats to biodiversity values
  - regenerate areas of poor condition or non-native vegetation to functional native ecosystems
– Ongoing water quality management as part of an integrated stormwater management system
– Measures to reduce the increased risk of fire
– Prescribed fencing requirements
– Ecologically sensitive street lighting design
– Domestic animal restrictions.

– There is 12.91 ha of vegetation commensurate with Illawarra Lowlands Grassy Woodland across the study area, that comprises an entity at risk of SAII. This is the only remaining patch of the community in the local area though there is around 130.01 ha of the community in a 10 km radius, the majority of which is Forest Red Gum (*Eucalyptus tereticornis)*-dominated patches of the community located as fragmented remnants in the Yatte Yattah-Milton area around 8 km to the southwest of the study area. In this context the Illawarra Lowlands Grassy Woodland at the study area and that would be removed for the proposal is a floristically atypical and relatively isolated patch of the community.

As part of the proposal:

– 1.38 hectares of the community in moderate condition would be removed or modified in the development footprint comprising around 1.06% of the extent of the community in the locality and 0.170% of the extent of the community in the sub-region
– 11.03 hectares of the community in moderate condition would be permanently protected within the conservation lot within the avoidance footprint for the proposal
– a further 0.5 hectares of the community in poor condition and 1.43 hectares of non-native vegetation that comprises gaps in the current extent of the community in the study area would be regenerated under the VMP. This can be further conserved in perpetuity under a BSA ensuring that in the longer term there would be 'no net loss' of the community at the study area.
– The proposal has included purposeful design of the subdivision within the readily developable land at the study area to substantially avoid and minimise impacts to the community, resulting in residual impacts to just 1.38 ha of the community and regeneration of 1.93 hectares as part of a functional patch of the community with a greater extent and improved condition and security than the baseline condition. Therefore, the area of removal of the community is equalled or bettered by the revegetation efforts on the degraded land. Additional areas of the community would be retained in the conservation lot, as well as areas of non-native vegetation in the central portion of the study area that are fragmented by tracks and previous clearing and would be regenerated to increase the extent and integrity of Illawarra Lowlands Grassy Woodland. As such the proposal is likely to avoid the risk of a SAII to Illawarra Lowlands Grassy Woodland.

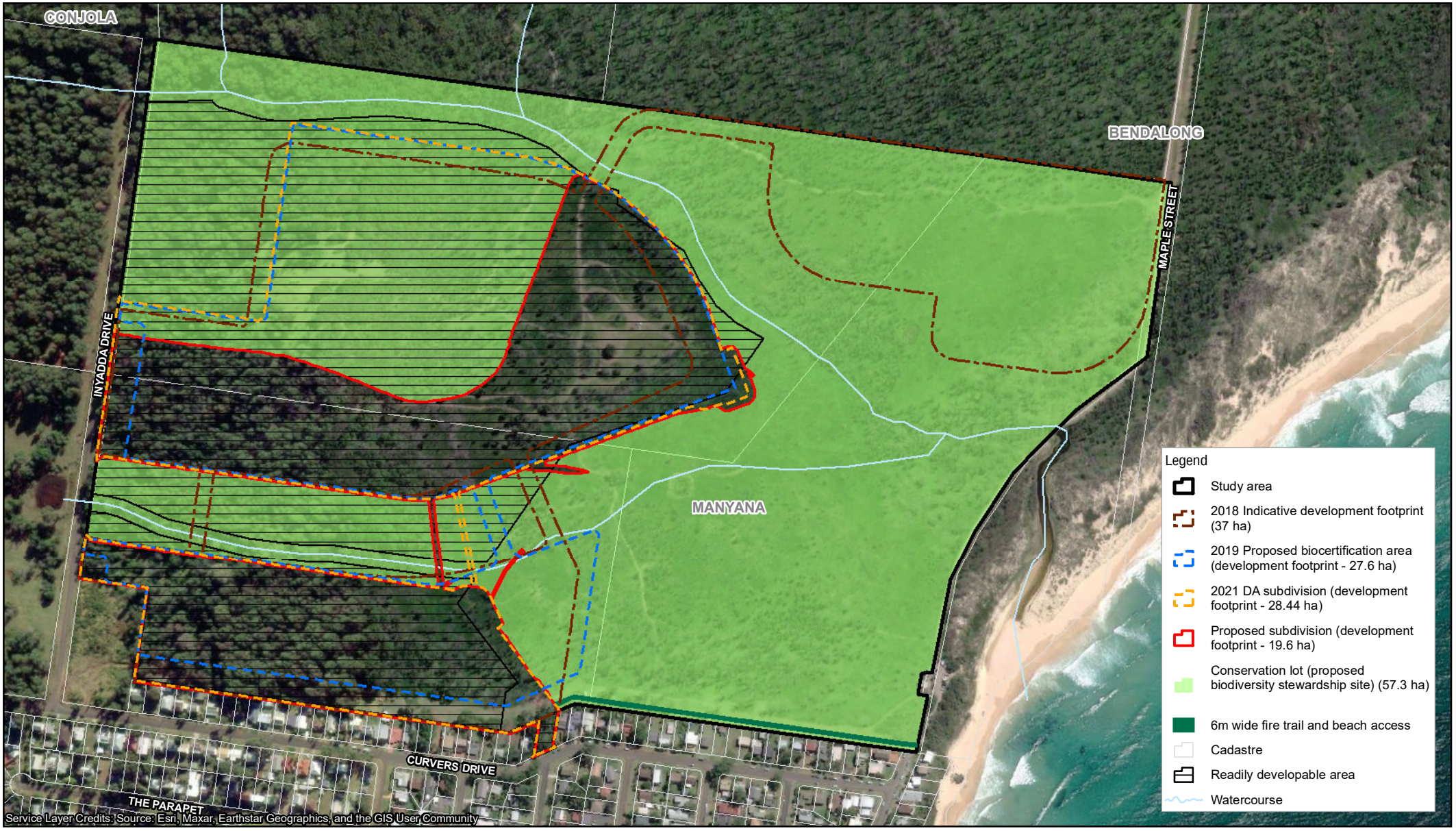
BAM credit calculations have been performed in accordance with the methodology and using credit calculator version 1.4.0.00. Credits required to be secured and retired to offset the residual impacts of the proposal on threatened species habitats are summarised in Table 9.1 below. Credits required to commence construction, and prior to any BSA being established would be secured on the open market from stewardship sites that provide biodiversity credits that comply with the trading rules of the NSW Biodiversity Offsets Scheme. A payment to the Biodiversity Conservation Fund is also considered an appropriate action if a suitable number and type of biodiversity credits cannot be secured from stewardship sites. Should a BSA come into force over the conservation lot adjacent to the development footprint, appropriate credits could be secured and retired from this. This approach would further enhance a 'like for like' conservation of the PCTs and threatened species affected by the proposal and directly benefit local populations of the species affected by development impacts.

The proposal has been determined to be a controlled action under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). The proposal will be assessed by the Commonwealth Department of Climate Change, Energy the Environment and Water (DCCEEW) through consideration of preliminary documentation based on this BDAR. Biodiversity offsets required as a result of this decision would be delivered via the NSW Biodiversity Offsets Scheme in accordance with the EPBC Act Condition-setting Policy.

Table 1 Biodiversity credits required to offset residual impacts of the proposal

Zone ID	Plant community type	Area (ha)	Current vegetation integrity score	Future vegetation integrity score	BC Act status	EPBC Act status	Ecosystem credits required
1	PCT 694 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (Moderate)	4.62	58.6	0	Not listed		118
2	PCT 694 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (Poor)	2.36	45.8	0	Not listed		47
3	PCT1231: Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	2.81	78.3	0	EEC[1]	EEC[4]	110
4	PCT 1232 - Swamp Oak Floodplain Swamp Forest of the Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	0.06	74.3	0	EEC[2]	EEC[5]	2
5	PCT 1236 - Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	6.71	65.8	0	EEC[2]	EEC[5]	221
6	PCT 1326 – Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands of the southern Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	1.38	65.3	0	EEC[3]	CEEC[6]	45
	Total native vegetation and threatened species habitat	**17.95**					**543**
	Non-native vegetation	1.64					**0**
	Total development footprint	**19.58**					**514**
	Species credit matter impacted	**Area of Habitat (hectares)**					**Species Credits Required**
	Eastern Pygmy Possum (*Cercartetus nanus*)	17.88			Vulnerable	Not listed	**565**

Notes: 1 Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community (EEC).
2 Swamp Oak Floodplain Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC.
3 Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion EEC, potential SAII entity.
4 Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland EEC.
5 Coastal Swamp Oak (Casuarina glauca) Forest of NSW and South East Queensland EEC.
6 Illawarra and south coast lowland forest and woodland CEEC.



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Avoidance of impacts - subdivision location

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Figure 1

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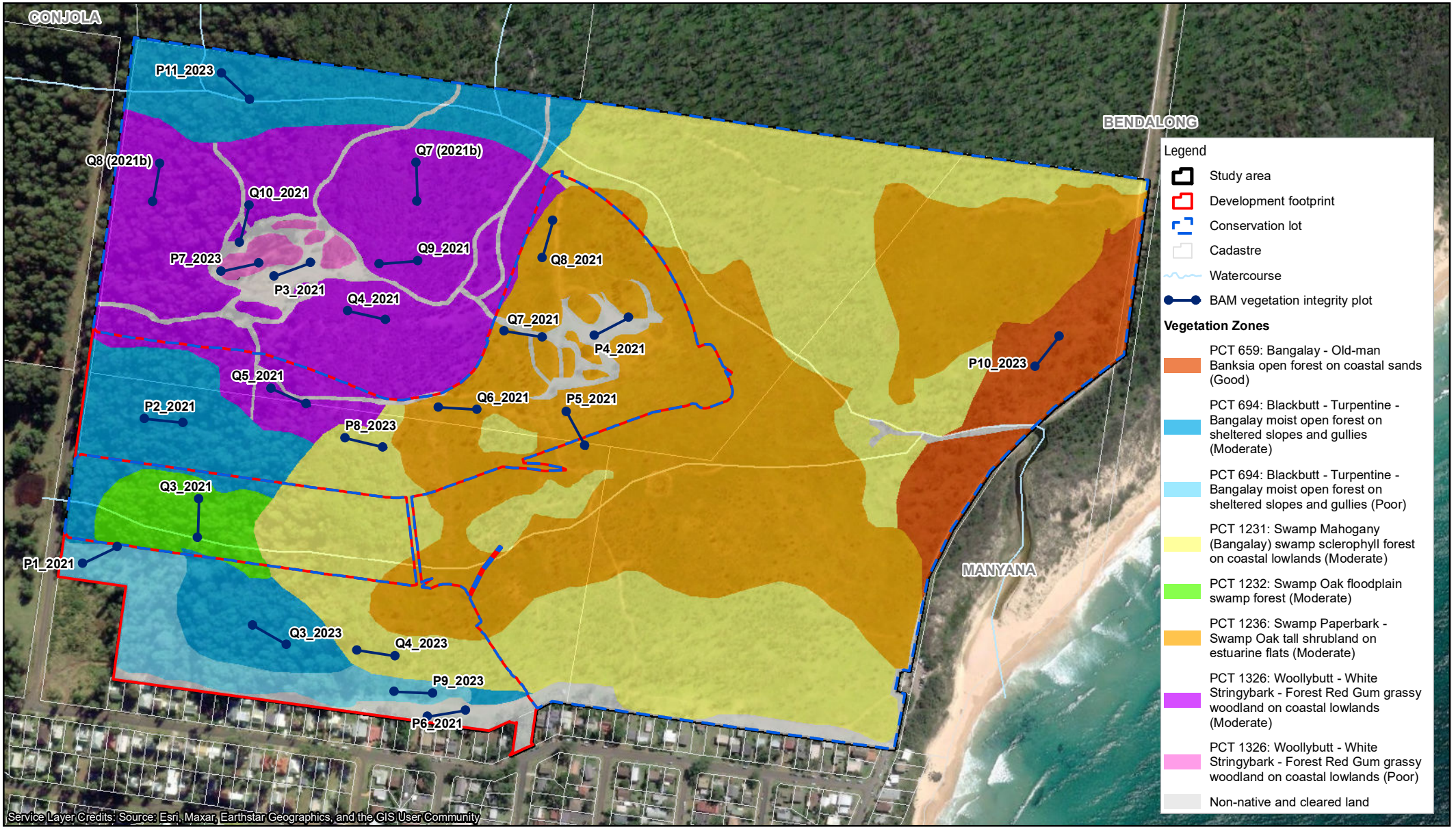
Data source: Calibre Group: Development footprint, 2021; AE: Proposed subdivision. 2020; ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay



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Vegetation zones

Figure 2

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Data source:ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

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1. Introduction

1.1 Proposal description

GHD Pty Ltd (GHD) has been engaged by Heir Asquith Pty Ltd (Heir Asquith) to prepare a Biodiversity Development Assessment Report (BDAR) for impacts resulting from a proposed 65-lot residential subdivision ('the proposed subdivision' or 'the proposal'). The proposed subdivision is located at Lot 106 DP 755923 and Lot 2 DP 1161638 at Manyana on the south coast of NSW as shown on Figure 1.1. A large, community title conservation lot will be established incorporating land outside of the proposed residential subdivision lots and the adjacent Lot 2 DP 1121854. The conservation lot will be managed under a vegetation management plan (VMP) until such time any Biodiversity Stewardship Agreement (BSA) under the NSW *Biodiversity Conservation Act 2016* (BC Act) is obtained over the land. The proposed subdivision layout is shown in Figure 1.2 including the indicative lot layout, internal and perimeter roads, vehicular access points to Inyadda Drive at the western boundary of the site and to Curvers Drive at the southern boundary of the site.

The Development Application seeks consent for a 65-lot residential subdivision including the following (Egis Consulting 2023a):

– Lot 1 – 57.53 ha Community title lot for biodiversity protection purposes
– Lots 2-66 – Torrens title residential lots ranging in size from 2000 m^2 to 284 0m^2
– Lot 67 – Proposed public reserve for a local park (2088 m^2) containing grave site to be dedicated to Council
– Lot 68 – Proposed RE1 Open Space Lot (3054 m^2) to be acquired by Council
– Creation of a timber pedestrian accessway over Lot 1
– Creation of a 6 m wide fire trail including a beach access trail
– Creation of a 6m wide drainage easement
– Construction of an 8 m wide pavement for emergency purposes with restricted access to Curvers Drive
– Road Construction and dedication including intersection treatments to existing public roads
– Indicative Building Envelope Plans in order to protect hollow-bearing trees where possible
– Asset Protection Zones
– Tree removal within the development footprint
– Bulk earthworks to facilitate building platforms
– Culvert upgrades on Inyadda Drive for flood free access
– Retaining walls around perimeter road
– Stormwater and Water Quality works including swales in the road reserve
– Street tree planting
– Proposed sewer servicing scheme including pump out system.

The primary purpose of the subdivision would be to provide residential allotments to assist in meeting housing demand on the south coast of NSW, in line with the South Coast Regional Strategy. The proposed subdivision will be assessed as a complying development under Part 4 of the New South Wales Environmental Planning and Assessment Act (EP&A Act) through a Development Application (DA) to Shoalhaven City Council (Council). The Part 4 DA must be accompanied by a 'Biodiversity Development Assessment Report' (BDAR) prepared by an accredited assessor in accordance with the BAM 2020 (DPIE 2020a). A description of the proposal and a summary assessment of potential environmental impacts is provided in the statement of environmental effects (SEE) that accompanies the DA (Egis Consulting 2023a).

This BDAR describes the ecological values at the site, with particular focus on plant community types (PCTs), threatened ecological communities, populations, and species. It assesses the impact of the proposal on biodiversity values, documents the steps taken to avoid and minimise impacts to biodiversity values, describes and quantifies the biodiversity credits required to offset the residual impacts of the proposal on biodiversity values. Potential impacts of the proposed subdivision on biodiversity values would include the removal of up to 24.34 ha of native vegetation. The impact area shown on Figure 1-1 includes indicative building envelopes, associated asset

protection zones, proposed access roads and likely disturbance footprints for surface water management, access, parking and utilities.

Proposed conservation measures to offset the impacts of the development and to demonstrate that biodiversity values are being improved and maintained are briefly discussed in Section 8.2. Biodiversity offsets would include conservation of lands outside the development footprint via a stewardship agreement. Biodiversity values and credits generated from the proposed Biodiversity Stewardship Site (BSS) adjacent to the subject site would be described in detail in a separate Biodiversity Stewardship Site Assessment Report (BSSAR).

The proposal requires assessment and approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Commonwealth Department of Agriculture, Water and the Environment (DAWE) confirmed a decision to assess a previous iteration of the proposal as a controlled action in June 2021 and provided a request for preliminary documentation in July 2021 (proposal NSW 2021/8948). DAWE approved a Request for a Variation of the proposal under section 156A of the EPBC Act in November 2021. These decisions means that the proposed subdivision must be approved by the Department under the Commonwealth EPBC Act, in addition to the requirement for approval by Council under NSW legislation. The Commonwealth has formally endorsed the NSW BOS and BAM and so the preliminary documentation package will substantially rely on the information in the BDAR and any biodiversity offsets required under the EPBC Act would be secured through biodiversity credits according to the NSW system.

A number of previous ecological surveys have been undertaken within the development footprint. In 2014, the site was subject to a planning proposal for rezoning. EMM undertook the ecological assessment in accordance with this proposal. Environmental Resource Management (ERM) also undertook vegetation mapping and detailed flora and fauna surveys of the site in 2004. Similarly, a previous survey was undertaken by Kevin Mills and Associates in 1997. Additional ecological surveys were conducted within the site by Parsons Brinckerhoff in 2006 as part of the Draft Manyana Local Environment Plan Report. More recently an iteration of the proposed subdivision was the subject of a draft 'Biodiversity Certification Assessment Report' (BCAR) prepared by GHD accredited assessors intended to accompany a Planning Proposal to rezone and subdivide the site.

A BDAR was prepared to support a development application (DA) for a proposed 100-lot residential subdivision, and was submitted to Shoalhaven City Council (Council). A revised proposal was prepared by the proponent, consisting of a 65-lot residential subdivision that avoids impacts to the areas with highest biodiversity value within the site. The current proposal includes construction of road and infrastructure services associated with the subdivision in accordance with relevant standards to service the allotments. The BDAR prepared for the current proposal builds upon the field survey and assessment data presented in the BCAR and previous biodiversity assessments of the site.

The final design layout for the subdivision which is the subject of this assessment has considered the study area's biodiversity values. These values have been assessed in accordance with the BAM and the development footprint has aimed to satisfy the requirement to avoid and mitigate impacts according to the BAM. The proposal has sought an appropriate balance between development and conservation, avoiding and minimising impacts on native vegetation and habitat by:

– locating the proposal in areas of non-native or poor condition native vegetation as far as possible
– reducing the number of residential lots proposed in the area of readily developable land with suitable land use zoning from 100 to 65 lots
– locating the proposal in vegetation with lower conservation significance including reducing the clearing of an ecological community at risk of serious and irreversible impact as far as possible.

Impacts would be further minimised through the implementation of an environmental management plan during construction and management of vegetation within the conservation lot in perpetuity. Residual biodiversity impacts would be offset in accordance with the BAM.

1.1 Purpose and scope of this report

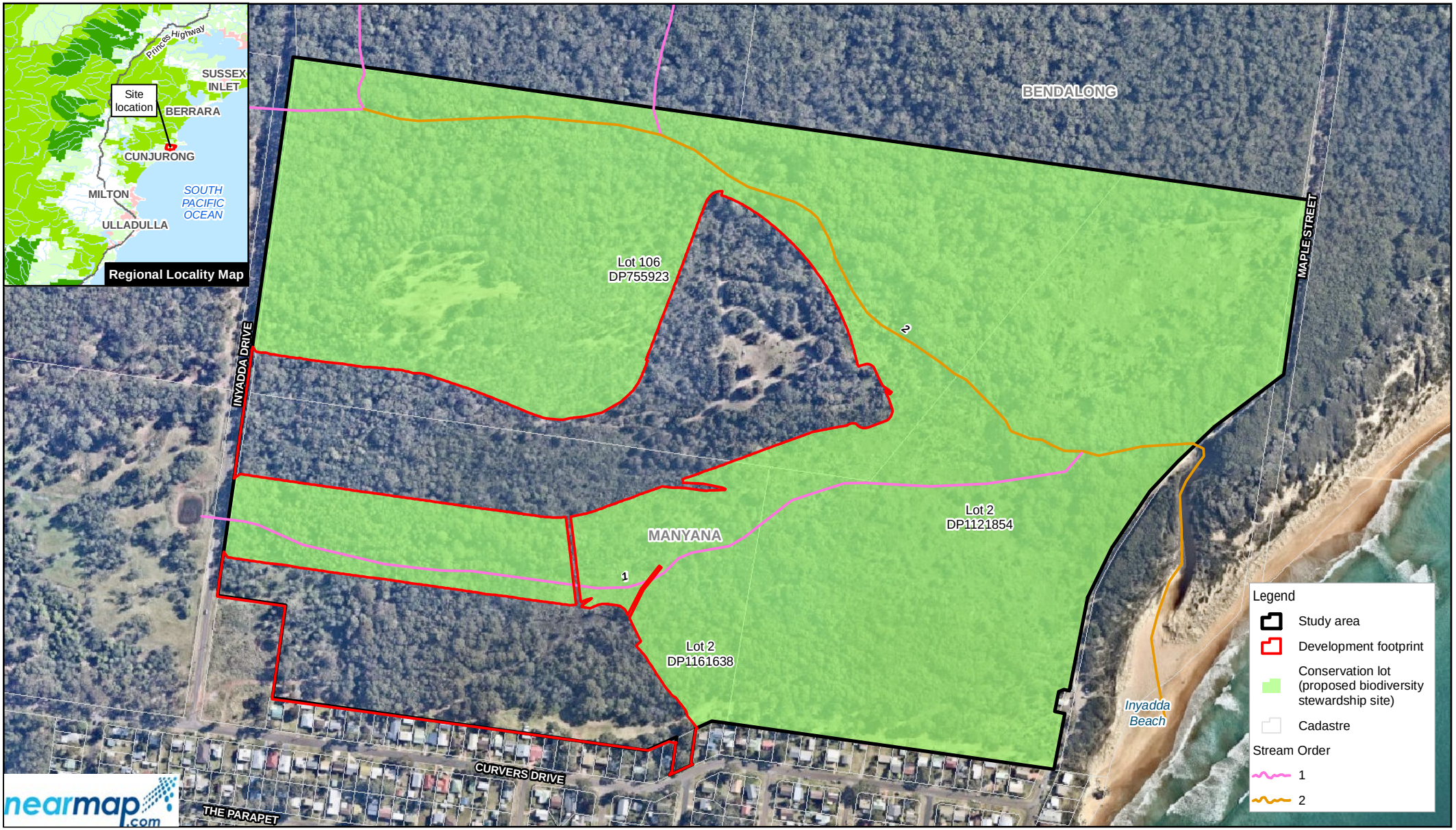
The purpose of this report is to assess the potential biodiversity impacts from the construction and operation of the proposal. The report:

– Outlines the methods used in the biodiversity assessment

- Describes the existing environment of the study area, including the results of the desktop assessment and site surveys
- Assesses the value and conservation significance of native vegetation and habitats at the proposal site and the potential for threatened biota and matters of national environmental significance (MNES) to occur at the study area or be affected by the proposal
- Provides a description of the proposal, including potential impacts on biodiversity values and measures to avoid or mitigate impacts, including a comparison of the current 65-lot residential subdivision proposal against the previous 100-lot residential subdivision proposal
- Assesses the significance of impacts on threated biota and MNES
- Presents the data used to perform the BAM credit calculations for the proposal
- Calculates the number and type of biodiversity credits that would be required to offset impacts of the proposal in accordance with the BAM.

The following terms are used in this report:

- The '**proposal**' refers to the proposed 65-lot residential subdivision
- The '**development footprint**' refers to the area that would be directly impacted by the proposal
- The '**study area**' refers to the area contained within Lot 106 DP 755923, Lot 2 DP 1161638 and Lot 2 DP 1121854 that was subject to field survey and assessed for direct or indirect impacts that may arise from the proposal. The study area includes the current development footprint, previous iterations of the development footprint and the balance of these lots proposed for conservation
- The '**conservation lot'** refers to the area contained within the large, community title lot that will be established incorporating land outside of the proposed residential subdivision lots and the adjacent Lot 2 DP 1121854.
- The '**locality**' refers to the area within a 10 km radius of the study area.



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Site map (pre-fire)

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Figure 1.1

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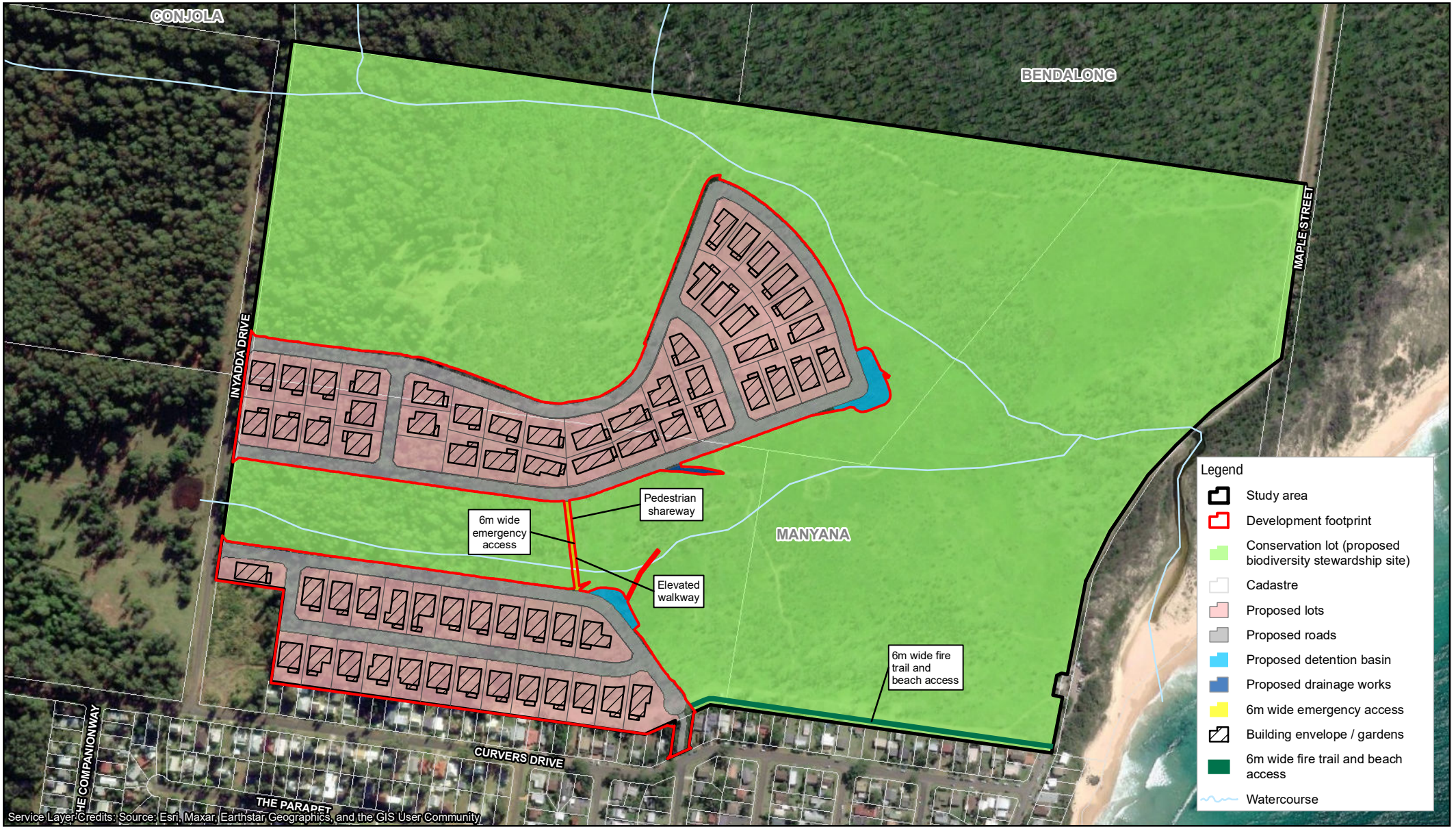

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Residential subdivision layout

Figure 1.2

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Data source: Calibre Group: Development footprint, 2021; AE: Proposed subdivision. 2020; ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

1.2 Glossary of terms and acronyms

Term	Definition
AHD	Australian Height Datum, 0m above sea level above which elevation is measured in Australia
AOBV	Areas of Outstanding Biodiversity Value
BAM (Biodiversity Assessment Method) 2017	Biodiversity Assessment Method published by the Office of Environment and Heritage for the NSW Government dated August 2017. The rules for biodiversity assessment established under the BC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values. The rules associated with the method established under the BC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values. This methodology has been replaced by the BAM 2020 (see below).
BAM (Biodiversity Assessment Method) 2020	Biodiversity Assessment Method published by the Office of Environment and Heritage for the NSW Government dated October 2020. The rules for biodiversity assessment established under the BC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values.
BAM-C; Biodiversity Assessment Method Calculator; credit calculator	Biodiversity Assessment Method Calculator; Online application of the BAM. The calculator uses the rules and data collected in accordance with the BAM to calculate the biodiversity credits required to offset a development or the biodiversity credits generated at a stewardship site.
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BC Regulation	Biodiversity Conservation Regulation 2017
BCAR	Biodiversity Certification Assessment Report
BCD	Biodiversity and Conservation Division (formerly OEH, part of NSW DPE))
BCF	Biodiversity Conservation Fund
BCT	Biodiversity Conservation Trust
BDAR	Biodiversity Development Assessment Report
Biodiversity credit	A unit of biodiversity value to measure specific development impacts or conservation gains in accordance with the BAM. Includes ecosystem credits or species credits.
Biodiversity credit report	Specifies the number and type of biodiversity credits: required to offset the impacts of a development to obtain a Biodiversity Certification Agreement; or that would be generated through conservation and management of a Stewardship site under a Stewardship Site agreement.
Biodiversity offsets	Specific measures that are put in place to compensate for impacts on biodiversity values.
Biodiversity values	The composition, structure and function of ecosystems, including threatened species, populations and ecological communities, and their habitats.
BOS	Biodiversity Offset Scheme
BSS	The area proposed to be placed under a Biodiversity Stewardship Agreement.
BSSAR	Biodiversity Stewardship Site Assessment Report
Buffer area	1,500 metre area surrounding the development footprint in which vegetation cover is assessed under the BAM
CEEC	Critically endangered ecological community
CEMP	Construction Environmental Management Plan
DA	Development application
DAWE	Former Commonwealth Department of Agriculture, Water and the Environment (now DCCEEW)
DBH	Diameter at breast height
Development footprint	The area shown as development footprint in Figure 1.2 and other figures throughout this report. See also definition of 'proposal'.
DoEE	Former Commonwealth Department of the Environment and Energy (now DCCEEW)
DPE	NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries

Term	Definition
DPIE	Form NSW Department of Planning, Industry and Environment (now DPE)
Ecosystem credit	A credit that relates to a vegetation type and the threatened species that are reliably predicted by that vegetation type (as a habitat surrogate).
EEC	Endangered ecological community
EES	Environment, Energy and Science Group (part of NSW DPE)
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FFMP	Flora and Fauna Management Plan
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater dependent ecosystem
GIS	Geographic information system
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometre
LEP	Local Environment Plan
LGA	Local Government Area
Locality	The area within a 10 km radius of the development footprint.
m	Metre
Migratory species	Species listed under listed under international agreements (i.e. Ramsar, JAMBA and CAMBA conventions) to which Australia is a party.
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	Office of Environment and Heritage (now the BCD, part of NSW DPE)
PCT	Plant community type
PMST	Protected Matters Search Tool
SAII	Serious and irreversible impacts
SAII entity	Species and ecological communities that may be the subject of serious and irreversible impacts (SAIIs)
SCC, Council	Shoalhaven City Council
SEPP	State Environment Planning Policy
Species credit	A credit that relates to an individual threatened species that cannot be reliably predicted based on habitat surrogates. Threatened species that require species credits are identified in the Threatened Biodiversity Data Collection.
Study area	The area that was subject to a site survey and assessed for direct or indirect impacts arising from construction and operation of the proposal.
Subject site	The area that would be directly impacted by construction and operation of the proposal.
TBDC	Threatened Biodiversity Data Collection
TEC	Threatened ecological community
The proposal	The proposed residential subdivision at Lot 106 DP755923 and Lot 2 DP1161638, in Manyana on the south coast of NSW as shown in Figure 1.2
Threatened biota	Threatened species, populations or ecological communities listed under the BC Act and/or the EPBC Act.

1.3 Scope and limitations

This report: has been prepared by GHD for Heir Asquith Pty Ltd and may only be used and relied on by Heir Asquith Pty Ltd for the purpose agreed between GHD and Heir Asquith Pty Ltd as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Heir Asquith Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.2, 1.4 and 3.6 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD has prepared this report on the basis of information provided by Heir Asquith Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

This report has been prepared based on a proposal description and subdivision design provided by Egis Consulting Pty Ltd. A ‘development footprint’ polygon (i.e. disturbance footprint) was prepared for the biodiversity assessment based on these inputs, and was modified through several iterations and finally confirmed in consultation with Heir Asquith Pty Ltd and the consultant team, taking into account the results of this BDAR as well as such things as bushfire considerations, flooding impacts and road and infrastructure constraints. It is assumed that the description and spatial data accurately represent the extent of direct impacts arising from the development footprint and so these data have been used to calculate the extent of removal of vegetation and habitat arising from the proposal using GIS. These calculations have in turn been relied upon in the BAM calculations and the determination of key thresholds such as whether the development footprint would have a direct impact on a threatened entity, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated proposal design and/or spatial data.

2. Legislative context

2.1 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) provides legal protection for biota of conservation significance in NSW. The BC Act aims to, amongst other things, 'maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development'. It provides for the listing of threatened species and communities, establishes a framework to avoid, minimise and offset the impacts of proposed development (the Biodiversity Offsets Scheme, or BOS), and establishes a scientific method for assessing the likely impacts on biodiversity values and calculating measures to offset those impacts (the Biodiversity Assessment Method, BAM). These are discussed further below.

2.1.1 Biodiversity Offset Scheme and Biodiversity Assessment Methodology

The BC Act, together with the *Biodiversity Conservation Regulations 2017*, provides a mechanism to address impacts on biodiversity from land clearing associated with development, clearing or conferral of biodiversity certification. Under this legislation, there are provisions for a Biodiversity Offsets Scheme (BOS), which includes a framework to avoid, minimise and offset impacts of development on biodiversity.

The aim of the BOS is to provide a transparent, consistent and scientifically based approach to biodiversity assessment and offsetting, to ensure that the impacts of development, clearing or biodiversity certification will result in no net loss of biodiversity. The scheme creates a market framework for the conservation of biodiversity values and the offsetting of development impacts, by establishing the mechanisms to offset impacts of development, clearing or biodiversity certification through biodiversity credit trading such that there is no net loss of biodiversity values. The scheme also allows for the establishment of biodiversity stewardship agreements, which are in-perpetuity agreements entered into by landholders, to secure offset sites and generate biodiversity credits, which can be used to offset impacts of development.

The Biodiversity Conservation Fund (BCF) ensures that landowners have the funds needed to carry out the management actions required each year and provides a financial incentive to landowners to carry out those actions. The scheme is administered by the Biodiversity and Conservation Division (BCD, formerly the Office of Environment and Heritage, or OEH) and ensures accountability and compliance through legislation, regular reporting requirements and financial measures.

The BAM was established by the New South Wales (NSW) Office of Environment and Heritage (OEH). The BAM underpins the BOS and establishes a standard method to address the loss of biodiversity and threatened species. The BAM sets out how biodiversity values will be assessed, prescribes requirements to avoid and minimise impacts, establishes rules for calculating the number and class of credits required for unavoidable impacts, and determines the trading rules that will apply.

The methodology includes a software package known as the Biodiversity Assessment Method Calculator (the credit calculator, or BAM-C) which processes site survey and assessment data. The credit calculator specifies the type and extent of surveys required for a Biodiversity assessment and then processes survey data to calculate the number and type of biodiversity credits that are either required at a development site or will be generated at a stewardship site. The BAM must be applied by a person accredited under the BC Act.

2.2 Fisheries Management Act 1994

The objects of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. It provides for the listing of threatened species, populations and ecological communities, listing of 'Key Threatening Processes' (KTPs), and the requirements or otherwise for the preparation of a Species Impact Statement (SIS).

One of the objectives of the FM Act is to 'conserve key fish habitats ' which includes aquatic habitats that are important to the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. To assist in the protection of key fish habitats, DPI has produced the Policy and guidelines for fish habitat conservation and management (DPI 2013). This policy applies to the following developments, works or activities, each of which can impact on key fish habitat:

– Dredging or reclamation.
– Impeding fish passage.
– Damaging marine vegetation.
– De-snagging.

2.3 Biosecurity Act 2015

The *Biosecurity Act 2015* provides for risk-based management of biosecurity in NSW. It provides a statutory framework to protect the NSW economy, environment and community from the negative impact of pests, diseases and weeds.

The primary object of the Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers.

In NSW, all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

Priority weeds were recorded in the study area. Legal requirements to minimise the potential for the introduction and/or spread of weeds as a result of the proposal are discussed in Section 5.6.

2.4 Environment Protection and Biodiversity Conservation Act 1999

The purpose of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to ensure that actions likely to cause a significant impact on ‘matters of national environmental significance’ undergo an assessment and approval process. Under the EPBC Act, an action includes a project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things. An action that ‘has, will have or is likely to have a significant impact on a matter of national environmental significance (MNES)’ is deemed to be a ‘controlled action’ and may not be undertaken without prior approval from the Australian Minister for the Environment. MNES relevant to this report include threatened species and ecological communities and migratory species.

Specific consideration of the approval and offsetting requirements for MNES is only required for controlled actions. The NSW Government and Australian Government finalised amendments to the Assessment Bilateral Agreement after changes to NSW legislation, and the Amending Agreement no. 1 was signed on 24 March 2020. The Australian Government formally endorsed the NSW BOS through the EPBC Act Condition-setting Policy (DAWE 2020). The EPBC Act condition setting policy (DAWE 2020) notes that where a proposal demonstrates compliance with an endorsed state or territory policy, the proponent will not be required to simultaneously comply with the corresponding Australian Government policy. As such, a proponent for a controlled action is not required to calculate offsets separately using the EPBC Act offsets policy (DSEWPaC 2012) and associated calculator, unless offsets are required for a matter not considered by the BAM.

A referral was submitted to the Commonwealth Department of Agriculture, Water and the Environment (DAWE) including assessment of significance of impacts on protected matters. DAWE confirmed a decision to assess a previous iteration of the proposal as a controlled action in June 2021 (proposal NSW 2021/8948) due to the potential for significant impacts on the following matters protected under the EPBC Act:

– Coastal Swamp Oak (*Casuarina glauca*) Forest
– Illawarra and south coast forest and woodland ecological community
– the Grey-headed Flying-fox.

Further consideration of impacts on these protected matters is provided in chapter 7 and section 8.7.

DAWE provided a request for preliminary documentation in July 2021 and approved a Request for a Variation of the proposal under section 156A of the EPBC Act in November 2021. These decisions means that the proposed subdivision must be approved by the Department under the Commonwealth EPBC Act, in addition to the requirement for approval by Council under NSW legislation. Preliminary documentation will be prepared separately to this BDAR, and will be submitted to DAWE for consideration. The Commonwealth has formally endorsed the NSW BOS and BAM and so the preliminary documentation package will substantially rely on the information in the BDAR and any biodiversity offsets required under the EPBC Act would be secured through biodiversity credits according to the NSW system.

The EPBC Act has been considered in this assessment through:

– Desktop review to determine the listed biodiversity matters that are predicted to occur within the locality of the proposal and hence could occur, subject to the habitats present
– Targeted field surveys for listed threatened biota and migratory species
– Identification of suitable impact mitigation and environmental management measures for threatened and migratory biota, where required
– Discussion of how offsets for significant residual impacts on protected matters would be delivered within the framework of the NSW BOS.

3. Methods

3.1 Overview

This BDAR has been prepared to meet the requirements of BAM 2020 (DPIE 2020a) as applied to the proposed subdivision and to support a complying DA to Council. A previous iteration of the proposed subdivision was the subject of a draft 'Biodiversity Certification Assessment Report' (BCAR) prepared by GHD accredited assessors and intended to accompany a Planning Proposal to rezone and subdivide the site. This BDAR has been developed using a combination of pre-fire field data collected for the original draft BCAR proposal, as well as supplementary field data collected post-fire.

The main components of the methodology for the biodiversity assessment include:

– Desktop assessment to describe the existing environment and landscape features of the study area and to identify the suite of threatened biota potentially affected by the proposal
– Field survey in accordance with the BAM to describe the biodiversity values within development footprint and surrounding study area and determine the likelihood of threatened biota and their habitats occurring in the development footprint or being affected by the proposal
– Determining reasonable actions to avoid and minimise impacts to biodiversity values
– Completing calculations using the BAM calculator version 1.4.00 to quantify the residual biodiversity impacts of the proposal and to determine the ecosystem and species credits that would require retirement to offset residual impacts.

The credit calculations presented in this report have been completed by Ben Harrington (BAAS17023), based on BAM assessment and report inputs prepared by himself and Kath Chesnut (BAAS17031) and reviewed by Kirsten Crosby (BAAS17011).

3.2 Assessment guidelines and information

In addition to the BAM, this BDAR has also been prepared in accordance with the Guideline for applying the BAM at severely burnt sites (EES 2020). The application of this guideline to the development footprint is required, since:

– A portion of the development footprint was burnt in the 2019-2020 bushfires.
– Areas of the development footprint were determined to be severely burnt, as assessed in accordance with Table 1 of the guideline (EES 2020) as of February 2020.

The draft BCAR, including BAM Stage 1 assessment, was completed prior to the 2019-2020 bushfire event. Additional assessment was requested in November 2019 by the BCD (and prior to the bushfire event in late December 2019 / early January 2020). GHD has engaged in further consultation with the BCD, primarily between January and May 2020 regarding the assessment approach and completion of the assessment. The proposal was the subject of an EPBC Act referral to the then Australian Department of Agriculture, Water and Environment (DAWE, now the Department of Climate Change, Energy, the Environment and Water, DCCEEW) in 2021. The delegate determined that the proposal was a 'controlled action' under the EPBC Act and requested additional information to support the referral. Some of this additional information required completion of additional field surveys, as outlined in section 3.4.

Consistency of this assessment with the guidelines for applying the BAM to severely burnt sites is provided in Appendix A.

3.3 Desktop assessment

3.3.1 Data review

A desktop database review was undertaken to identify threatened flora and fauna species, populations and ecological communities (threatened biota) listed under the BC Act and EPBC Act, that could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present. These were also used to obtain the necessary site data to perform BAM calculations.

Information sources used in the preparation of this report include:

– NSW Department of Planning, Industry and Environment (DPIE) BioNet Atlas for records of threatened biota previously recorded in a 10 kilometre radius around the proposal site (DPIE 2021)
– NSW BioNet (DPE 2023a):
  - Vegetation Classification to identify candidate plant community types (PCTs) in the study area and help confirm PCT to threatened ecological community (TEC) associations
  - Threatened Biodiversity Data Collection to help confirm PCT to threatened species associations, accessed via the BioNet portal as well as the list of candidate species credit-type species and predicted species accessed via the BAM calculator
– DPE (2023c). BAM - Important Areas viewer to identify mapped areas of important habitat that comprise species credit matters
– DPE Threatened biodiversity profile search online database for threatened ecological communities and species listed under the BC Act (DPIE 2023d)
– DAWE (2021) EPBC Act Protected Matters Search Tool – for a 10 kilometre radius around the proposal site (searched July 2021)
– DCCEEW (2023) Species profile and threats database, online profiles (SPRAT)
– Department of Primary Industries (DPI) freshwater threatened species distribution maps. For distribution of threatened aquatic species that may occur in the locality (DPI 2018).

The threatened biota and migratory species identified in the desktop assessment are presented in Appendix B. Following collation of database records and threatened species and community profiles, a list of threatened species requiring assessment was compiled according to the ‘steps for identifying habitat suitability for threatened species’ in the BAM. This was further refined following field surveys and identification and assessment of habitat present within the project site. A likelihood of occurrence ranking was attributed to biota based on this information and used to compile lists of ‘predicted threatened species’ (that is, ecosystem credit species) and ‘candidate threatened species’ (that is, species credit entities requiring targeted survey) according to Step 2 ‘assessment of habitat constraints’ of the BAM.

3.3.2 Background research

Background research was conducted to identify:

– Landscape-scale features of the study area in accordance with Subsection 3.1.3 of the BAM
– Site context of the study area that includes assessing vegetation cover and patch size as required under Section 3.2 and Subsections 4.3.2 of the BAM
– The likely distribution of native vegetation and threatened ecological communities, based on previous mapping and aerial photograph interpretation, for targeted field verification as required under Section 4 of the BAM
– A list of predicted and candidate threatened species and populations of flora and fauna to assess the habitat suitability and threatened biodiversity data collection as required under Section 5 of the BAM
– Availability of baseline information to determine whether additional surveys, mapping and reporting is required to support project approval.

The background research included analysis of the following information sources:

– NSW (Mitchell) Landscapes mapping Version 3.1 (DPIE 2016) and Descriptions for NSW (Mitchell) Landscapes Version 2 (DECC 2002)
– Interim Biogeographic Regionalisation of Australia (IBRA version 7.0) mapping
– Initial BAM calculations
– Compilation map: Biometric vegetation types and endangered ecological communities of the Shoalhaven, Eurobodalla & Bega Valley local government areas (VIS_ID 3900) (OEH 2013)
– Climate Data Online (BOM 2023a)
– Atlas of Groundwater Dependent Ecosystems (GDE) (BOM 2023b)
– Australian Wetlands Database (DAWE 2021e)
– Previous ecological assessments completed for the site (ERM 2004; EMM 2014)
– Aerial photograph imagery of the development footprint and buffer area. This includes:
    - The most recent pre-fire aerial imagery (Nearmap, captured 14 September 2019)
    - The most immediate post-fire aerial imagery (Nearmap, captured 13 March 2020)
    - Aerial imagery (drone footage) of the site provided by the proponent, captured post-fire in January 2020

3.3.3 Threatened orchid assessment

GHD engaged an accredited *Pterostylis ventricosa* and Thick-lipped Spider Orchid (*Caladenia tesselata*) species expert (Brian Towle, ecoplanning) to prepare the Habitat assessment report – preliminary species expert advice, Inyadda Dr (Lot 106 // DP 755923 and Lot 2 // DP 1161638), Manyana, NSW (ecoplanning 2023). The habitat assessment report included as Appendix E to this BDAR aims to identify the extent and quality of potential habitat for the two orchid species, *Caladenia tessellata* and *Pterostylis ventricosa* within the study area noting that they are entities at risk of SAII. The information presented within Appendix E was collated to inform future targeted surveys, or preparation of an expert report, in accordance with the BAM.

Under Section 5.3 of the BAM an expert report can be used instead of a targeted survey to determine whether a species is present or not present on the subject land. An expert report can only be prepared by a person who, in the opinion of the Secretary of DPE or anyone authorised by the Secretary, has specialised knowledge, which may be based on training, study or experience, to provide an expert opinion regarding the threatened species to which the report relates. This preliminary advice has been prepared by Brian Towle, an approved species expert in accordance with the BAM for both *Caladenia tessellata* and *Pterostylis ventricosa* (full curriculum vitae provided in attachment 2 of Appendix E). While this preliminary advice does not represent an ‘expert report’ in accordance with the minimum requirements of Section 5.3 of the BAM, this advice aims to justify the likelihood of occurrence of the species within the subject land and estimate the area of potential habitat on the subject land.

The threatened orchid habitat assessment report and preliminary species expert advice was prepared based upon available information pertaining to the two subject species and their habitats and the author’s experience and

knowledge in undertaking targeted surveys. Inspections of the study area were completed on 17 and 18 April 2023 and on 3 and 4 October 2023 to help inform the habitat assessment.

The scope of works for the threatened orchid habitat assessment report and preliminary species expert advice commenced in early 2023 along with the initial stages of preparation of this BDAR and was intended to support preparation of expert reports as required if targeted seasonal surveys according to the BAM could not be aligned with the program for the DA submission. Concurrent with the habitat assessment, Brian Towle participated in targeted surveys for *Pterostylis ventricosa* (April 2023) and *Caladenia tessellata* (October 2023) across areas of potential habitat (associated PCTs) for the species within the development footprint, as well as adjoining areas of non-associated PCTs (see section 3.4.2). As such the species have been assessed through survey and no expert reports have been prepared. Appendix E is included in this BDAR to help inform the consideration of the subject species and provide additional certainty that the proposal would not result in a SAII.

3.4 Site survey

3.4.1 Survey overview

Staged surveys within the study area were conducted with reference to the BAM and appropriate threatened species survey guidelines for targeted species. Site surveys included:

– Initial site stratification, preliminary investigation of biodiversity values and vegetation mapping
– BAM plot surveys
– Incidental threatened flora surveys
– Fauna habitat assessment
– Opportunistic fauna surveys
– Targeted surveys for threatened flora
– Targeted surveys for threatened fauna.

Survey effort that has directly contributed to this BDAR is summarised in Table 3.1 and is described in detail below.

Table 3.1 Survey techniques and timing

Stage	Date	Survey Technique
Summer targeted species credit surveys	January 2018	Targeted threatened flora surveys with particular focus on Leafless Tongue Orchid (*Cryptostylis hunteriana)* Opportunistic fauna observations.
Preliminary investigation of biodiversity values and vegetation mapping	20 April 2018	Ground-truthing of previous vegetation mapping. Random meander in accordance with Cropper (1993) to: - Document fauna habitats and features within the development area - Assess the general condition of vegetation and habitats present - Confirm vegetation boundaries - Identify potential habitat for threatened biota
BAM plot survey and spring targeted threatened flora and fauna surveys	24-26 September 2018	BAM floristic and vegetation integrity plot sampling. Targeted threatened flora surveys Targeted diurnal bird surveys Opportunistic fauna observations.
Summer targeted threatened flora and fauna surveys	3-7 December 2018	Arboreal and terrestrial traplines for small mammals

Stage	Date	Survey Technique
		Anabat detectors deployed Infra-red cameras deployed Diurnal and nocturnal bird survey Koala Spot Assessment Technique (SAT) surveys Active nocturnal fauna surveys for bats, frogs and small mammals using spotlighting and call playback techniques Targeted threatened flora surveys
Autumn targeted threatened flora and fauna surveys	12 March 2019	Targeted diurnal bird surveys Targeted threatened flora searches Anabat detectors deployed
Winter targeted threatened fauna surveys	27-29 August 2019	Targeted diurnal bird surveys (with particular focus on large forest owls) Nocturnal spotlighting pre-dawn and after last light
Additional vegetation mapping, post-fire inspection and BAM plot surveys.	25 February 2020	Additional surveys and plot sampling of the site in response to BCD consultation on the vegetation mapping and after the December 2019 – January 2020 bushfires.
Additional vegetation mapping and verification and BAM plot surveys	6-7 September 2021	Additional surveys in response to requests for additional information from DAWE Re-sampling of BAM plots to collect post-fire and average-wet weather conditions data
Additional vegetation mapping and verification and BAM plot surveys	24 November 2021	Additional surveys in response to a change in development footprint. Additional sampling of BAM plots and revision of vegetation mapping
Illawarra Lowlands Grassy Woodland assessment	29 September 2022 and 2 October 2022	Assessment of extent and condition of PCT 3330 (legacy PCT 1326) / Illawarra Lowlands Grassy Woodland at the study area, locality and surrounding region
Supplementary Summer targeted threatened flora and fauna surveys	20-23 December 2022 24-27 January 2023	Targeted threatened flora searches with particular focus on Leafless Tongue Orchid (*Cryptostylis hunteriana*) Nocturnal fauna surveys using spotlighting and call playback techniques with particular focus on Green and Golden Bell-frog (*Litoria aurea)* Additional sampling of BAM plots to collect post-fire and average-wet weather conditions data Revision of vegetation mapping based on additional consideration of soil type, drainage and post-fire regeneration
Supplementary April targeted threatened flora and fauna surveys	17-20 April 2023	Site inspection and habitat quality assessment for *Pterostylis ventricosa* and Thick-lipped Spider Orchid (*Caladenia tesselata)* conducted by a threatened orchid species expert (Brian Towle, ecoplanning) Targeted threatened flora searches with particular focus on *Pterostylis ventricosa* Refinement of vegetation mapping

Stage	Date	Survey Technique
		Identification and mapping of management issues and approaches in the conservation lot
Supplementary October targeted threatened flora and fauna surveys	3-5 October 2023	Targeted threatened flora searches with particular focus on Thick-lipped Spider Orchid (*Caladenia tesselata)* Identification and mapping of management issues and approaches in the conservation lot Additional sampling of BAM plots to collect post-fire and average-wet weather conditions data

3.4.2 Vegetation and flora surveys

Vegetation Mapping

The following actions were completed in 2018 and 2019, prior to the fire that impacted the site over the summer of 2019/2020, which aligns with the requirements of the *Guideline for applying the BAM at severely burnt sites* (EES 2020).

Regional vegetation mapping (OEH 2013) and previous mapping of the study area (ERM 2004; EMM 2014) was ground-truthed in the field to verify community type and boundaries, floristic and structural homogeneity within patches and to update mapping as required. Vegetation mapping was undertaken via systematic walked transects across the entire development footprint and by walking the boundary of likely vegetation units, based on aerial photograph interpretation. At various points across the site, rapid data points (RDPs) were taken using a handheld GPS, with the dominant species in the canopy, midstorey, shrub and ground layer recorded. Other information recorded included observed vegetation structure, soil type, landscape position and condition. The overall condition of vegetation was assessed through general observation and comparison against the PCT condition benchmark data as well as using parameters such as species diversity, history of disturbance, weed invasion and canopy health.

Native vegetation communities in the study area were assigned to the closest equivalent Plant Community Type (PCT) held in the BioNet Vegetation Classification database (DPE 2023a). The closest equivalent PCT for each vegetation community was determined through a comparison of the floristic descriptions of PCTs in the database with the vegetation integrity plot data collected from the site. In addition to floristic and structural similarity, the landscape position, soil type and other diagnostic features of the vegetation communities on the sites were also compared to the descriptions in the database to determine the most suitable PCT. Threatened ecological communities (TECs) as defined in NSW and Commonwealth legislation were also identified.

2018 and 2019 plot data collected within the study area was reviewed and the NSW BioNet Vegetation Classification ‘PCT Filter Tool’ was used to generate a list of potential PCTs that align with the vegetation found on site, based on dominant species, vegetation formation, class and IBRA subregion. The results of the analysis were considered alongside the descriptions of each PCT within the NSW BioNet Vegetation Classification Database, along with previous vegetation mapping of the site. The native vegetation in the proposal site was then stratified into vegetation zones in accordance with the BAM. A vegetation zone is defined in the BAM as a relatively homogenous area that is the same PCT and has the same broad condition state. Each vegetation zone was assigned a patch size in accordance with Subsection 4.3.2 of the BAM.

Additional surveys were completed post-fire, in February 2020 and again in September and November 2021 and through 2023. These surveys were completed in response to a request from BCD (February 2020), DAWE (July 2021) and a change in footprint, approval pathway and revised BAM methodology (November 2021, January, April and October 2023).

Following the September and November 2021 and 2023 surveys, supplementary plot data was considered against the candidate PCTs previously identified at the site, and characteristic species, soil types, landscape position and geographic extent data listed in the NSW BioNet Vegetation Classification Database (DPE 2023b). Revisions to

PCT mapping included specific consideration of species composition, vegetation structure, and abiotic factors such as soil texture and drainage under the post-fire regeneration and above average rainfall conditions at the time of preparation of this BDAR. Justification for selected PCTs selected is provided in Section 5.2.3.

The NSW DPE released the revised PCT classification for the NSW coastal and tablelands bioregions for consideration in mid-2022 and the BAM-Calculator (BAM-C) was updated on 14 April 2023 to include the revised PCTs (DPE 2023). The update includes transitional arrangements for BAM-C cases that were in-progress prior to the update which will apply to the project, noting that the BAM-C case for the proposal was commenced in 9/11/2018 and all PCT mapping was completed by November 2021. The transitional arrangements are established in the BAM-C and allow assessors with in-progress BAM-C to maintain access to the legacy PCTs and avoid changes to assessments (DPE 2023). The vegetation zone mapping and credit calculations included in this BDAR refer to the legacy PCTs. PCTs and associated ecosystem credits are presented along with 'offset trading groups' in accordance with the BAM allowing for comparison of ecosystem credits associated with legacy and revised PCTs. Closest matching revised PCTs are also referenced throughout this BDAR where appropriate to assist with matters such as assessment of habitat suitability for threatened biota and regional extents of communities.

Vegetation integrity survey plots (assessing site condition)

Following the stratification of the proposal site into vegetation zones, plot surveys were conducted in accordance with the BAM (DPIE 2020a) to obtain vegetation integrity data for the calculation of biodiversity credits. The sampling was undertaken using 20 x 20 metre plots nested within a larger 20 x 50 metre plot.

The site value was determined by assessing ten attributes used to evaluate vegetation function, composition and structure (see Table 3.2). These attributes were then assessed against benchmark values.

All flora species recorded within each plot was allocated a growth form group and designated as either native, exotic or high threat weeds (HTWs) in accordance with defined lists obtained from the BAM calculator. Plant identification and nomenclature follows keys and taxonomy in PlantNET (National Herbarium of NSW 2021).

Table 3.2 Site data collected within each plot

Attribute	Area assessed
Native plant species richness	20 X 20 metre plot
Percentage foliage cover for each species	20 X 20 metre plot
Estimated number of individuals for each species	20 X 20 metre plot
Number of large trees	50 X 20 metre plot
Tree regeneration (presence/absence)	50 X 20 metre plot
Tree stem size class	50 X 20 metre plot
Total length of fallen logs	50 X 20 metre plot
Litter cover	5 times 1 X 1 metre plot
High threat exotic vegetation cover	50 X 20 metre plot
Hollow bearing trees	50 X 20 metre plot

The sampling effort undertaken to address the minimum plot sampling required by the BAM is summarised in Table 3.3 below. Plots were surveyed across the study area, including within land that is now inside the boundary of the proposed stewardship site. These plots were originally located within the development footprint, which has since been refined. The locations of the survey plots are shown in Figure 3.1, and details regarding the timing of sampling (pre- and post-fire) are provided in Table 3.3.

Plots were located randomly within each of the vegetation zones by walking a random distance into the vegetation zone and then locating the plot on a randomly generated compass bearing; this was then repeated for subsequent plots within the vegetation zone. Plots were located away from ecotones, tracks and track edges or other disturbed areas where possible.

The development footprint was reduced and altered several times throughout this assessment in order to avoid and minimise impacts on biodiversity values. This resulted in some of the plots that have been completed now

being located outside the final development footprint considered in this BDAR and as shown in Figure 1.2. Locations of all plots used are shown in Figure 5.2. 'Assessor's use of judgement' has been used to extrapolate the data from these plots to support BAM credit calculations for the development footprint because:

– Plots are located within vegetation patches that are contiguous with the vegetation zone to which they are applied
– Plots are located near the development footprint boundary (i.e. are not located at sufficient distance from the development footprint to expect that vegetation would substantially change with environmental gradients)
– In some instances, plots sample a patch of vegetation, of which only a very small area extends into the development footprint and it would not have been possible to locate a plot entirely within the portion of the vegetation zone within the development footprint.

BAM vegetation integrity plots were initially sampled at the study area prior to the 2019-2020 bushfires, but under drought conditions. A wildfire burnt the eastern portion of the study area in January 2021 and an assessment of fire impact severity was conducted at the site in February 2020 (see section 4.9 below). BAM vegetation integrity plots were sampled in unburnt portions of the site in February 2020 to help meet the minimum plot requirements of the BAM and/or to replace plots sampled in areas that had been severely burnt. Additional plot data was collected in September and November 2021 and in January and October 2023. Some of these plots were located in areas that were not burnt in the 2019-2020 bushfires (i.e. were in the western portion of the site). Some of the plots that were sampled or re-sampled in the post September 2021 survey rounds were in areas that had been severely burnt as assessed immediately post fire, in February 2020. Despite this, there was sufficient regeneration that plants could be readily identified to species level and vegetation structure and function attributes contributed to an appropriate index of the vegetation integrity of the development footprint.

Section 4.9 includes an assessment of extent and burn severity of the 2019-2020 wildfire on vegetation within the study area with reference to the EES (2020) *Guideline for applying the Biodiversity Assessment Method at severely burnt sites*. Table 4.3 presents an assessment of fire impact severity at the time of collection of plot data in the post September 2021 survey rounds and confirms that these areas did not comprise severely burnt vegetation at the time of sampling. Noting that 2018-2019 plot data may have limitations associated with the drought conditions during that period, BAM vegetation integrity plots sampled in unburnt portions of the site and/or when substantial post fire regeneration had occurred have been preferred for BAM-C calculations in this BDAR (i.e. plot data from unburnt vegetation or mature post-fire regeneration in September 2021, November 2021, January 2023 or October 2023).

Vegetation integrity and floristic data collected from land mapped as 'Non-native and cleared land' was collected post fire. There was substantial regeneration in surrounding areas to provide the assessors with certainty that allocation of this land as non-native was appropriate, given a lack of native species or in some instances, vegetative cover. Visual inspection suggested that the absence of vegetation cover was related to use of tracks and other human disturbance rather than fire.

Table 3.3 BAM vegetation integrity plots sampled within development footprint

Zone ID	PCT ID	Vegetation zone	Area(ha)	Minimum number of plots required	Plots sampled and entered into BAM-C	Assessment of plot data adequacy
1	694	PCT 694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (moderate)	4.62	2	2 (Q3_2023, and P2_2021)	Both plots were sampled under average rainfall conditions and post-fire in vegetation that was not burnt. Q3 was also sampled in February 2020 to confirm the post-fire integrity of the vegetation however was re-sampled in October 2023 as the vegetation may have been drought-affected in February 2020.
2	694	PCT 694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (poor)	2.36	2	2 (P1_2021 and P9_2023)	Both plots were sampled under average or higher rainfall conditions and post-fire in vegetation that was not burnt.
3	1231	PCT1231: Swamp Mahogany (Bangalay) swamp sclerophyll forest on coastal lowlands (moderate)	2.81	2	2 (Q4_2023, P8_2023)	Both plots were sampled under average or higher rainfall conditions and post-fire in vegetation that was not burnt. Q4 was also sampled in February 2020 to confirm the post-fire integrity of the vegetation however was re-sampled in October 2023 as the vegetation may have been drought-affected in February 2020.
4	1232	PCT 1232 Swamp Oak Floodplain swamp forest (moderate)	0.06	1	1 (Q3_2021)	Q3_2021 was sampled under average or higher rainfall conditions and post-fire, in vegetation that was not burnt. Plot was sampled outside of the very small area of this vegetation zone within the development footprint, because the majority of the PCT occurs in a riparian corridor that is not suitable for development. The plot was sampled within the same, single patch of the PCT that intersects the development footprint, around 50m from the impact area.
5	1236	PCT 1236 Swamp Paperbark -Swamp Oak tall shrubland on estuarine flats (moderate)	6.71	3	3 (Q6_2021, Q8_2021) and P5_2021)	Q6 and Q8 originally sampled pre-fire in 2018. Re-sampled in September 2021, under average or higher rainfall conditions and nearly two years post-fire in vegetation that was severely burnt but had substantial regrowth. P5_2021 sampled in November 2021. Substantial regeneration was evident at this time, with all species able to be identified to species level. Q7_2021 was also originally sampled pre-fire in 2018 and re-sampled in September 2021 and has contributed to the general description of PCT 1236. However, this plot included edge-affected native vegetation and non-native vegetation associated with tracks and so was not included in BAM credit calculations.
6	1326	PCT 1326 Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands (moderate)	1.38	1	1 (Q5_2021)	Q5_2021 sampled under average or higher rainfall conditions and post-fire, in vegetation that was not severely burnt. Substantial regeneration was present at the time of field surveys, with all species present able to be identified to species level.

Zone ID	PCT ID	Vegetation zone	Area(ha)	Minimum number of plots required	Plots sampled and entered into BAM-C	Assessment of plot data adequacy
N/A		Non-native and cleared land	1.64	N/A	N/A	P4_2021 and P6_2021 were sampled under average or higher rainfall conditions and in vegetation that was severely burnt. Substantial regeneration was evident in adjoining areas at this time, with all species able to be identified to species level. The areas sampled by these plots featured bare earth, mown exotic grass and/or environmental weeds that could be sampled at this time.

Threatened plant surveys

Potential candidate species credit entities for the proposal site were identified and assessed in accordance with the BAM (DPIE 2020a). All threatened plants are classified under the BAM as species credit entities as their occurrence cannot be reliably predicted based on vegetation type. The suite of threatened plants with potential to occur in the proposal site was identified based on the desktop assessment results and the species credit entities identified at stage 5 of BAM credit calculations (see section 6.1.2).

A likelihood of occurrence ranking was attributed to potential candidate species based on this information and used to compile lists of confirmed 'candidate threatened species' (that is, threatened flora requiring targeted survey) according to Step 2 'assess the habitat constraints and vagrant species on the subject land' of section 5.2.2 of the BAM (see section 6.1.2 and Appendix B). The list of confirmed candidate species and survey effort employed to discount their presence at the development footprint is provided in Table 6.2.

Habitat for these species was identified and assessed based on existing literature relating to the study area (ERM 2004; EMM 2014), threatened species profiles, observations of habitat features and resources during field surveys and the experience and judgement of GHD, OMVI and ecoplanning ecologists.

Targeted surveys were undertaken by GHD, ecoplanning and OMVI. Surveys were completed for threatened flora species that were either predicted to occur at the site by the BAM calculator or identified during the desktop review as having potential to occur within the study area given known distributions, previous records in the locality and habitat requirements for each species (refer to Appendix B).

Surveys for conspicuous species that are readily detectable when present, such as *Melaleuca biconvexa* (Biconvex Paperbark), *Rhodamnia rubescens* (Scrub Turpentine) and *Syzygium paniculatum* (Magenta Lilly Pilly) included random meander transects across the study area, according to the methods of Cropper (1993) at all stages of field surveys. This was supplemented by systematic threatened flora traverses over multiple additional flora survey rounds. Targeted threatened flora survey rounds were undertaken in summer (January 2018 and December 2018), spring (September 2018) and autumn (March 2019) to address survey timing requirements for the candidate threatened flora species identified as having potential to occur. The initial rounds of threatened flora survey effort included in the 2021 DA version of this BDAR are shown on Figure 3.1 including GPS track logs indication the location of threatened flora traverses.

Supplementary surveys were conducted in December 2022, January 2023, April 2023 and October 2023 to provide additional certainty in survey results for threatened orchid species and other more cryptic flora that may have been less detectable under drought conditions during 2018 and 2019 (see Section 6.1.2). The 2022-23 survey rounds were conducted in unburnt or mature post fire regeneration greater than six months after the 2020 wildfire in accordance with the *Guideline for applying the BAM at severely burnt sites* (EES 2020). The suitability of survey conditions was further confirmed by checking of reference populations (see section 6.1.2).

Targeted searches for more cryptic species such as *Cryptostylis hunteriana* (Leafless Tongue Orchid*), Caladenia tessellata* (Thick Lip Spider Orchid), *Galium australe* (Tangled Bedstraw), *Haloragis exalata* (Square Raspwort), *Pterostylis gibbosa* (Illawarra Greenhood), *Pterostylis ventricosa* and *Prostanthera densa* were completed by walking parallel transects spaced 5-10 metres within areas of suitable habitat with reference to threatened species survey guidelines (OEH 2016b, DPIE 2020c). Concurrent with the threatened orchid habitat assessment summarised in Appendix E, the approved species expert participated in targeted surveys for *Pterostylis ventricosa* (April 2023) and *Caladenia tessellata* (October 2023) across areas of potential habitat for the subject species within the development footprint along with additional threatened flora listed as candidate species in Table 6.2 with aligned PCT associations, survey season and growth form.

'Systematic targeted surveys' were conducted for confirmed candidate threatened flora species, which comprised systematic traverses with 5-10m wide spacing through all areas of suitable habitat. These surveys were focused in areas of proposed impact in potentially suitable habitat in PCTs with which each species is associated according to the TBDC (DPE 2023a) and within immediately adjoining vegetation. GPS track logs were used to help ensure appropriate coverage of potential habitat and to demonstrate survey effort. Targeted threatened flora traverse survey effort across the supplementary seasonal survey rounds are shown on:

– Figure 3.2 Supplementary flora survey effort December – January 2023
– Figure 3.3 Supplementary flora survey effort April 2023

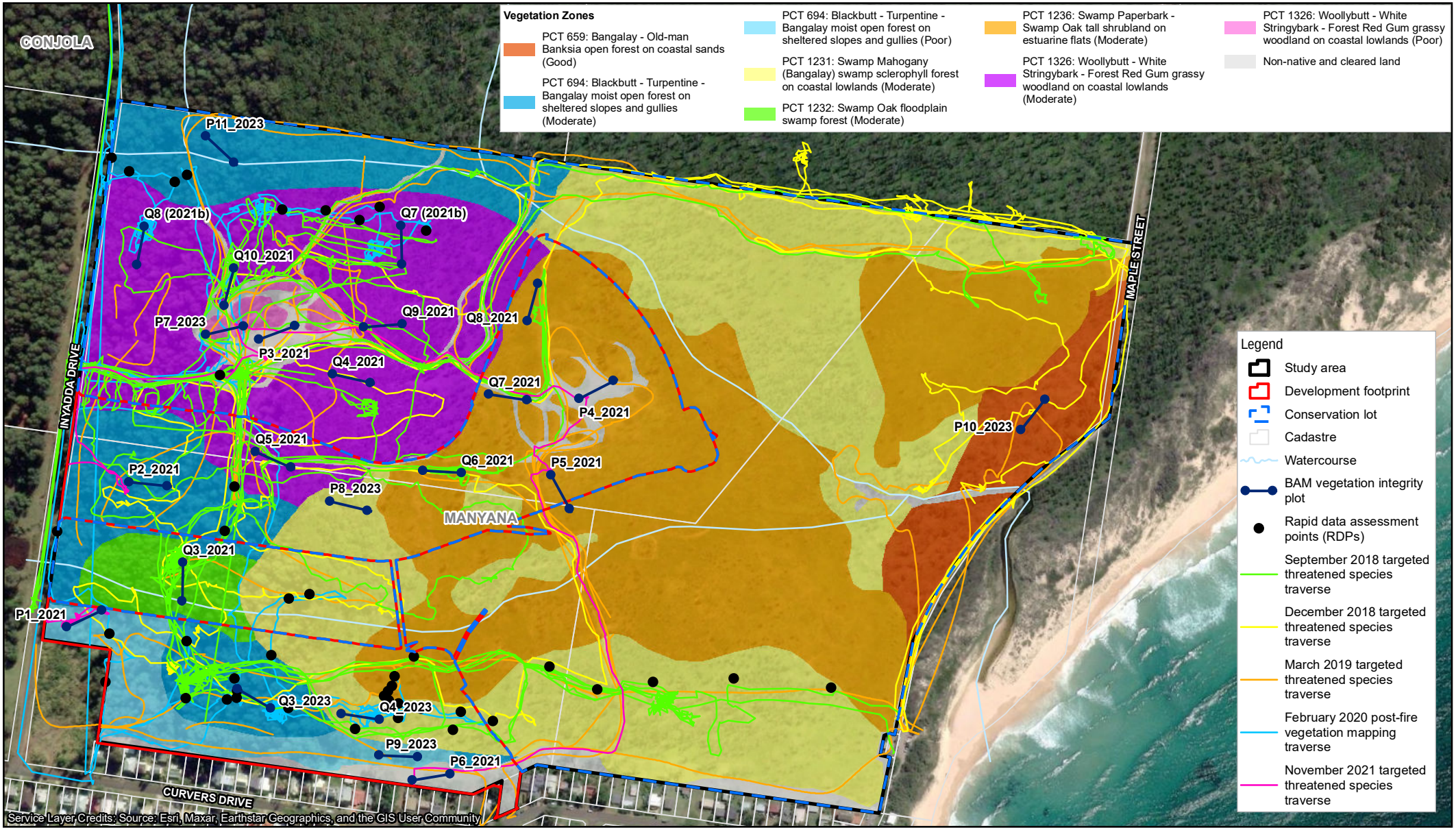
– Figure 3.4 Supplementary flora survey effort October 2023.

The suitability of the timing of these three supplementary survey rounds was confirmed by checking of reference populations for the key species that were targeted as follows:

– *Cryptostylis hunteriana* was confirmed flowering at a reference site at Manyana water treatment plant on 20/12/22, coinciding with the December 2022 survey round, and still flowering at this reference site and a nearby area in Conola NP on 26/01/23, coinciding with the January 2023 survey round (GHD ecologists, B Ryan OMVI pers. obs.)
– *Pterostylis ventricosa* was confirmed flowering at a reference site at Falls Creek on 17/4/2023 (B Towle, ecoplanning, pers. obs.) coinciding with the April 2023 survey round and at additional reference sites in the Sussex Inlet area in preceding weeks (Oliver L. DPE, pers. comm) and in the Yalwal area on 11 April (Coutts-McClelland K., DPE pers. comm.; emails provided with the BDAR application)
– *Caladenia tesselata* was confirmed flowering at a reference site in Morton NP near Sassafras on 3/10/2023 (B Towle, ecoplanning, pers. obs.) coinciding with the October 2023 survey round.

Overall survey effort included general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as dumped fill, dense weed infestations, edges of water bodies or dense patches of non-target species within associated PCTs.

Section 6.1.2 provides additional details regarding candidate threatened species that were targeted during field surveys including PCT associations, survey effort and survey timing.



Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

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Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

2021 DA Flora survey locations

Figure 3.1

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR002_FloraSurveyEffort.mxd
Print date: 12 Oct 2023 - 14:22

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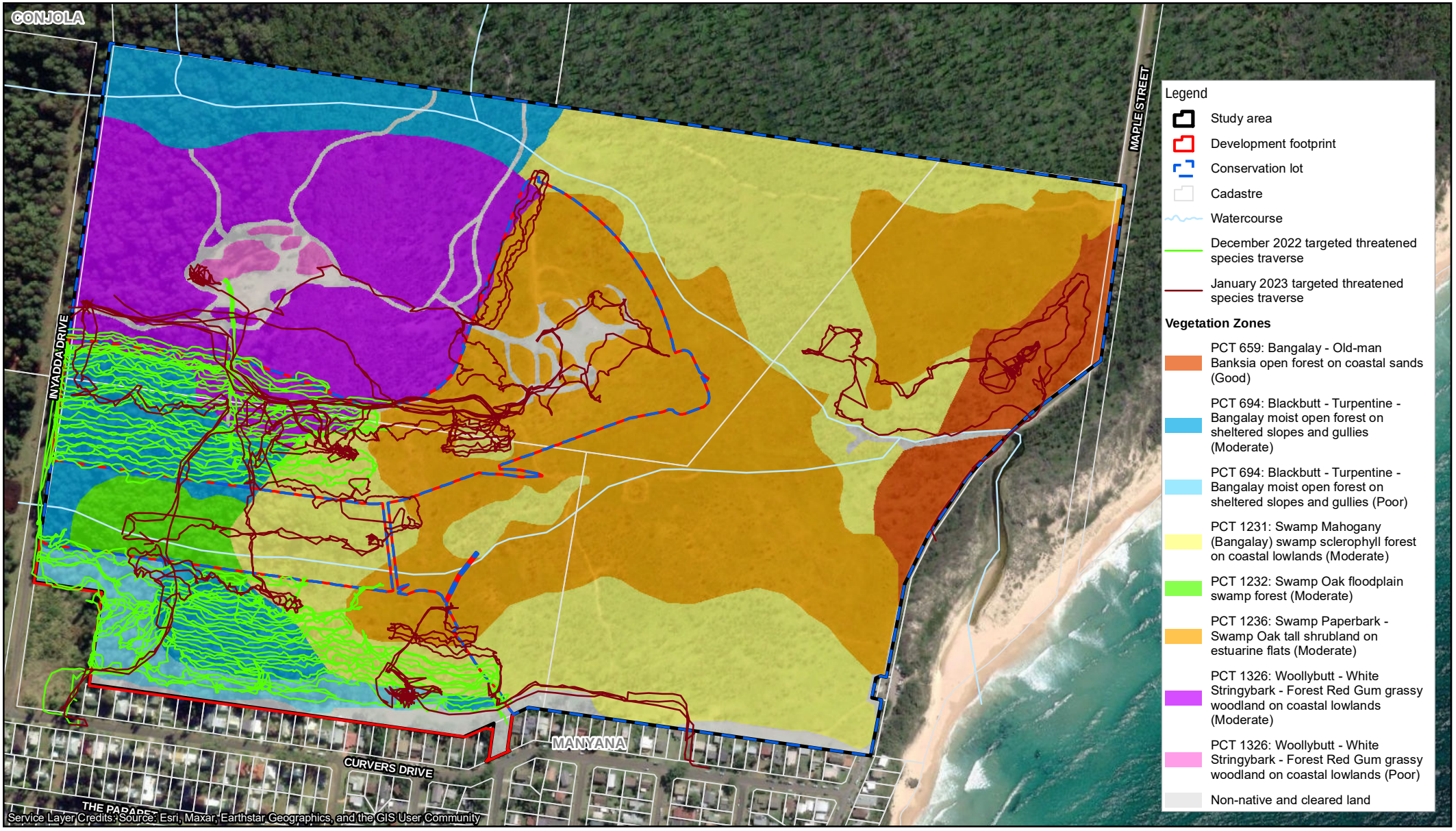

Note: targeted threatened species traverse' comprise systematic walked traverses with 5-10m wide spacing through all areas of suitable habitat in associated PCTs for target threatened flora species. Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as non-native vegetation, dumped fill, dense weed infestations, poorly drained / waterlogged soil or dense patches of non-target species within associated PCTs.

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

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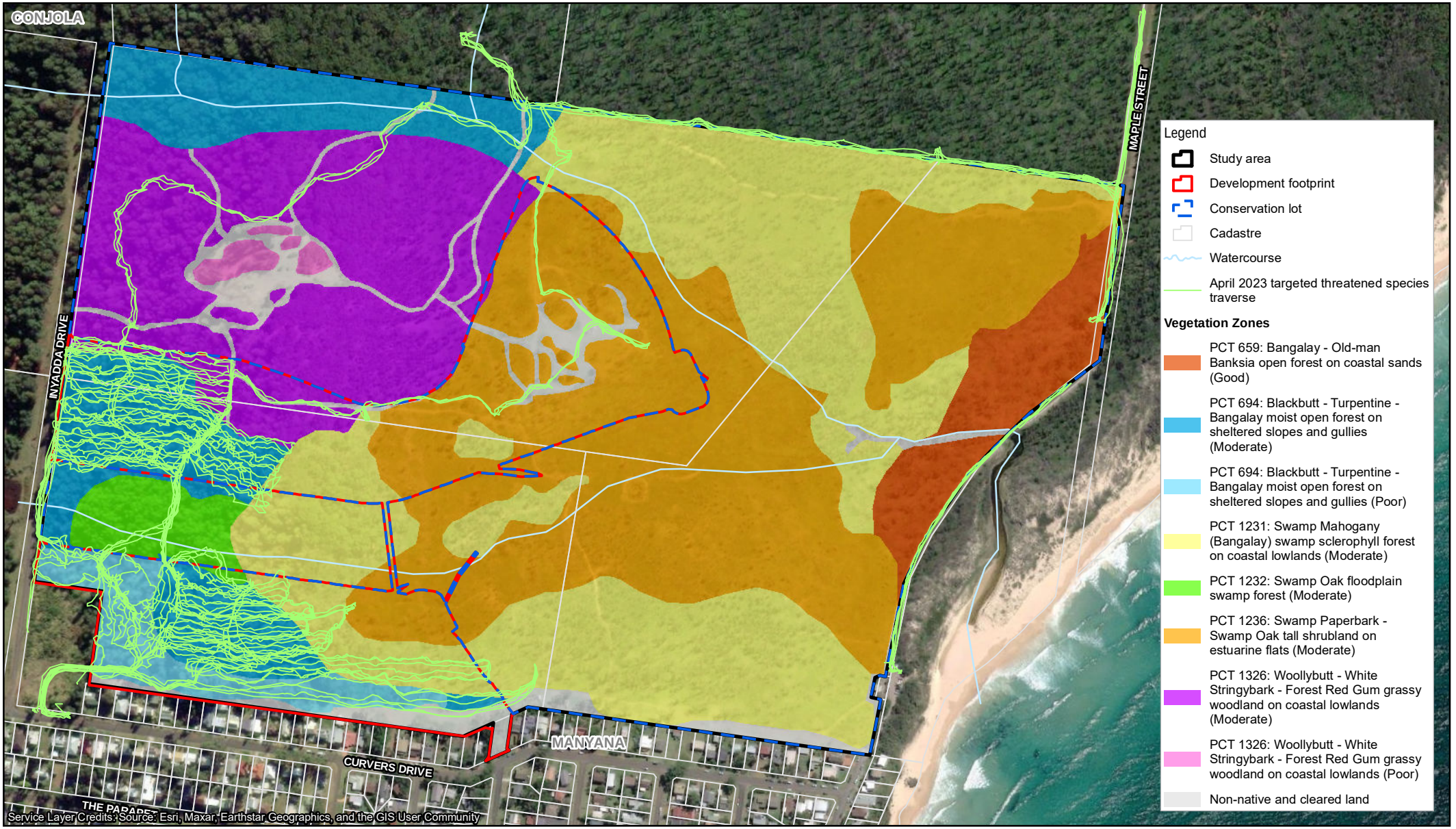
Supplementary flora survey locations
December 2022, January 2023 traverses

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 3.2

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR014_SuppFloraSurveyEffort_Dec22_Jan23.mxd
Print date: 12 Oct 2023 - 14:27

Data source:ESRi: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay



Note: targeted threatened species traverse' comprise systematic walked traverses with 5-10m wide spacing through all areas of suitable habitat in associated PCTs for target threatened flora species. Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as non-native vegetation, dumped fill, dense weed infestations, poorly drained / waterlogged soil or dense patches of non-target species within associated PCTs.

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

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Supplementary flora survey locations
April 2023 traverses

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 3.3

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR015_SuppFloraSurveyEffort_Apr23.mxd
Print date: 12 Oct 2023 - 14:28

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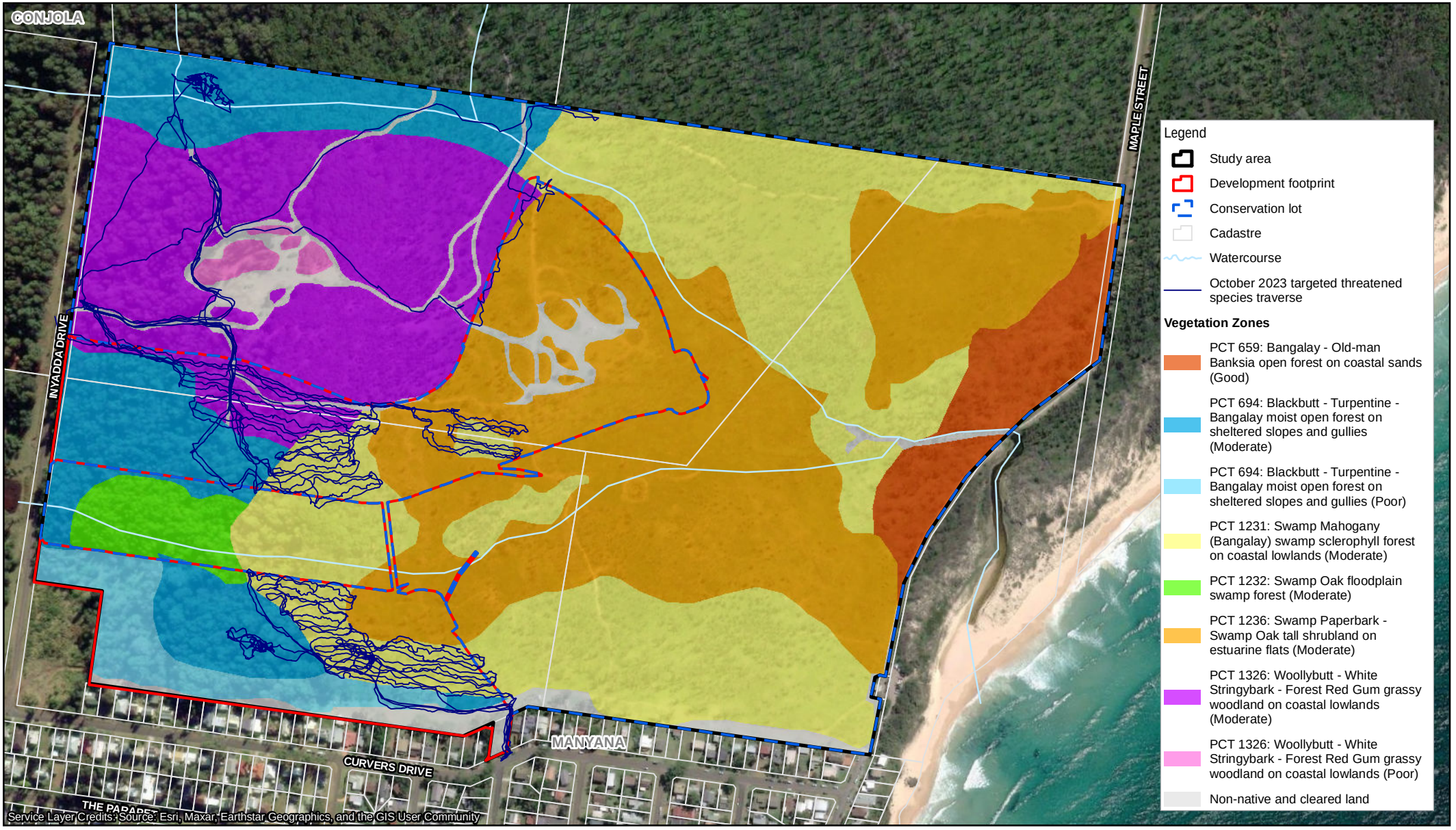

Note: targeted threatened species traverses comprise systematic walked traverses with 5-10m wide spacing through all areas of suitable habitat in associated PCTs for target threatened flora species. Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as non-native vegetation, dumped fill, dense weed infestations, poorly drained / waterlogged soil or dense patches of non-target species within associated PCTs.

Paper Size ISO A4

0 40 80 120 160

Metres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

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Supplementary flora survey locations
October 2023 traverses

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 3.4

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR022_SuppFloraSurveyEffort_Oct23.mxd
Print date: 12 Oct 2023 - 14:31

Data source:ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

3.4.3 Terrestrial fauna surveys

Potential candidate species credit entities for the proposal site were identified and assessed in accordance with the BAM (DPIE 2020a). The suite of threatened fauna with potential to occur in the proposal site was identified based on the desktop assessment results and the species credit entities identified at stage 5 of BAM credit calculations (see section 6.1.2).

A likelihood of occurrence ranking was attributed to potential candidate species based on this information and used to compile lists of confirmed 'candidate threatened species' (that is, species credit entities requiring targeted survey) according to Step 2 'assess the habitat constraints and vagrant species on the subject land' of section 5.2.2 of the BAM (see section 6.1.2 and Appendix B). The list of confirmed candidate species and survey effort employed to discount their presence at the development footprint is provided in Table 6.2.

A variety of techniques were used to assess fauna habitat values and to target confirmed candidate fauna species within the development footprint. Detailed descriptions of survey techniques are provided below and summarised in Table 3.4. All fauna observations were recorded on proforma field data sheets. Fauna survey locations are shown on Figure 3.5.

Seasonal targeted surveys were undertaken over multiple seasons as required to address survey timing requirements for the candidate threatened fauna species identified as having potential to occur (see section 6.1.2). Summer targeted fauna surveys were undertaken within the development footprint over one 4 day/4 night period on 3-7 December 2018, 3 day/2 night period on 20-22 December 2022 and 5 day/4 night period 23-27 January 2023. Rounds of survey over a three day period on 24-26 September 2018 in Spring, a two day period on 12-13 March 2019 in Autumn and a 1 day/2 night period on 27-29 August 2019 in winter were also undertaken. No fauna surveys were completed immediately post-fire.

Opportunistic observations of fauna and identification of fauna habitat was also completed during all stages of vegetation and flora surveys.

Fauna habitat assessment

General fauna habitat assessments were undertaken throughout the development footprint, including active searches for potential shelter, basking, roosting, nesting and/or foraging sites. Specific habitat features and resources such as water bodies, food trees, the density of understorey vegetation, the composition of ground cover, the soil type, presence of hollow-bearing trees, leaf litter and ground debris were noted.

Indicative habitat criteria for targeted threatened species (i.e. those determined as having the potential to occur within the development footprint following the desktop review) were identified prior to fieldwork. Habitat criteria were based on information provided in OEH and DAWE threatened species profiles, field guides, and the knowledge and experience of GHD field ecologists.

Habitat assessments included active searches for the following:

- Hollow bearing trees and number of hollows (large >20 cm, medium >5-20 cm, small <5 cm)
- Trees with bird nests or other potential fauna roosts.
- Rock outcrops or overhangs providing potential shelter sites for fauna.
- Burrows, dens and warrens.
- Distinctive scats or latrine sites (of particular relevance for the Spotted-tailed Quoll), owl whitewash and regurgitated pellets under roost sites.
- Tracks or animal remains.
- Evidence of activity such as feeding scars, scratches and diggings.
- Specific food trees and evidence of foraging (e.g. chewed *Allocasuarina* cones as evidence for Glossy Black-Cockatoo).

The locations and quantitative descriptions of significant habitat features were captured with a handheld GPS unit and photographed where appropriate.

Fauna habitat assessments were completed with reference to the condition of the site and habitat resources present pre-fire, based on observations made during the field surveys completed in 2018 and 2019.

Supplementary habitat assessments were completed in September and November 2021 and in December 2022 and January 2023 during periods of above average rainfall, and advance post fire regeneration. No habitat assessments were completed or elide upon in severely burnt vegetation. This approach meets the requirements specified in the *Guideline for applying the BAM at severely burnt sites* (EES 2020).

Targeted surveys

A summary of the type and total effort of the targeted surveys completed is provided in Table 3.4. Survey effort is related to the list of confirmed candidate species in Table 6.2 in section 6.1.2.

Table 3.4 Targeted fauna survey techniques and effort

Survey type	Effort
Arboreal and terrestrial trap lines	A total of three transects were sampled. Two transects contained a total of 62 traps (six Elliott A (arboreal), six Elliott B (arboreal), 25 cage traps (terrestrial) and 25 Elliott E (terrestrial). One transect contained a total of 50 traps (25 cage traps (terrestrial) and 25 Elliott E (terrestrial)) over 4 day/nights on 3-7 December 2018. 174 traps / night. **Total effort = 696 trap-nights**.
Spotlighting and call playback, including: - Nocturnal amphibian survey - Forest owl breeding habitat survey - Arboreal mammal survey	Four consecutive nights of spotlighting from 3-7 December 2018 (4 x person hours each night) were conducted between the hours of 8 – 10 PM. Survey effort included call playback targeting the Squirrel Glider, Yellow-bellied Glider, Bush Stone-curlew and walked transects in 2018 in four different locations **Total effort = 16 person-hours.** Two consecutive nights of call playback and spotlighting targeting the Powerful Owl, Sooty Owl and Masked Owl from 27-29 August 2019 (5 person hours each night). 3 of these hours were conducted between the hours of 7 – 10 PM and 2 hours conducted between 4.00– 6.30 am within areas of potential breeding habitat for these species. **Total effort = 10 person-hours.** Two consecutive nights of frog aural-visual surveys on 21-22 December 2022 and four consecutive nights 24-27 January 2023 respectively targeting Green and Golden Bell Frogs along aquatic habitat (including drainage line, dams and saline lagoons) within the study area. **Total effort = over 48 person-hours.**
Daytime traverses, including: - Active searches for scats and signs of fauna use - Active reptile/amphibian searches - Koala Spot Assessment Technique survey	Undertook targeted searches in identified preferred habitat for 2 person hours x four days (3-7 December 2018). **Total effort = 8 person-hours**. Included dedicated searches for any signs of fauna occupation/activity in areas of suitable habitat. Included searching for evidence of feeding (e.g. *Allocasuarina* chewed cones, which are signs of Glossy Black-Cockatoo (*Calyptorhynchus lathami)* in dense stands of *Allocasuarina*), foraging and signs of bird presence (such as pellets, whitewash, nests etc.) and other biota (scats, scratchings, diggings, nests etc.). Active searches of woody debris and other ground litter were conducted throughout the development footprint targeting threatened frogs and reptiles. Included Koala surveys using the Spot Assessment Technique (SAT) at three locations.
Ultrasonic call recording	Four anabats positioned in different flyways within the site over four nights (8 hours each/per night over 3-7 December 2018). Two anabat units deployed at two different locations over two nights (8 hrs each/per night over 12-14 March 2019) **Total effort = 160 hours**.
Camera traps	6 x baited motion activated camera traps active for four nights (3-7 December 2018) positioned around the site in suitable habitat. **Total effort = 24 trap-nights**
Diurnal bird surveys	Bird surveys in suitable habitat throughout the study area. 4 person-hours x 6 days (September 24-26 and 3-7 December) 8 person-hours x 1 day (March 12 2019) 4 person-hours x 1 day (27 August 2019) **Total effort = 36 person-hours**.

Nest tree census

A ‘systematic nest tree census’ was conducted over the entire proposal site and accessible vegetation in adjoining areas to help determine the presence of threatened species nest trees to inform the assessment of species credits. All mature trees were inspected for the presence of stick nests and/or hollows. Any large stick nests and hollow bearing trees were mapped and data collected on tree species, diameter at breasts height and number of hollows in the size classes >20 cm, 15-20 cm, 5-15cm and <5cm.

Nest tree census surveys included targeted effort within the breeding season to detect evidence of nesting birds as noted in the TBDC profiles for target species such as the presence of a male and female; or any adult with nesting material; or an individual on a large stick nest in the top half of the tree canopy; or pairs displaying (soaring, diving, engaging in chases, or a male observed calling in flight with a female begging from tree)(DPE 2023b). Additional surveys were conducted outside the breeding season for target species, aligned with diurnal bird survey effort, habitat searches and all other time spent on site. These additional survey periods contributed to the overall effort for species credit matters through observation of candidate nest trees with suitable large stick nests or hollows that could be used for breeding at other times of year.

The initial, core nest tree census and survey effort for candidate species credit matters was conducted in 2018 and 2019 including dedicated survey effort during the breeding season for target species nominated in the TBDC (DPE 2023b). Supplementary inspection of previously mapped candidate nest trees and general searches for additional nest trees were undertaken in December 2022, January 2023, April 2023 and October 2023 along with supplementary surveys for threatened flora and frogs.

Active searches

Active searches of woody debris and other ground litter were conducted throughout the development footprint during the survey periods targeting threatened frogs and reptiles. Fallen timber and other potential shelter sites such as corrugated iron sheets and rock piles were carefully turned and inspected.

Opportunistic observations

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. This included a conscious focus on suitable areas of habitat during flora surveys, for instance fallen timber was scanned and/or turned for reptiles and mature trees and stags were scanned for roosting birds.

Aquatic habitat survey

No permanent aquatic habitat occurs within the development footprint. There are two intermittent, unnamed first and second order drainage lines that run through the study area. The nature and condition of these drainage lines was assessed for fauna habitat values.

Arboreal Elliott trapping and terrestrial cage traps

Targeted threatened arboreal mammal trapping was completed within the development footprint over a 4 day/4 night period on 3 – 7 December 2018.

Species targeted include Squirrel Glider (*Petaurus norfolkensis*), Eastern Pygmy-possum (*Cercartetus nanus*), Southern Brown Bandicoot (*Isoodon obesulus obesulus*), Greater Glider (*Petauroides volans*) and Brush-tailed Phascogale (*Phascogale tapoatafa*).

A total of three trapping transects were conducted. Two transects consisted of 60 traps (six Elliott A, six Elliott B, 25 bandicoot cage traps and 25 Elliott E), while one transect consisted of 50 traps (25 bandicoot cage traps and 25 Elliott E) due to differences in suitability of habitat types. All traps were opened in the late afternoon and checked each morning, closed and then reopened in the afternoon for four consecutive days. The total trapping effort amounted to 440 trap-nights.

Diurnal bird surveys

Targeted surveys for diurnal birds were undertaken throughout the development footprint within two hours of dawn over two separate three-day periods in September and December 2018 as well as one day in March 2019 and one day of 4 person hours for targeted owls in August 2019.

Surveys followed the area search method, and birds were identified by observation with binoculars and/or call identification. Diurnal bird surveys also included searches for signs indicative of particular threatened species, including searching for evidence of feeding (e.g. *Allocasuarina* chewed cones which are signs of Glossy Black-cockatoo (*Calyptorhynchus lathami*) foraging and signs of bird presence, such as pellets, whitewash, nests etc.)

All opportunistic observations of birds were recorded during all field surveys.

Frog surveys

In the initial December 2018 Summer fauna survey round, active searches for frogs were performed within and adjacent to the development footprint focussing on areas of potential breeding habitat, including swamp forest and shrubland, pools of standing water and drainage lines (see 'Frog survey' locations on Figure 3.5). Frogs were identified by sight and call, and call-playback was used to target predicted threatened species with particular focus on the Green and Golden Bell Frog (*Litoria aurea*). Conditions during the survey period were generally suitable for targeted frog surveys (see Table 3.6) however the preceding months featured below average rainfall.

Supplementary frog surveys including aural-visual surveys in accordance with the *NSW Survey Guide for Threatened Frogs* (DPIE 2020) were conducted in the December 2022 and January 2023 survey rounds. A frog breeding habitat assessment was undertaken including identification of potential breeding habitat for the Green and Golden Bell Frog and other candidate threatened frog species. Systematic traverses were conducted of low-lying areas and 'potential wetland frog breeding habitat' was identified and mapped to inform targeted frog survey effort. Potential breeding habitat including drainage line, dams and saline lagoons within the study area is shown on Figure 3.5. A detailed description of wetland and aquatic habitat resources at the study area, including potential frog breeding habitat, is provided in section 5.8.3.

Two consecutive nights of aural-visual surveys on 21-22 December 2022 and four consecutive nights over the period 24-27 January 2023 were conducted targeting Green and Golden Bell Frogs under appropriate seasonal survey conditions (see Table 3.6). Four frog aural-visual survey transects (frog AV transects) were sampled for at least one hour each night along <250 m reaches of potential breeding habitat in accordance with the *NSW Survey Guide for Threatened Frogs* (DPIE 2020). This comprised five minutes of silence, followed by two minutes of call playback and then five minutes of active searches over each 50m of potential breeding habitat over at least one hour per frog AV transect per survey night. Two ecologists sampled two frog AV transects each per survey night. Total effort comprised over 48 person-hours including at least one person-hour of aural visual surveys, per transect per night. Additional spotlighting and quiet listening was undertaken between frog AV transects and at all times during nocturnal survey rounds.

A Green and Golden Bell Frog reference site was checked at Sussex Inlet around 10km north of the study area on at least one night per survey round in December 2022 and January 2023. Green and Golden Bell Frogs were heard calling at the Sussex Inlet reference site on 22 December 2022 and on 25 January 2023. A Green and Golden Bell Frog call response was elicited with call playback on 22 December 2022 and a recording was made using the FrogID app. and confirmed as the species by Australian Museum experts. The FrogID report is included in the field data package provided with this BDAR application. The calling Green and Golden Bell Frogs in the January survey round were too distant for a recording and a call response could not be elicited from any wetland habitat closer to the observer. The observations of Green and Golden Bell Frogs at the Sussex Inlet reference site confirm that survey conditions were suitable for detection of the species if present at the development footprint. This is confirmed by the observation of multiple other frog individuals and species by both call and sight during each frog AV transect survey at the development footprint. Weather conditions and suitability for the frog survey techniques employed are summarised in Table 3.6.

Microchiropteran bat survey

Bat calls were recorded during field surveys using Anabat Express detectors and Anabat II coupled with ZCAIMS (Titley Scientific).

Stationary Anabat recordings were undertaken in four locations over a total of four nights in December and two locations over on night in March. Anabats were positioned over waterbodies and adjacent flyways as shown on Figure 3.5. Recording commenced at least half an hour before dusk and continued until the following morning.

Calls were identified using zero-crossing analysis and AnalookW software (version 4.2n, Chris Corben 2017) by visually comparing the time-frequency graph and call characteristics (e.g. characteristic frequency and call shape) with reference calls and/or species call descriptions from available reference material.

The Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats (Pennay *et al*., 2004) was used to assist call analysis. Call identification was also assisted by consulting distribution information for possible species (Pennay et al. 2004; Churchill 2008; Van Dyck *et al*. 2013) and records from BioNet (October 2016). No reference calls were collected during the survey.

A call (pass) was defined as a sequence of three or more consecutive pulses of similar frequency and shape. Calls with less than three defined consecutive pulses of similar frequency and shape were not unambiguously identified to a species but were used as part of the activity count for the survey area. Due to variability in the quality of calls and the difficulty in distinguishing some species the identification of each call was assigned a confidence rating (see Mills *et al*. 1996; Duffy *et al*. 2000) as summarised in Table 3.5. Due to the absence of reference calls from the study area, high level of variability within a bat call and overlap in call characteristics between some species, a conservative approach was taken when analysing calls. Species nomenclature follows van Dyck *et al*. (2013) and Reardon *et al*. (2014).

Spotlighting

Spotlight searches were undertaken throughout the development footprint for nocturnally active mammals, birds and frogs, including dedicated listening periods for fauna vocalisations. Mammals and nocturnal birds were identified by observation under spotlight or by vocalisations heard whilst spotlighting.

Transects were conducted on foot during the December survey period for four consecutive nights. Transects were walked for a period of 4 person-hours each night between the hours of 9-11 pm. Species targeted during spotlighting surveys included the Bush Stone Curlew (*Burhinus grallarius*), Eastern Pygmy Possum (*Cercartetus nanus*), Barking Owl, (*Ninox connivens*), Squirrel Glider (*Petaurus norfolcensis*), Brush-tailed Phascogale (*Petrogale penicillata*), Koala (*Phascolarctos cinereus*), Grey-headed Flying Fox (*Pteropus poliocephalus*), Green and Golden Bell Frog (*Litoria aurea*) and Yellow- bellied Glider (*Petaurus australis*).

Spotlighting was also conducted on foot during the August 2019 survey period for two consecutive nights. A random meander search within areas known to contain hollow bearing trees was used to target Powerful Owl (*Ninox strenua*) and Masked Owl (*Tyto novaehollandiae*) was conducted for 10 person hours each night, 6 person hours between 7 and 10 pm and 4 person hours pre-dawn between 4 and 6.30 am.

Table 3.5 Confidence ratings applied to calls

Identification	Description
D - Definite	Species identification not in doubt.
PR - Probable	Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call type or call lacks sufficient detail.
SG - Species Group	Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species e.g. *Chalinolobus gouldii* / *Mormopterus ozimops* sp. *Nyctophilus* sp. The calls of *Nyctophilus geoffroyi* / *gouldi* cannot be distinguished during the analysis process and are therefore lumped together. *Nyctophilus sp* / *Macropus*. The calls of these species can be easily confused during the analysis process and are therefore often lumped together.

Camera traps

Six baited infra-red motion cameras were set up across the development footprint for the four day survey period in December (3-7 December 2018). These cameras were used to target Bush Stone-curlew (*Burhinus grallarius*) Brush-tailed Phascogale (*Petrogale penicillata*), and Long-nosed Potoroo (*Potorous tridactylus*).

Call playback

Nocturnal call playback surveys were conducted over three consecutive nights during each of the December survey period. Species targeted included Bush- stone Curlew (*Burhinus grallarius*), Greater Glider (*Petauroides*

volans) and Yellow- bellied Glider (*Petaurus australis*). It is acknowledged that Greater Glider is not typically responsive to call- playback, so this technique was used in conjunction with spotlighting and trapping.

Surveys involved an initial listening period of five minutes, followed by call playing for three minutes, followed by a listening period of five minutes (undertaken separately for each species), with a final listening period of approximately 10 minutes. Calls were played through a portable MP3 player connected to a 45-watt megaphone. All potential habitat in the immediate area was then scanned for 10 minutes using spotlights.

Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Heir Asquith Pty. Ltd.
North Manyana Subdivision
Biodiversity Development Assessment Report

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Fauna survey locations

Figure 3.5

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR003_FaunaSurveyEffort.mxd
Print date: 12 Oct 2023 - 14:22

Data source: ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

1.2 Application of the BAM to severely burnt sites

The *Guideline for applying Biodiversity Assessment Method at severely burnt sites* (EES 2020) ('the Guideline') was reviewed and the methods outlined in the document were applied where appropriate to this assessment.

The initial step in the Guideline questions whether the BAM stage 1 assessments for a site were partially completed prior to bushfire impacting the site, which is the case for this assessment. In line with the requirements of section 4.1.2 of the Guideline, consultation with the consent authority (who at the time, was BCD) was undertaken to determine the appropriate approach for the remaining assessment. Vanessa Allen (Senior Conservation Planning Officer, BCD) confirmed that it was appropriate to continue with the assessment of the proposed development site, given much of the development site was not severely burnt and that the assessment should refer to the Guideline once published (Vanessa Allen, BCD pers. com. via email, 30/1/2020) (n.b. this consultation occurred prior to publication of the Guideline but was informed by an understanding of its purpose and likely content).

Once confirmation of approach was received, section 4.2 of the Guideline was reviewed and the severity of fire impacts on the site was determined. This involved accessing the Google Earth Engine Burnt Area Map (GEEBAM) (DPE 2020), combined with aerial/drone photography of the study area post-fire in January 2020, and the results of field surveys completed in February 2020 to ground truth the accuracy of the GEEBAM as it applied to the site. The GEEBAM burnt area classes as they apply to the site were updated based on the actual extent of fire across the site. Table 1 of the Guideline was reviewed to determine burn severity (refer to Table 4.3). This exercise allowed the assessor to indicate the areas of the site that had been severely burnt and those which had not been severely burnt.

This BDAR has been completed with reference to the Guideline, in the following ways:

– A description of the bushfire impacts has been provided, including figures demonstrating where GEEBAM burnt area classes 'canopy fully affected', 'canopy partially affected' and 'canopy unburnt' are present within the site, as well as a description of the fire.
– Use of pre-fire aerial imagery to estimate the native vegetation cover and extent on the subject land and within a 1500m buffer.
– Determination of PCTs, any corresponding TECs, and vegetation zones present within the site based the results of field surveys completed prior to bushfire impacting the site, or once advanced post-fire regeneration had occurred, and information provided indicating whether vegetation zones were severely burnt or not severely burnt, based on the criteria in Table 1 of the Guideline.
– Habitat assessments and targeted threatened species searches were completed prior to the bushfire, or once advanced post-fire regeneration had occurred and species polygons have been mapped based on the conditions on site prior to fire.
– SAII assessments have been completed based on the extent and distribution of relevant threatened biota pre-fire.

3.5 Survey conditions

Bureau of Meteorology (BOM) records for survey dates are outlined in Table 3.6 along with an assessment of suitability of conditions for targeted surveys. Rainfall observations were taken from Climate Data Online statistics from Bendalong STP weather station (BOM Station ID 68229) around 1 km from the study area for the period September 2018 to February 2023 (BOM 2023a).

Temperature records and rainfall records for the period February 2023 to October 2023 were taken from the Ulladulla weather station (BOM Station ID 069138) located approximately 13 km south of the development footprint because data for Bendalong were not available (BOM 2023a).

Note that these confirmed observations may differ from records on field data sheets which were noted in the field using weather apps and may comprise unverified data and/or data from another weather station.

Table 3.6 Weather observations during targeted survey periods (BOM 2023a)

Survey round	Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall previous 24 hours (mm)	Rainfall previous 7 days (mm)[1]	Suitability of conditions for targeted surveys
Targeted flora surveys	January 2018	Not recorded	Not recorded	Not recorded	Not recorded	*Cryptostylis hunteriana* flowering at reference site.
Vegetation and habitat assessment, BAM plots, targeted flora surveys	24-27 September 2018	8.3	14.2	2.6	8.8	Moderate to below average rainfall in preceding months. Conditions generally suitable for vegetation and habitat assessment. Dry conditions may have limited results from targeted threatened flora surveys and BAM plots.
Targeted fauna surveys including frog surveys, targeted flora surveys	3 December 2018	14.4	29.3	0	130	>30 mm of rainfall in preceding 7 days for most of the survey period and a heavy, 130 mm rainfall event prior to the survey round. Warm, humid evening conditions suitable for detection of frog species.
	4 December 2018	Not recorded	22	0	130	
	5 December 2018	Not recorded	20.1	7.6	31	
	6 December 2018	Not recorded	22.2	0.2	38.6	
	7 December 2018	Not recorded	24.3	0	8.6	
Autumn targeted threatened flora and fauna surveys	12 March 2019	17.8	32.7	0	0.6	Below average rainfall in preceding months. Dry conditions may have limited results from targeted threatened flora surveys. Conditions suitable for bird and microbat surveys.
Winter targeted threatened fauna surveys	27-29 August 2019	9.4	27.6	2.6	7	Conditions suitable for nocturnal bird surveys and nest tree census.
Vegetation and habitat assessment, BAM plots	25 February 2020	18.4	27.6	0.2	2.2	Below average rainfall in preceding months, above average in preceding weeks. Conditions generally suitable for vegetation and habitat assessment. Timing suitable for confirmation of fire impact extent and severity following the January 2020 bushfire.
Targeted fauna surveys, BAM plots	6-7 September 2021	8.0	n/a	3.8	17.6	Advanced post fire regeneration and above average rainfall in preceding months suitable for calculating vegetation integrity in BAM plots and to give an

Survey round	Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall previous 24 hours (mm)	Rainfall previous 7 days (mm)[1]	Suitability of conditions for targeted surveys
						indication of winter-flowering species productivity in the development footprint for Grey-headed Flying-fox.
BAM plots	24 November 2021	16.9	21.7	0.6	35	Advanced post fire regeneration and above average rainfall in preceding months suitable for calculating vegetation integrity in BAM plots.
Illawarra Lowlands Grassy Woodland surveys, vegetation and habitat assessment	29 September 2022	13.0	16.0	55.2	61	Advanced post fire regeneration and above average rainfall in preceding months suitable for revising vegetation mapping and confirming extent of Illawarra Lowlands Grassy Woodland at the study area and locality. Advanced post fire regeneration and above average rainfall in preceding months suitable for revising vegetation mapping and confirming extent of Illawarra Lowlands Grassy Woodland at the study area and locality.
	2 October 2022	9.1	16.2	47.4	153.2	
Targeted flora surveys, frog habitat assessments	20 December 2022	14.3	22.9	0	5	Advanced post fire regeneration and above average rainfall in preceding months suitable for detection of target plant species and frog breeding habitat assessment. *Cryptostylis hunteriana* flowering at a reference site at Manyana water treatment plant on 20/12/23.
Targeted frog surveys	21 December 2022	17.7	20.1	0	2.8	<30 mm of rainfall in preceding 7 days, however warm and humid evening conditions suitable for detection of frog species. Around 4.4 mm of rain during survey period (see rainfall for 23/12/22 below). *Litoria aurea* calling at reference site on 22/12/22.
	22 December 2022	14.3	20.3	0	0	
Targeted flora surveys	23 December 2022	14.7	22.9	4.4	4.4	Advanced post fire regeneration and above average rainfall in preceding months suitable for detection of target plant species. *Cryptostylis hunteriana* flowering at a reference site at Manyana water treatment plant on 20/12/23.
Targeted frog surveys,	23 January 2023	17.1	22.9	31.4	67.4	>30 mm of rainfall in 7 days preceding each survey night including 31.4 mm on the 24 hrs leading up to the
	24 January 2023	15.9	24.9	0	67.4	

Survey round	Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall previous 24 hours (mm)	Rainfall previous 7 days (mm)[1]	Suitability of conditions for targeted surveys
vegetation and habitat assessment, BAM plots, targeted flora surveys	25 January 2023	17.5	25.0	5.2	72.6	first night. Warm, humid evening conditions suitable for detection of frog species. *Litoria aurea* calling at reference site on 25/1/23. *Cryptostylis hunteriana* flowering at a reference site at Manyana water treatment plant on 26/01/23. Advanced post fire regeneration and above average rainfall in preceding months suitable detection of target plant species and for calculating vegetation integrity in BAM plots.
	26 January 2023	19.1	28.3	0	72.6	
	27 January 2023	17.6	23.3	1.2	39.6	
Targeted flora surveys	17-20 April 2023	12.0	23.0	0	107.0	*Pterostylis ventricosa* flowering at a reference site at Falls Creek on 17/4/2023 (B Towle, ecoplanning, pers. obs.) and at additional reference sites in preceding weeks (Coutts-McClelland K., DPE pers. comm.; Oliver L. DPE, pers. comm.) Advanced post fire regeneration and above average rainfall in preceding months suitable for detection of target plant species.
Targeted flora surveys	3-5 October 2023	16.9	34.5	0.8	7.4	*Caladenia tesselata* flowering at a reference site at Sassafaras on 3/10/2023 (B Towle, ecoplanning, pers. obs.) Advanced post fire regeneration and non-drought conditions in preceding months suitable for detection of target plant species.

Notes: 1) Rainfall previous 7 days (mm) reported for first day of multi-day flora and general fauna survey periods and individual days for targeted frog survey periods.

3.6 Geographic Information System (GIS) analysis

GIS analysis is an integral part of the BAM. GIS was used to plot the development footprint on a high-resolution aerial photo and to map vegetation types and biodiversity values across the site. GIS analysis was used to calculate the extent of native vegetation to be impacted as well as the extent of native vegetation within the buffer area.

GIS analysis was used to accurately determine the relevant IBRA region, IBRA Sub-region and Mitchell Landscape for the site.

Additional GIS analysis was used to plot a 1,500 metre buffer area surrounding the site in which site context components were calculated. Native vegetation cover, extent and connectivity were assessed using aerial photography. Air photo interpretation was used to identify and record distinct vegetation patches, determine the broad condition state of vegetation types and the location and extent of vegetated habitat corridors. The buffer area and GIS area calculations were used to enter information about landscape value and to determine the change in Landscape Value score by assessing the impact of the development on native vegetation cover and connectivity as well as the patch size.

3.7 BAM calculations

1.2.1 Predicted threatened species (ecosystem credit entities)

Based on the bioregional context for the assessment and the PCTs, patch size, vegetation cover and habitat resources present at the project site, the BAM calculator generates a list of threatened fauna species that are predicted to utilise the project site (that is, potential 'predicted threatened species', or potential 'ecosystem credit entities'). The potential for these predicted threatened species to occur within the site were further refined based on the desktop assessment, habitat resources observed during field surveys, records during the surveys, and the knowledge and experience of the assessor. Targeted surveys are not required under the BAM for these species as they are assumed to be present.

Targeted surveys may, however, be required if the predicted species are also listed under the EPBC Act, to assess the significance of impacts in accordance with the *MNES Significant impact guidelines 1.1 – Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013). A range of methods were employed to ensure appropriate survey effort for EPBC Act threatened species.

1.2.2 Candidate threatened species (species credit entities)

Threatened species that cannot reliably be predicted to occur on a development site based on PCT, distribution and habitat criteria are identified by the Threatened Biodiversity Data Collection as 'species credit' entities. In some circumstances, the particular habitat components of species assessed for ecosystem credit species, such as the breeding habitat of a cave roosting bat or forest owls, are also assessed for species credits.

The credit calculator references geographic, vegetation and habitat data for the project site to generate a list of the species credit entities that are predicted to occur (ie the 'potential candidate threatened species'). Searches of threatened species databases were also completed to identify any additional potential candidate threatened species (to those generated by the credit calculator) that are known or predicted to occur in the locality. The likelihood of occurrence of potential candidate threatened species were reviewed, giving consideration to the habitats available in the study area (refer to likelihood of occurrence tables in Appendix B).

1.2.3 Assessor's use of judgement

The BAM-C calculations were finalised by Ben Harrington using credit calculator version 1.4.0.00, BAM data version 61, based on the data and assumptions presented throughout this BDAR. The biodiversity credit report is included in Appendix F.

The BAM-C calculations are based on legacy PCTs in accordance with associated transitional arrangements (DPE 2023b) as described in section 3.4.2. As the BAM-C case for this assessment was in progress prior to the deployment of the Eastern NSW PCTs, the legacy PCTs and associated vegetation zones and data were retained.

To enable this, ‘legacy data’ was selected in the ‘reference data version’ drop down option in the ‘Site Context’ tab of the BAM-C.

The draft BCAR, including BAM Stage 1 assessment, was completed prior to the 2019/2020 summer bushfire event when a portion of the site was burnt. GHD engaged in further consultation with the BCD, primarily between January and May 2020 regarding the assessment approach and completion of the BDAR in accordance with the *Guideline for applying the BAM to severely burnt sites* (EES 2020). Section 4.9 and Table 4.3 presents an assessment of fire impact severity at the time of collection of plot data in the post September 2021 survey rounds and confirms that these areas did not comprise severely burnt vegetation at the time of sampling. Noting that 2018-2019 plot data may have limitations associated with the drought conditions during that period, BAM vegetation integrity plots sampled in unburnt portions of the site and/or when substantial post fire regeneration had occurred have been preferred for BAM-C calculations in this BDAR (i.e. plot data from unburnt vegetation and/or mature post-fire regeneration sampled in September 2021, November 2021, January 2023 or October 2023).

On 1 February 2023, the BAM-C was updated to include Version 1.2 benchmarks. During the designated transitional period, assessors with in-progress assessments on the date that the BAM-C Version 1.2 benchmarks update occurs may opt to manually modify benchmarks and continue to apply (the previous) Version 1.1 benchmarks. To be eligible to apply transitional arrangements to a BAM-C case, the assessor must finalise the BAM-C assessment prior to 2 August 2023 and submit the certified Biodiversity Assessment Report (BAR) prior to 16 August 2023 (DPE 2023b). The BAM-C case for the project was commenced prior to 1 February 2023 however was not finalised prior to 16 August 2023 and so the version 1.2 benchmarks have been retained in the BAM-C.

Accredited assessors also made the following judgements and/or assumptions while completing this BDAR:

– Use of data from plots outside the current development footprint, due to changes to the subdivision layout:
  - Zone 4 (PCT 1232_moderate condition) relies on one plot (Q3_2021) that was sampled just outside the development footprint in a connected patch of vegetation that is considered representative of vegetation in the development footprint
– Manual addition of a hollow bearing tree record in plots sampled in the development footprint to ensure compliance with the BAM (section 4.3.4 *5. The assessor must ensure that all function attributes relevant to the PCT, including the presence of any hollow bearing trees, are captured within a minimum of one plot. 8-12. 8. The assessor must assess the vegetation zone for the presence of hollow bearing trees. 11. Where hollow bearing trees are present within a vegetation zone, the assessor must include a hollow bearing tree in at least one plot for that zone*)(DPIE 2020a) as follows:
  - A hollow bearing tree record added to plot Q4 (2020) to ensure that Zone 3 (PCT 1231_moderate) was recognised as containing hollow bearing trees
  - A hollow bearing tree record added to plot P8_2023 to ensure that Zone 6 (PCT 1326_moderate) was recognised as containing hollow bearing trees.
– Omission of data from plot Q7_2021 because it may have included non-native vegetation and/or locally degraded native vegetation associated with tracks that intersected part of the plot.

1.3 Assumptions

This BDAR relies upon the description of the proposal and summary assessment of potential environmental impacts provided in the SEE that accompanies the DA (Egis Consulting 2023a). A ‘development footprint’ polygon (that is, disturbance footprint) was prepared for the project based on subdivision layout and design data provide by Egis Consulting Pty Ltd on behalf of Heir Asquith in August 2023. It is assumed that the description and spatial data accurately represent the extent of direct impacts arising from the proposal and so these data have been used to calculate the extent of removal of vegetation and habitat arising from the proposal using GIS. These calculations have in turn been relied upon in the BAM calculations and the determination of key thresholds such as whether the proposal would have a direct impact on a threatened species, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated subdivision design and/or spatial data.

The assessment of potential indirect and prescribed impacts in this BDAR relies on modelling, data analysis and conclusions presented in the Integrated Water Cycle Stormwater Management Report (Egis Consulting 2023a)

and coastal engineering advice report (Horton Coastal Engineering 2023) that accompany the DA and SEE (Egis Consulting 2023a).

3.8 Staff qualifications

This BDAR and associated credit calculations has been prepared and certified by Ben Harrington (accredited assessor number BAAS17023). The credit calculator and BDAR were peer reviewed by Kirsten Crosby (accredited assessor number BAAS17017).

This BDAR has drawn upon early drafts of credit calculations and reporting undertaken by other GHD ecologists and accredited assessors. Qualifications of GHD and subconsultant ecologists who completed field surveys and report inputs are presented in Table 3.7.

Table 3.7 Field staff qualifications and project role

Name	Position/Project role	Qualifications	Relevant experience
Ben Harrington	Technical director - Biodiversity / lead author of BDAR and credit calculations, flora and fauna surveys	BSc. MSc. BAM Assessor Accreditation	18+ years
Kath Chesnut	Senior ecologist / accredited assessor, co-author of BDAR, flora surveys, BAM plots	BEnvSc (Hons) BAM Assessor Accreditation	12+ years
Kirsten Crosby	Technical director – Biodiversity / technical review of BDAR	BSc. Phd	16+ years
Mal Weerakoon	Senior ecologist / targeted flora and fauna surveys	BSc, Mphil	9+ years
Gary Leonard	Botanist / Vegetation mapping, BAM plots	MSc, DipEd, Dip Horticulture	40+ years
Cecilia Phu	Senior ecologist / plot surveys, targeted flora surveys, credit calculations, contributing author of draft BDAR	BSc (Hons) BAM Assessor Accreditation	12+ years
Kim Baker	Fauna ecologist / targeted fauna trapping	BEnvSc	8+ years
Philippa Fagan	Ecologist / plot surveys targeted flora and fauna surveys, credit calculations, contributing author	BBiod.&Cons. BAM Assessor Accreditation	4+ years
Madeline Young	Ecologist / flora surveys, contributing author	BEnvSc (Hons) BAM Assessor Accreditation	4+ years
Bridie Halse	Graduate ecologist / assistant for targeted flora and fauna surveys	BEnvSc&Mgt	1+ years
Natasha Reid	Graduate ecologist / targeted threatened fauna surveys	BEcology, Dip Agriculture	1+ years
Isabel Lyons	Graduate ecologist / targeted threatened flora surveys, BAM plots	BNatural Resources and Agriculture	1+ years

Name	Position/Project role	Qualifications	Relevant experience
Brian Towle (ecoplanning)	Senior botanist / targeted *Pterostylis ventricosa and Caladenia tesselata* surveys. Orchid habitat assessment	BEnvSc (Hons) BAM Assessor Accreditation Approved *Pterostylis ventricosa and Caladenia tesselata* species expert	15+ years
Brendan Ryan (OMVI Ecological)	Senior ecologist / targeted *Cryptostylis hunteriana* and threatened fauna surveys	BSc (Hons)	22+ years

4. Landscape context

The BAM requires the assessment of landscape features to help describe the biodiversity values of the development footprint and assess the impacts of the proposal. Landscape features are discussed in relation to a buffer area of 1,500 metres surrounding the boundary of the development footprint. Landscape features relevant to this assessment are shown on Figure 1.1 to Figure 4.2, are discussed below and summarised in Table 4.2.

The landscape assessment has also been undertaken with due respect to pre-fire conditions. A description of the effects of the 2019-2020 bushfires on the landscape and development footprint is provided in section 4.9 and has been prepared in accordance with the Guideline for applying the BAM to severely burnt sites (EES 2020).

4.1 Location and existing land uses

The study area is situated approximately 0.5 km north of the township of Manyana, and 12 km north of the regional town of Ulladulla, within the Shoalhaven City Local Government Area (LGA). The study area is located across Lot 106 DP 755923 and Lot 2 DP 1161638, Manyana, NSW (refer to Figure 1.1).

The study area is bound by Sunset Strip and Maple Street in the east and Inyadda Drive to the west. Residential housing along Curvers Drive adjoins the southern boundary, and native vegetation extends along and to the north of the northern study area boundary.

The western portion of the development footprint is zoned R5 – Large Lot Residential, while the eastern portion is zoned C3 – Environmental Management. There is also a small area of R1 – General Residential in the centre of the development footprint.

The study area contains relatively intact native vegetation, apart from small areas modified by clearing, underscrubbing or other recent human disturbances. Two previously cleared areas are situated within Lot 106 DP 755923, in the north of the study area. There are a number of cleared tracks and areas of disturbed land throughout the study area, which contain patches of exotic perennial grasses and exposed soil. These areas have been subject to significant and ongoing disturbance, such as rubbish dumping, including household refuse and car bodies. Some tracks throughout the study area also appear to be used regularly by four-wheel drives, with evidence of heavy use in wet conditions. A transmission line easement also occurs along the eastern boundary.

The study area was originally cleared for farming, with further clearing occurring between the 1950s and 1970s. The vegetation on the study area has regrown in places, and parts of the study area were previously affected by bushfires in 2001.

The three lots that make up the study area considered as part of this assessment were affected by the bushfires in the summer of 2019 – 2020. The eastern half of the study area was severely burnt (refer to Figure 4-4 and section 4.9) by the fires. Much of the proposed conservation lot severely burnt, while the western portion of the study area, including most of the development footprint, was unburnt or only understorey vegetation was burnt, with minimal damage to the tree canopy.

4.2 Geology and soils

4.2.1 Soil landscapes

No soil landscape reports of the study area are available. Instead, the following information has been obtained from the Ulladulla 1:250,000 Geological Map (Rose 1966) available on DIGS (DPIE 2016) and the NSW Geology app.

Most of the study area, including the majority of the development footprint falls on Cenozoic alluvium, made up of unconsolidated alluvial clay, silt, sand and gravel deposits. There are small patches of Quaternary alluvium, mapped as alluvial valley deposits, made up of silt, clay (fluvially deposited), lithic to quart-lithic sand and gravel. There is a small patch of Quaternary alluvium of coastal deposits – backbarrier flat facies made up of fine to medium-grained quartz-lithic sand with carbonate and humic components (marine deposited), indurated sand, silt,

clay, gravel, organic mud and peat to the east of the study area, in an area that corresponds to the lagoon near the beach.

4.2.2 Soil hazards

Soil landscapes for the development footprint and surrounding buffer area indicate that the soils have low erosional risk and have low (Class 5) acid sulphate potential (Shoalhaven City Council 2018). (refer to Figure 4.2).

4.2.3 Geology

There are no karst, caves, crevices, cliffs or other areas of geological significance located within the development footprint or buffer area surrounding the study area.

4.3 Hydrology

4.3.1 Waterways

The study area includes two small un-named ephemeral drainage lines that merge in the eastern portion of the study area and drain east into an un-named lagoon, which in turn drains into the Pacific Ocean at Inyadda Beach around 400 metres east of the development footprint. For convenience, this creek is referred to as 'Inyadda Creek' in this BDAR and other specialist reports attached to the DA for the proposal. The lower reaches of Inyadda Creek where it meets Inyadda Beach forms an Intermittently Closed and Open Lake / Lagoon (ICOLL) (Horton Coastal Engineering 2023).

The northern of the two drainage lines is a second order stream and the southern drainage line is a first order stream (refer to Figure 1.1). These drainage lines are ephemeral. The ICOLL opens to the ocean infrequently and is rapidly closed as wave action builds up the sand berm across Inyadda Beach (Horton Coastal Engineering 2023).

There are no mapped estuaries within the development footprint. The closest major estuary is associated with Berringer Lake, which is located over 1,500 m west of the development footprint.

4.3.2 Wetlands

No registered nationally important wetlands and mapped coastal wetlands, occur within or adjacent to the development footprint. Wetland habitat associated with smaller waterbodies is described in section 5.8.3.

4.4 Climate

The study area has a temperate climate. Based on data from the Ulladulla weather station the study area has a mean annual rainfall of 1,108 mm, falling predominantly in autumn and late summer. The mean daily maximum temperature is 20.7 degrees and mean daily minimum temperature of 13.2 degrees Celsius (BOM 2018b).

4.5 IBRA region and subregion

The development footprint occurs mainly within the Jervis IBRA (Interim Biogeographic Regionalisation for Australia) subregion of the Sydney Basin Bioregion (refer to Figure 4.1). The Sydney Basin Bioregion lies on the central east coast of NSW and covers an area of about 3,624,008 hectares which includes about 4.53 per cent of NSW (DoEE 2018). The bioregion extends from north of Batemans Bay to Nelson Bay and West to Mudgee and includes a significant proportion of the catchments of the Hawkesbury-Nepean, Hunter and Shoalhaven river systems.

4.6 NSW (Mitchell) landscape

The study area is mapped entirely within the "Milton Basalts and Sands" Mitchell Landscape (refer to Figure 4.2) (DECC 2008d).

The Milton Basalts and Sands landscape is described as occurring on low flat hills near the coast on Tertiary basalts and underlying quartz gravel and sand, elevation 40 to 60 metres. It occurs on well- structured, fertile, brown to red- brown loams and clay loams on basalt with bleached sandy podsols with thin iron pan development on the sands (DECC 2008a).

Vegetation communities typical of this soil landscape include open forests of *Corymbia gummifera* (Red Bloodwood) and *Banksia serrata* (Old Man Banksia). On the coastal headlands, heaths of *Hakea sericea* (Hakea), *Melaleuca armillaris* (Bracelet Honey-myrtle), *Westringia fruticosa* (Coast Rosemary) and dwarfed Red Bloodwood occur in shallow soils subject to high salt spray input and frequent fire (DECC 2008a).

4.7 Determining site context

To determine site context as required under the BAM, an assessment of native vegetation cover and patch size (Section 4.7.1 and 4.7.2) has been undertaken and is outlined below.

4.7.1 Native vegetation cover

Native vegetation cover (woody and non-woody) was assessed on the proposal site and within a 1,500 metre buffer area around the outside edge of the boundary of the development footprint. Aerial photography was examined at scales between 1:2000 and 1:4000. The percent native vegetation cover within the 1,500 metre buffer area includes (see Figure 4.1):

– Remnant native vegetation types
– Planted native vegetation types
– Derived native grasslands.

Areas that were excluded include:

– Cleared areas
– Non-native vegetation
– Dams, ponds and other waterbodies
– Buildings.

The identification of native vegetation in the buffer area was based on review of the *Compilation map: Biometric vegetation types and endangered ecological communities of the Shoalhaven, Eurobodalla & Bega Valley local government areas* (VIS_ID 3900) (OEH 2013), in combination with aerial photograph interpretation.

, the percent native vegetation cover that is estimated to remain in the landscape is 58%, which falls within the >30-70% size class according to the BAM (DPE 2020a).

The native vegetation cover is shown on Figure 4.1.

Table 4.1 Native vegetation cover

Native vegetation cover unit	1,500m buffer area
Total assessment area	1102 ha
Area of native vegetation cover (woody and non-woody)	635 ha
% native vegetation cover	58%
Cover class	>30-70%

4.7.2 Patch size

Patch size is defined under the BAM (DPIE 2020a) as an area of native vegetation that:

– Occurs on the development site or biodiversity stewardship site (i.e. proposal site).
– Includes native vegetation that has a gap of less than 100 metres from the next area of native vegetation (or ≤ 30 metres for non-woody ecosystems).

Patch size may extend into adjoining land that is not part of a development site or a biodiversity stewardship site. Patch size area is assigned to each vegetation zone as a class, being < 5 hectares, 5-<25 hectares, 25-<100 hectares or ≥ 100 hectares, and is used by the BAM calculator as a filter to predict threatened species likely to occur in the project site.

Vegetation that would be disturbed within the site is part of a much larger remnant patch that extends to the north and west of the site. The size of this patch is greater than 600 hectares.

Given the large amount of native vegetation in the development area and surrounding landscape, in all cases the patch size was greater than 100 hectares and therefore patch size for these zones was entered as 101.

Within the 1,500 metre buffer area surrounding the development footprint, native vegetation comprises 58% of the area. While this number suggests that a large proportion of the buffer area has been previously cleared, it is actually because the development footprint occurs adjacent to the coast, and a large portion of the buffer area contains ocean.

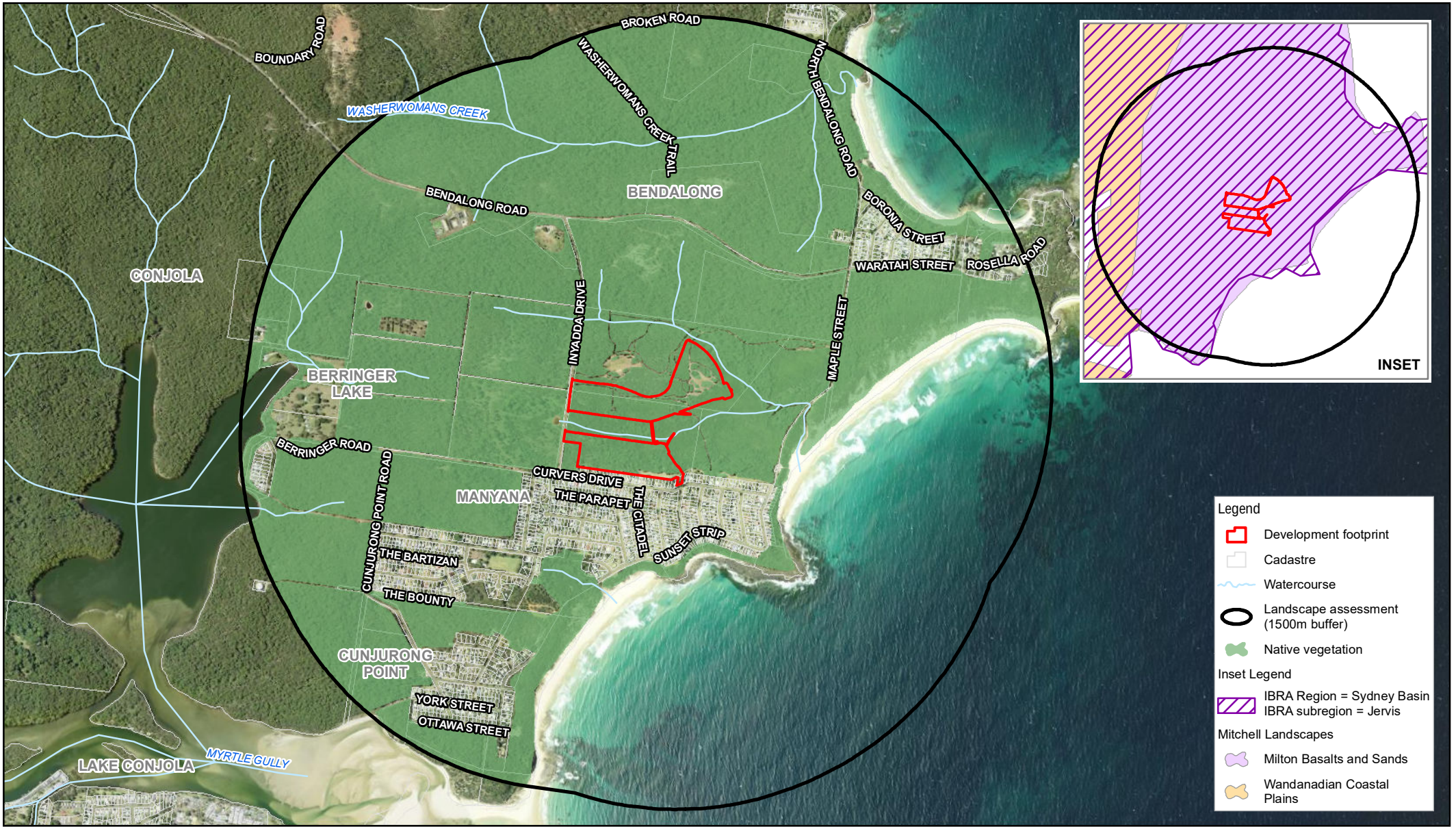
Habitat within the development footprint is connected to extensive areas of native vegetation that extends to the north and west of the site (refer to Figure 4.1).

4.8 Landscape features

A summary of the landscape features requiring assessment is provided in Table 4.2 below.

Table 4.2 Summary of landscape features present within the development footprint

Landscape features	Development footprint
Method applied for site context components	Site-based
Interim Biogeographic regionalisation of Australia (IBRA) bioregion	Sydney Basin
IBRA subregion	Jervis
Mitchell landscapes	Milton Basalts and Sands
% native vegetation extent within buffer area	58%
Rivers, streams and estuaries	The development footprint contains two small un-named ephemeral drainage lines (one first order and one second order) that connect to a lagoon, located on the eastern boundary, which opens intermittently into the Pacific Ocean.
Wetlands	None
Connectivity features	Habitat within the development footprint is connected to extensive areas of habitat that extend to the north and west of the site.
Areas of geological significance or soil hazard features	Soil landscapes for the development footprint and surrounding buffer area indicate that the soils have low erosional risk and low acid sulphate potential. There are no areas of geological significance of relevance to the site.
Areas of outstanding biodiversity value	No areas identified under the BC Act as being of outstanding biodiversity value have been mapped in the development footprint.
Other landscape features	Nil



Paper Size ISO A4

0 175 350 525 700

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Heir Asquith Pty. Ltd.
North Manyana Subdivision
Biodiversity Development Assessment Report

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Location map (pre-fire)

Figure 4.1

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR005_LocationMap_PreFire.mxd
Print date: 12 Oct 2023 - 14:24

Data source: LPI: DTDB / DCDB / Aerial Imagery, 2017; DECCW: IBRA bioregions, 2013, Mitchell Landscapes, 2008. Created by: fmackay

Paper Size ISO A4

0 175 350 525 700

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Biodiversity Development Assessment Report

Project No. 21-27200
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Soil landscapes and soil hazards

Figure 4.2

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR006_SoilHazards.mxd
Print date: 12 Oct 2023 - 14:24

Data source: ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017; OEH: ASS Risk, Soil types 2016; DECCW: IBRA bioregions, 2013, Mitchell Landscapes, 2008. Created by: fmackay

4.9 Consideration of severely burnt vegetation

4.9.1 Overview

The 2019-2020 bushfire season started earlier than normally experienced (NSW Rural Fire Service 2019; 2019, August 1), with multiple bushfire complexes burning through millions of hectares across the state (SBS News 2019, November 11). The 2019-2020 bushfire season worsened significantly around November 2019, with increasing temperatures and prolonged drought representing contributing factors (CDP 2019, September 9) and catastrophic fire danger levels declared in a number of regions including Greater Sydney, the Illawarra and Greater Hunter.

There were a few major fires on the south coast in late December 2019; at Currawan, Clyde Mountain, Palerang and Badja Forest Road (Bladen 2020, January 1). The Currawan bushfire spread to the eastern side of Lake Conjola on 31 December 2019, cutting off access to the hamlets of Bendalong, Manyana and Cunjurong Point (Bladen 2020, January 1; Davies 2020, January 3; Lapham and Moss 2020, January 8). Extreme fire conditions were experienced on Saturday 4 January 2020. It is understood between 31 December 2019 and 6 January 2020, parts of Manyana were burnt, including the study area (Bladen 2020, January 1; Davies 2020, January 3; Lapham and Moss 2020, January 8).

Most of the fires in NSW were contained by 10 February 2020 after significant rainfall events, and all fires in NSW were extinguished by 3 March 2020 (Cox 2020, February 10; Guy 2020, March 3). There were no further fires within the study area after 6 January 2020.

4.9.2 Estimated extent of fire impact in the study area and surrounds

The Google Earth Engine Burnt Area Map (GEEBAM) (DPE 2020) burnt area classes are defined as:

- No data – No data provided
- Low – Burnt understory with unburnt canopy
- Medium – The canopy is partially burnt. A mix of burnt and unburnt canopy vegetation. May act as a refugia within the fire ground that may act for native fauna. The understorey may be burnt.
- High – The canopy and understory are likely to be completely burnt.
- Very high – The canopy or highest stratum have been completely consumed.
- Not native vegetation – Not mapped as native vegetation.

Within the site, the GEEBAM indicates ‘low’ to 'very high’ burnt area classes are in the study area, as shown on Plate 1.

Plate 1 GEEBAM burnt area classes as mapped within the study area (source: GEEBAM, DPE 2020)

In late January 2020, following the bushfires, the proponent organised for a drone to be flown over the study area to further assess the extent and severity of the bushfires. The key findings from the drone imagery were:

– The eastern portion of the study area (predominantly outside of the development footprint) was severely burnt with a very hot canopy fire throughout (Photograph 1). The canopy was completely consumed, along with all other stratum. These impacts align with the definition of 'severely burnt', as per Table 1 of the Guideline.
– A narrow linear strip extending north/south along the western edge of the severely burnt vegetation was subject to some impacts to canopy vegetation as well as understorey vegetation, aligning with the definition of 'medium' or 'high' burnt area classes, with medium being a mix of burnt and unburnt canopy vegetation, and high being both a canopy and understory likely to be completely burnt. This strip is evident in Photograph 1 and 2, in areas where the canopy appears brown, rather than black.
– The canopy in the western portion of the study area, including much of the development footprint, was not burnt, however there may have been some small areas of minor fire damage to the understorey, which aligns with the 'low' burnt area class of the GEEBAM, indicating that the understorey has burnt but the canopy has not (Photograph 2).
– A portion of the development footprint has been subjected to understorey burn only (Photograph 3), which also aligns with the 'low' burnt area class of the GEEBAM, indicating that the understorey has burnt but the canopy has not.

Based on the drone imagery in conjunction with on-ground data from the February 2020 site visit, an extent of burn map was estimated for the study area and is shown in Figure 4.3. The mapping shown on Figure 4.3 shows the actual estimated extent of bushfire impacts within the study area, as opposed to the coarse scale of mapping provided in the GEEBAM, which was designed as an interim product only, with "*no ground truthing or assessment of accuracy*" (DPE 2020). Ground-truthing of the impacts of fire on the site was completed once it was safe to do so, in February 2020.

The far south-eastern portion of the development footprint would have comprised severely burnt vegetation in early 2020 (refer to Table 1, EES 2020). In these areas, the canopy trees of the dry sclerophyll forest were severely impacted, or the canopy was largely consumed (with most leaf material charred and scorched) and only early stage epicormic growth was observed on some trees (Photograph 4). The understorey (including the shrub layer and ground vegetation) was largely consumed by the fire with only new resprouting growth evident during the February 2020 site visit.

In areas where only the understorey was impacted by fire, regeneration of the understorey was more developed by comparison, but the mid story was severely burnt or absent as of February 2020 (Photograph 5 and Photograph 7). The understorey and mid storey vegetation had substantially regenerated at the time the BAM vegetation integrity plots that are included in this BDAR were sampled in September 2021 and January 2023 (Photograph 6 and Photograph 8).

The eastern portion of the conservation lot was almost completely burnt and comprised severely burnt vegetation in February 2020. In these areas, the canopy trees of swamp oak – Melaleuca scrub, swamp forest and dune forest were severely impacted, or the canopy was largely consumed (with most leaf material charred and scorched). Early stages of regrowth have been observed in this area, in the form of epicormic growth (Photograph 4). Smaller areas in the western portion of the conservation lot were not impacted by the bushfires.

The topography of the study area is generally flat, with excess surface flows/runoff draining into the northern and southern drainage lines which drain to the east. The Swamp Oak vegetation within the eastern portion of the development footprint situated between the two drainage lines indicates that drainage on site is relatively impeded in these areas, as is typical of low-lying coastal lands. This is supported by observations on site of soft, wet organic soils in these areas a few days after rain events. Excepting in high rainfall events, moisture and nutrients accumulated on site are likely to stay onsite and permeate through the soil.

Within the surrounding 1,500 m buffer assessment area, the estimated extent of burn is approximately 3 km^2, which extends north of the study area beyond Bendalong Road and Washerwomans Creek and west of the study area primarily along the eastern and northern foreshore of Bellinger Lake, and further to the north of the lake (Figure 4.3).

Photo 1 ***February 2020: view to the west from the south-east corner of the study area (Curvers Drive at the left of the photo). Severely burnt areas in the foreground, with unburnt areas within the development footprint in the background***

Photo 2 ***February 2020: view towards north-east (Inyadda Drive at the left of the photo). The central clearing at the study area is in the mid-ground, with severely burnt areas in the background towards the foreshore***

Photo 3 ***February 2020: view to the south-east from the centre of the study area. Vegetation in the foreground exhibits burnt understorey with canopy scorching. Vegetation in the midground, to the rear of Manyana Beach, between the hamlets of Manyana and Cunjurong Point was unburnt. Cunjurong Point is visible in the background with Green Island and Buckley's Beach beyond the point***

Photo 4 ***February 2020: severely burnt shrubby swamp sclerophyll forest in the south-eastern portion of the study area***

Photo 5 ***February 2020: grassy woodland to the north of the development footprint. Only the understorey has been burnt below a largely intact canopy. Photo oriented south in the vicinity of plot Q7 (2020) / Q7 (2021b)***

Photo 6 ***September 2021: grassy woodland to the north of the development footprint. Advanced understorey and mid storey regeneration. Photo oriented south in the vicinity of plot Q7 (2020) / Q7 (2021b).***

Photo 7 ***February 2020: PCT1231 along the drainage line between the northern and southern portions of the development footprint. Only the understorey has been burnt below a largely intact canopy***

Photo 8 ***January 2023: PCT1231 along the drainage line between the northern and southern portions of the development footprint. Advanced understorey and mid storey regeneration.***

The most recent pre-fire aerial imagery was accessed, dated September 2019, and burnt area classes were refined in September and November 2021 in response to a response to request for additional information from DAWE. Figure 1.1 and Figure 4.1 show the extent of vegetation pre-fire across the study area. Figure 4.3 shows the refined burnt area classes, as per the GEEBAM classification. As shown on Figure 4.3, as of February 2020 only the eastern portions of the site were severely burnt, while the western portions of the study area were not severely burnt.

The extent and burn severity of the 2019-2020 wildfire on vegetation within the study area was assessed with reference to the EES (2020) *Guideline for applying the Biodiversity Assessment Method at severely burnt sites*. The guideline may require modifications to the application of the BAM for vegetation integrity plot data sampled within severely burnt vegetation. Table 4.3 below provides a summary of the extent and burn severity of the 2019-2020 wildfire on vegetation within the study area as assessed post September 2021 and governing the use of BAM vegetation integrity plots in this BDAR. Some of these plots were located in areas that were not burnt in the 2019-2020 bushfires (i.e. were in the western portion of the site). Some of the plots that were sampled or re-sampled in the post September 2021 survey rounds were in areas that had been severely burnt as assessed immediately post fire, in February 2020. However post September 2021 there was sufficient regeneration that plants could be readily identified to species level and vegetation structure and function attributes contributed to an appropriate index of the vegetation integrity of the development footprint. Notably the highest cover values for shrubs, grasses, herbs/forbs and other plant growth forms were recorded in plots sampled post September 2021 and frequently exceeded values in plots sampled in similar areas in 2018 and 2019.

Table 4.3 presents an assessment of fire impact severity at the time of collection of plot data in the post September 2021 survey rounds and confirms that these areas did not comprise severely burnt vegetation at the time of sampling. Noting that 2018-2019 plot data may have limitations associated with the drought conditions during that period, BAM vegetation integrity plots sampled in unburnt portions of the site and/or when substantial post fire regeneration had occurred have been preferred for BAM-C calculations in this BDAR (i.e. plot data from unburnt vegetation in February 2020 and mature post-fire regeneration sampled in September 2021, November 2021 or January 2023). Photos 9 and 10 show areas of advanced advanced understorey and mid storey regeneration and sub-mature overstorey regeneration in an area that was formerly severely burnt as of February 2020.

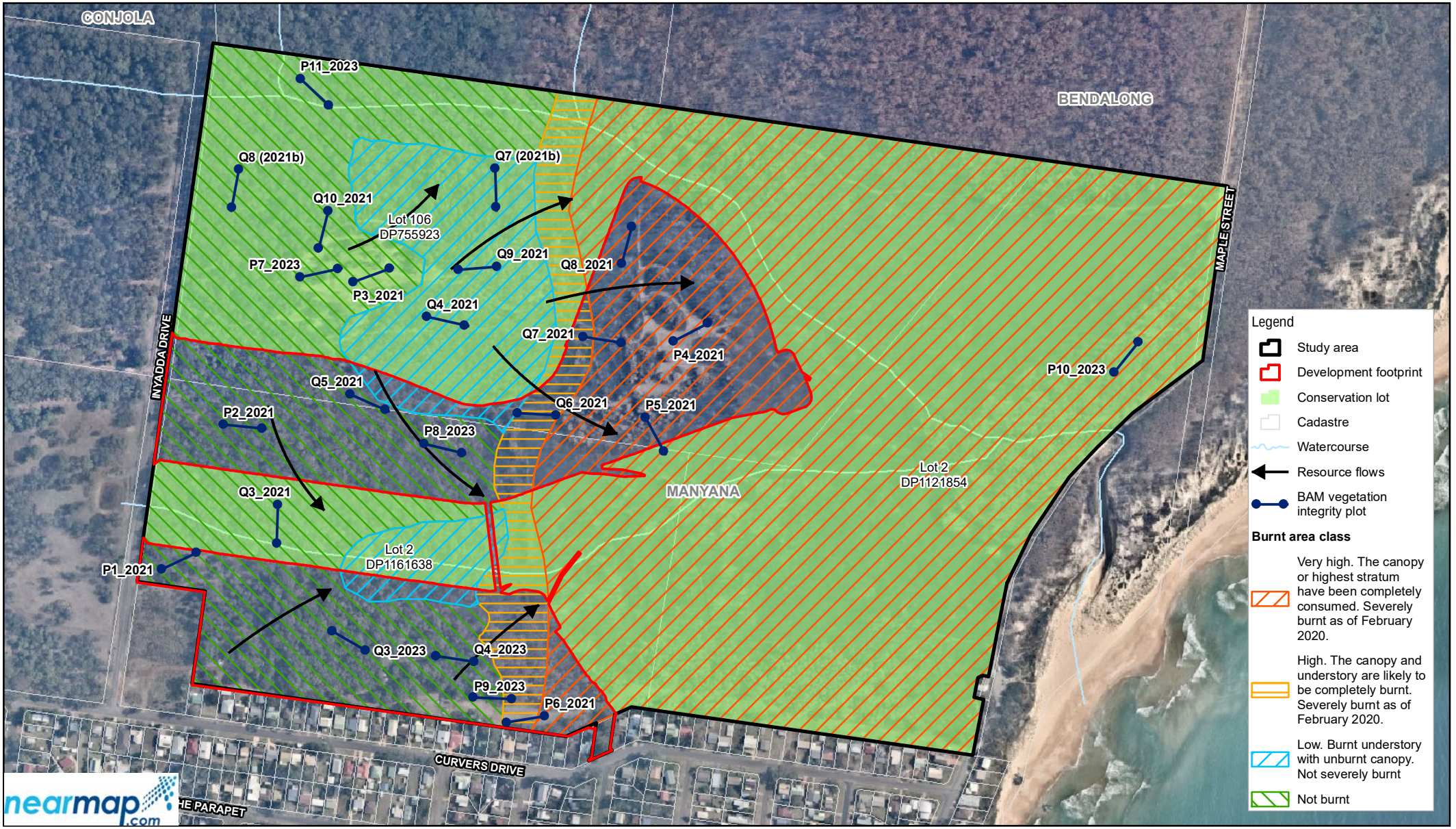
Appendix A provides a summary of how this BDAR is consistent with the Guideline (EES 2020).

Table 4.3 ***Assessment of criteria for determining a severely burnt site as applied to vegetation containing BAM vegetation integrity plots sampled in this BDAR***

Feature	Descriptive characteristics for severely burnt vegetation (EES 2020, Table 1)	Applicability to vegetation on site mapped as 'Very high' and 'High' burnt area classes on GEEBAM 1,2	Applicability to vegetation on site mapped as 'Medium' and 'Low' burnt area classes on GEEBAM
Species richness	The range of species present before the fire are burnt and/or cannot be identified. Dominant species cannot be easily identified until regeneration occurs.	No. Species could be readily identified, including 21 to 32 native plant species per plot in areas of native vegetation[1].	No. Species could be readily identified.
Growth form: trees	Canopy trees are killed and/or canopy is consumed or largely consumed with most leaf material charred/scorched. Epicormic growth, if present, is not well developed (<1m long).	Yes. Canopy has been largely consumed by fire. 6.2 to 41% native tree cover per plot present as regenerating trees in areas of native vegetation [1].	No. Canopy trees remain intact, without damage or scorch to leaf material.
Growth form: shrubs, forbs, ferns and other	All understorey plants are consumed or largely consumed (some charred). Re-growth, if present, is immature (very few species have attained full height).	No. Understorey plants had been consumed by fire, but regrowth was mature post September 2021, including 10.2-52.6% native shrub cover and 0.2 to 3.4% native forb/herb and other cover per plot in areas of native vegetation. This is at least comparable to cover of 0.2 to 0.7% in plots sampled in similar locations prior to the fire. The greatest forb/herb cover overall (3.2%) was recorded in P5_2021, and greatest other cover recorded overall (3.4%) was recorded in Q6_2021 sampled post fire [1]. Fern cover	No. Most to all understorey species remain present and identifiable.

Feature	Descriptive characteristics for severely burnt vegetation (EES 2020, Table 1)	Applicability to vegetation on site mapped as 'Very high' and 'High' burnt area classes on GEEBAM 1,2	Applicability to vegetation on site mapped as 'Medium' and 'Low' burnt area classes on GEEBAM
		was negligible pre- and post-fire.	
Growth form: grasses and grass-like	Ground cover is consumed, or largely consumed. Evidence of ground scorch is present. Re-growth, if present, consists predominately of new resprouting growth (native vegetation).	No. Understorey had been consumed by fire, but regrowth was mature post September 2021, including 29.5-58.6% native grass cover per plot in areas of native vegetation. Grass cover is likely to be higher in these post-fire conditions than in a mature successional stage of PCT 1236 once Melaleuca and Swamp Oak overstorey had fully developed (per. obs.)	No. ground cover species are still present, and there is no sign of ground scorch.
Logs	Logs (if expected to have been previously on site) are absent or largely consumed.	No. Logs not absent or largely consumed. An average 7.4 lm of logs in plots sampled in 2021 versus 10.1 m in plots sampled in similar locations prior to the fire. Greatest length of logs overall (34 lm) recorded in P5_2021, sampled post fire.[1]	No. Coarse woody debris remains intact.
Litter cover	Pre-fire surface litter (if expected) is consumed. Soil organic layer is consumed or largely consumed. New leaf may be occurring where the canopy was burnt but not scorched	No, pre-fire surface litter not consumed and present as 9.2 to 59% cover per plot in areas of native vegetation[1]	No. Litter cover remains intact.
Ash	White ash deposition and charred organic matter is present to several centimeters depth.	N/A There was evidence of charred organic matter in the February 2020 field survey, however this feature is not relevant to this assessment of fire impact severity >18 months post fire.	No. No ash deposits or charred organic matter present.
Conclusion		Areas mapped as 'very high' and 'high' on the GEEBAM, and which are shown on the refined fire extent and severity mapping shown on Figure 4.3 did not comprise 'severely burnt' vegetation as defined by the Guidelines (EES 2020) post September 2021, and so there is no requirement to modify the application of the BAM in these areas.	Areas mapped as 'medium' and 'low' on the GEEBAM, and which are shown on the refined fire extent and severity mapping shown on Figure 4.3 were not 'severely burnt', as defined by the Guidelines (EES 2020) post September 2021 OR at February 2020, and so there is no requirement to modify the application of the BAM in these areas.

Notes: 1) BAM vegetation integrity plots sampled in September or November 2021 native vegetation on site mapped as 'Very high' and 'High' burnt area classes and used to calculate vegetation integrity score in BAM C - Q6_2021, Q7_2021, Q8_2021 and P5_2021. 2) BAM vegetation integrity plots sampled in November 2021 in areas adjoining the plots sampled in native vegetation listed above and used to confirm the presence of non-native vegetation on site - P4_2021 and P6_2021.



Note: 'severely burnt' areas as of February 2020 defined in accordance with the Guideline for applying the Biodiversity Assessment Method at severely burnt sites (EES 2020). These areas did not comprise severely burnt vegetation at the time of sampling BAM vegetation integrity plots post September 2021.

Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Site map (post-fire)

Figure 4.3

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Print date: 12 Oct 2023 - 14:25

Data source: Nearmap: Aerial dated March 2020, extracted 20200818; LPI: DTDB / DCDB, 2017. Created by: fmackay

Photo 9 ***November 2021: PCT 1236 at plot P5_2021. Advanced understorey and mid storey regeneration and sub mature over storey regeneration in an area that was formerly severely burnt as of February 2020.***

Photo 10 ***September 2021: PCT 1236 at plot Q7_2021. Advanced understorey and mid storey regeneration and sub mature over storey regeneration in an area that was formerly severely burnt as of February 2020.***

5. Native vegetation and habitats

5.1 Native vegetation extent

The majority of the development footprint and wider study area comprises native vegetation. There is approximately 17.95 ha of native vegetation in the 19.58 ha development footprint, and about 54.89 ha of native vegetation in the remainder of the study area (ie, within the conservation lot).

There are several narrow cleared 4WD tracks and other cleared and disturbed areas through the study area that do not contain native vegetation (see Figure 5.2). Some of these areas that contain non-native vegetation are mowed/slashed areas at the northern end of properties along Curvers Drive, where it appears that asset protection zones (APZs) have been established to minimise bushfire risk. P6_2021 and P4_2021 were sampled in the development footprint and P3_2021 in the conservation lot to help confirm the lack of native vegetation (refer to Figure 3.1 for their locations and Appendix D for the plot data collected).

All of the native vegetation within the development footprint is connected with off-site vegetation and comprises a single patch exceeding the 635 ha of connected vegetation in the buffer area. Therefore, the patch size for each of the vegetation zones in the development footprint was entered as 635 ha.

The current native vegetation extent at the study area is significantly greater than historically. The site was extensively cleared for agriculture, residential dwellings and related infrastructure prior to 1970. NSW Government (2023) *Historical Imagery – Search and Discover* aerial imagery from 1970 shows that the majority of the tree cover at the study area had been removed prior to this date. As shown in Plate 2, native vegetation had been cleared from the study area other than a narrow strip along the northern boundary, a patch of wet sclerophyll forest in the south west, dune vegetation in the far east and occasional paddock trees. This vegetation removal coincides with the extent of volcanic, fine grained sedimentary and alluvial soil at the study area that is likely to have been more productive for agriculture than much of the land in the surrounding area (pers. obs.).

As of 1997 native vegetation cover was still considerably lower than at present. As shown in Plate 3, vegetation cover mainly consisted of sub mature regrowth and there were extensive areas of cleared land that are roughly aligned with the current extent of non-native and poor condition native vegetation at the study area. As discussed in sections 5.2 and 5.3 below, this pattern of clearing and regeneration has influenced the character of the vegetation at the study area including areas of structurally simple and species-poor forest and the relatively few hollow-bearing trees compared to the surrounding landscape.

Contemporary (May 2023) aerial imagery shows native vegetation cover across the majority of the study area. As shown in Plate 4, areas of non-native vegetation have been maintained along the southern edge of the study area adjacent to residential dwellings and where ongoing human use of clearings in the centre of the study area has suppressed native vegetation. Tall tree cover is still substantially lower than in remnant native vegetation to the north of the study area, however this probably reflects poor drainage at lower elevations favouring species such as Melaleuca species and Swamp Oak (*Casuarina glauca)* over eucalypts. As described above the lower elevation, eastern portion of the study area was also severely burnt in early 2020 which reduced tree cover.

Despite the extensive clearing of the study area as of 1970 it exhibits high resilience as shown by the establishment of moderate condition native vegetation over less than 50 years of passive regeneration. It would not appear that the study area was ever effectively sown with exotic pasture or grazed intensively or for long enough to exhaust the native soil seed bank. The native vegetation cover sampled by BAM vegetation integrity plots in this BDAR comprises mature regeneration. Areas of non-native vegetation in the conservation lot will be revegetated and are likely to have good potential for regeneration given the demonstrated resilience of the rest of the study area. The conservation lot and the approach to regeneration is described in the VMP (GHD 2023).

Plate 2 The study area (approximate red outline) on 23 May 1970 (NSW Government 2023)

Plate 3 The study area (approximate red outline) on 5 January 1997 (NSW Government 2023)

Plate 4 The study area on 27 May 2023 (NSW Government 2023)

5.2 Plant community types

5.2.1 Previous studies

EMM completed a brief ecological due diligence assessment of the site in 2011, which included a review of previous surveys and assessments completed by ERM (2004) and PB (2006). This assessment was based solely on the results of previous studies and did not include any field surveys. Given the lack of field surveys, the age of some of the mapping it relied upon (ie 2004, 2006), and the disturbance history of the site prior to completion of the 2004 and 2006 surveys including a bushfire in 2002, this BDAR has not relied upon the findings of EMM (2011) to a great degree. Similarly, the results of ERM (2004) or PB (2006) have not substantially influenced the vegetation mapping presented in this BDAR.

Vegetation within the site has been mapped and allocated to PCTs previously and is shown on the *Compilation map: Biometric vegetation types and endangered ecological communities of the Shoalhaven, Eurobodalla & Bega Valley local government areas* (VIS_ID 3900) (OEH 2013).

This mapping indicates the presence of the following PCTs on site:

– PCT 1061 Old-man Banksia - she-oak - Red Bloodwood heathland on coastal sands, southern Sydney Basin Bioregion
– PCT 659 Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion
– PCT 1326 Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
– PCT 1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion (OEH 2013).

This mapping was used as the basis for the field surveys completed for the draft BCAR and current BDAR and has been refined and adjusted based on the results of field verification.

5.2.2 Survey results

Flora species recorded at the study area site are listed in Appendix C. Characteristic species are discussed below in relation to the PCTs and vegetation zones occurring within the development footprint. Plot data and other site observation were considered against the candidate PCTs identified in previous studies. Characteristic species,

vegetation structure, soil type and landscape position were evaluated and compared with descriptions of candidate PCTs in the BioNet vegetation classification (DPE 2023a). The ground-truthed vegetation communities and associated PCTs that were identified and mapped within the study area are summarised in Table 5.1. The justification for selection of these PCTs as the basis of vegetation zones within the development footprint is explained in more detail below.

As outlined in Section 1.2.3, the Revised Eastern NSW PCTs were deployed 14 April 2023. This assessment was well established at this time, and the legacy PCTs and associated vegetation zones and data have been retained in the BAM-C case, this BDAR and within all associated vegetation mapping in accordance with the transitional arrangements for the revised Eastern NSW PCTs (DPE 2023b). The PCTs identified at the study area are summarized in Table 5.1 below.

These PCTs were further split into native vegetation zones based on condition. Vegetation zones are shown on Figure 5.1, summarised in Table 5.2, and described below.

Table 5.1 Vegetation communities, closest matching plant community types and associated TECs in the study area

Vegetation community	Plant community type	Legacy PCT ID	Closest equivalent revised PCT ID	BC Act status	EPBC status
Bangalay forest	Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion	659	3638	Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions EEC	Not listed
Grey Ironbark-Turpentine forest	Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion	694	3154	Not listed	Not listed
Bangalay swamp sclerophyll forest	Swamp Mahogany (Bangalay) swamp sclerophyll forest on coastal lowlands	1231	4009	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC	Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland EEC.
Swamp Oak forest	Swamp Oak Floodplain Swamp Forest, Sydney Basin Bioregion and South East Corner Bioregion	1232	4028	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South east Corner Bioregions EEC	Coastal Swamp Oak (*Casuarina glauca*) Forest of NSW and South East Queensland EEC
Swamp Oak – Paperbark low forest	Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats	1236	4056	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South east Corner Bioregions EEC	Coastal Swamp Oak (*Casuarina glauca*) Forest of NSW and South East Queensland EEC
Woollybutt grassy woodland	Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	1326	3330	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion EEC	Illawarra and south coast lowland forest and woodland ecological community CEEC

Vegetation community	Plant community type	Legacy PCT ID	Closest equivalent revised PCT ID	BC Act status	EPBC status
Non-native and cleared land	n/a			n/a	n/a

5.2.3 Justification of PCT selection

The native vegetation communities within the development footprint and surrounding study area include grassy woodland, both dry and wet sclerophyll forest types, and forested wetlands. There are clear distributional patterns associated with these native vegetation communities on site. Woollybutt (*Eucalyptus longifolia*) grassy woodland occurs in the western part of the study area, at high elevations, on heavy clay-loam soils derived from volcanic substrate with partially impeded drainage. Wet sclerophyll forest characterised by Grey Ironbark (*Eucalyptus paniculata*), Bangalay (*Eucalyptus botryoides*) and Blue Gum – Bangalay hybrid (*Eucalyptus saligna x botryoides* and Turpentine (*Syncarpia glomulifera*) occurs in the south-western and north-western portion of the study area on sheltered slopes, on heavy clay-loam soils derived from fine-grained sedimentary substrate with partially impeded drainage. Swamp Oak (*Casuarina glauca*) forest and Swamp Oak-Paperbark scrub occurs in low-lying areas in the eastern half of the study area, where surface water flow is influenced by the convergence of the northern and southern drainage lines towards the dunes in the east and where drainage becomes increasingly impeded. Shrubby swamp sclerophyll forest with an overstorey of Bangalay (*Eucalyptus botryoides*) and Woolybutt over moisture loving shrubs and sedges occurs as a transitional community between Swamp Oak-Paperbark scrub and drier forest and woodland communities at higher elevations. Shrubby dry sclerophyll forest dominated by Bangalay occurs on near-coastal dunes in the far-eastern portion of the study area, where the underlying sandy soils are relatively deep and free-draining.

Within the above general patterns of distribution, the vegetation within the study area includes broad ecotonal zones, that is areas where the plant species and vegetation structure is transitional between two adjoining communities. Such ecotonal zones are typical in coastal lowland vegetation communities along gradients of soil moisture, salinity, wind exposure and other environmental variables with distance from the coast and this is reflected in the overlapping canopy composition of relevant vegetation communities described by DPE (2023a), OEH (2018b), OEH (2016a), OEH (2013a), Tozer *et al*. (2010), NPWS (2002) and the respective final determinations and listing advice for associated TECs (namely, Bangalay Sand Forest, Illawarra Lowlands Grassy Woodland and Swamp Oak Floodplain Forest). At the study area patterns of disturbance have also had a significant influence on the vegetation composition with the majority of the study area previously cleared for agriculture and with many areas now comprising species poor regrowth in the overstorey stratum. As shown in Plate 2 above, trees were substantially cleared from the study area as of 1970 and so the current extent of forest reflects even aged regrowth from comparatively few remnant ‘parent’ trees over much of the study area.

The NSW BioNet Vegetation Classification PCT Filter Tool was used to identify candidate PCTs, by entering data including IBRA region and subregion, vegetation class, and dominant species from all strata. The results of the search were then considered alongside previous vegetation mapping of the site, the known distribution of each PCT, landscape position and PCT descriptions to select the closest matching PCTs.

The above factors have been considered in the assignment of the vegetation communities to PCTs in the development footprint. The selection of PCTs has also considered characteristic species, vegetation structure, landscape position and soil characteristics described for each candidate PCT against plot data and other site observations. The assignments of all PCTs were also undertaken with consideration of pre-fire conditions and floristics. Additional plot surveys were undertaken in September and November 2021 and January 2023 nearly two, to over three years post-fire and under above average rainfall conditions. Floristic data collected during these surveys was used to revise the PCT classification, noting that in some areas, canopy vegetation was burnt, but substantial regeneration in the understorey and midstorey was evident.

Bangalay forest

The following PCTs were identified as potential candidates for the Bangalay forest community:

– PCT 659 –Bangalay – Old- man banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion

– PCT 661 – Smooth- barked Apple – Swamp Mahogany low open forest of southern Sydney, Sydney basin bioregion
– PCT 771 – Coast Banksia – Coast Tea- tree low moist forest on coastal sands and headlands, Sydney Basin Bioregion and South East Corner bioregion
– PCT 1231 – Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion.

PCT 1231 was eliminated based on landscape position on an elevated dune, free draining soils and absence of moisture-loving sedges in the groundcover. The Bangalay forest mapped in the eastern portion of the study area is more characteristically a low dry sclerophyll forest rather than a forested wetland vegetation formation (n.b. this is distinct from the areas of Bangalay forest on poorly-draining soils described below).

PCT 661 was considered because it occurs on sandy soils, includes Bangalay (*Eucalyptus botryoides*) in the canopy layer and Banksia spp. in the mid storey. However, this is a wet sclerophyll forest that includes littoral rainforest elements such as *Cissus* spp., Tuckeroo (*Cupaniopsis anarcardioides*) and Hairy Clerodentrum (*Clerodendrum tomentosum*). None of these latter characteristics are consistent with the Bangalay forest observed within the development footprint.

PCT 771 is a littoral low forest, heath or scrub community that occupies coastal foredunes and beach ridges near the open ocean, which is inconsistent with the taller Bangalay forest recorded on a hind dune at the study area.

PCT 659 is the best fit for the Bangalay forest recorded in the study area because it is a dry sclerophyll forest on sandy soils, and is a good match floristically, supporting characteristic species such as Bangalay (*Eucalyptus botryoides*), Coast Banksia (*Banksia integrifolia*), Black She-Oak (*Allocasuarina littoralis*), Cheese Tree (*Glochidion fernandi*) and Coffee Bush (*Breynia oblongifolia*). PCT 659 has been mapped within the site in regional-scale vegetation classification (OEH 2013).

The closest matching revised Eastern NSW PCT 3638 South Coast Sands Bangalay Forest is also a good match for this community at the study area comprising 'mid-high to tall, rarely very tall, dry shrubby sclerophyll open forest found on low-lying marine sand deposits… canopy dominated by Bangalay. mid-stratum with taller small trees of *Banksia serrata* and *Banksia integrifolia* with lower dry shrubs…ground layer characterised by a mid-dense cover of *Pteridium esculentum*, *Lomandra longifolia* and *Imperata cylindrica*. This PCT extends south from Botany Bay in Sydney to Eden on the far south coast (DPE 2023a). The revised Eastern NSW PCT 3638 was a complex split from PCT 659 and represents a south coast form that is an even more precise match for the vegetation at the study area than the legacy PCT.

Grey Ironbark-Turpentine forest

In identifying candidate PCTs for the Grey Ironbark-Turpentine forest within the development footprint, vegetation formation, IBRA subregional distribution, and the occurrence of canopy species Grey Ironbark (*Eucalyptus paniculata*), Turpentine (*Syncarpia glomulifera*), Bangalay (*Eucalyptus botryoides*) and Blue Gum – Bangalay hybrid (*Eucalyptus saligna x botryoides)* were factors used to identify a shortlist of candidate PCTs.

The following candidate PCTs were selected for further evaluation:

– PCT 694 - Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion
– PCT 1206 - Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion
– PCT 1212 – Spotted Gum - Grey Ironbark - Woollybutt grassy open forest on coastal flats, southern Sydney Basin Bioregion and South East Corner Bioregion
– PCT 1245 - Illawarra Escarpment Blue Gum wet forest
– PCT 1841 - Coastal enriched sandstone moist forest.

Of the above, PCT 694 was the best match floristically to the wet sclerophyll forest recorded in the development footprint. Characteristic canopy species include Grey Ironbark (*Eucalyptus paniculata*) and Turpentine (*Syncarpia glomulifera*) with less frequent occurrences of White Stringybark (*Eucalyptus globoidea*), Woollybutt (*Eucalyptus longifolia*) and Bangalay and Blue Gum-Bangalay hybrids. Blackbutt (*Eucalyptus pilularis*) was recorded in low numbers elsewhere within this PCT at the development site. The occurrence of Blackbutt is more frequent in

contiguous wet sclerophyll forest offsite to the north of the northern drainage line that is more typical of the description of PCT694. PCT 694 is most typically associated with Narrabeen shale that is exposed along the northern Illawarra escarpment however the community extends along the escarpment foothills and coastal lowlands as far as Batemans Bay (Tozer et al. 2010) associated with similar claystones beneath the Hawkesbury sandstone plateau. The escarpment here is exposed to the open ocean and the full force of the prevailing southerly winds. A stunted sometimes gnarled open forest occurs on these clayey soils. Low-growing Bangalay and coast banksia (*Banksia integrifolia*) mix with Turpentine (DPE 2023b). This description of the southern regional variant of PCT 694 is a good fit for the landscape position, soils and vegetation structure of the Grey Ironbark-Turpentine forest at the study area.

PCT 1206 and PCT 1212 each contain several characteristic plant species that were evident on the site, however there were no Spotted Gum (*Corymbia maculata*) within the development footprint and forest surrounding the site. PCT 694 was a closer match floristically, with more 'hits' in the NSW BioNet vegetation classification PCT filter tool.

PCT 1245 is a layered wet sclerophyll forest that is dominated by Sydney Blue Gum x Bangalay. It is a tall wet sclerophyll forest characterised by a dense, layered sub canopy of palms and rainforest species. The wet sclerophyll forest vegetation community at the study area includes rainforest elements in the understorey composition like Lilly Pilly (*Acmena smithii*), Coffee Bush (*Breynia oblongifolia*), Hairy Clerodendrum (*Clerodendrum tomentosum*) and Scentless Rosewood (*Synoum glandulosum*). However, these species occur as an open, structurally simple mid storey and the study distinctive rainforest species like Jackwood (*Cryptocarya glaucescens*), and Bolwarra (*Eupomatia laurina*). This forest is associated with high rainfall (greater than 1400 millimetres) and deep chocolate clay soils on escarpment benches, alluvial flats and protected gullies of the Illawarra escarpment (NPWS 2002). PCT 1245 was eliminated as a suitable candidate for the Grey Ironbark-Turpentine forest in the development footprint based on the less pronounced rainforest elements and landscape position.

PCT 1841 is a tall wet sclerophyll forest with a variable canopy but where Smooth-barked Apple (*Angophora costata*) is invariably present. This PCT also tends to support a small tree layer of rainforest species including Coachwood (*Ceratopetalum apetalum*), Blueberry Ash (*Elaeocarpus reticulatus*) and a groundlayer of ferns. This PCT was eliminated based on the distinct lack of these characteristic elements within the development footprint.

The occurrence of Bangalay and Woollybutt within the vegetation zones on site, suggests that the occurrence of PCT 694 in the development footprint is ecotonal. The mapped extent of PCT 694 includes consideration of landscape position, soil type and vegetation structure in addition to the dominance of canopy species in certain areas, specifically:

– Areas dominated by Bangalay were discounted as PCT 1231 because they occurred at higher elevations not drainage lines and depressions subject to periodic inundation
– Areas dominated by Bangalay were also discounted as PCT 659 because they do not occur on free-draining, coastal sand dunes associated with this PCT and the associated Bangalay Dune Forest EEC. It should also be noted that that many of these trees appeared to be Blue Gum-Bangalay hybrids with a characteristic straight trunked, wet sclerophyll forest form as distinct from the spreading, wind-pruned crowns typical of pure Bangalay
– Areas with occasional Woollybutt or Blue Box (*Eucalyptus baueriana)* were also discounted as PCT 1326 because of the low grass cover and co-occurrence of Turpentine and various rainforest species in the mid storey in these areas.

The closest matching revised Eastern NSW 3154 Illawarra Blackbutt Moist Forest is described as a tall to very tall sclerophyll open forest with a sparse mesophyll shrub layer including scattered palms and a ground layer of ferns, graminoids and climbers found on fine grained sedimentary soils on escarpment slopes and coastal hills in the Illawarra and Shoalhaven regions. The tree canopy is variable however commonly includes a high cover of *Eucalyptus pilularis, Syncarpia glomulifera* and one or more species from the *Eucalyptus saligna* x *botryoides* species complex. Rarely, either or both of these species may be accompanied or replaced by *Eucalyptus paniculata* (DPE 2023b) (n.b. matching the dominance of *E. paniculata* at the study area). Despite this floristic similarity, the study area is not typical of the geographic extent and landscape of PCT 3154 as described in Bionet (DPE 2023b). The revised Eastern NSW PCT 3154 was a complex split from PCT 694 but is not a precise match for the vegetation at the study area.

Bangalay swamp sclerophyll forest

The same PCTs identified as potential candidates for the Bangalay forest community (PCT659) described above were considered for the Bangalay swamp sclerophyll forest, that occurs on poorly draining soils at mid elevations in the study area. Bangalay swamp sclerophyll forest mainly occurs between the mapped 4 m and 12m AHD contours. The current extent of the PCT shown on Figure 5.2 is based on post September 2021 plot data but also considers the pre-fire condition of the community with higher Swamp Oak and *Melaleuca* spp. cover based on previous plot data, site photos and the abundance of burnt Swamp Oak stems through the community.

PCT 659 has been mapped across the extent of this community by previous studies (OEH 2013) and previous versions of the BDAR and BCAR for the proposal but has been revised in this BDAR. Bangalay swamp sclerophyll forest has been separated from the PCT 659 Bangalay forest mapped in the eastern portion of the study area because PCT 659 is a dry sclerophyll forest on freely draining dune sands (DPE 2023a) rather than a forested wetland vegetation formation on poorly-draining soils. This Bangalay swamp sclerophyll forest community was separated from the Bangalay dune forest (PCT 659) described above based on landscape position on alluvial flats and low rises on volcanic or fine-grained sedimentary substrates, poor drainage, and relative abundance of moisture-loving trees and small shrubs such as *Melaleuca* spp., *Leptospermum* spp. and Swamp Oak in the midstorey, and sedges in the groundcover.

PCT 661 was similarly eliminated as a wet sclerophyll forest that occurs on sand dunes and includes littoral rainforest and PCT 771 as a littoral low forest, heath or scrub community that occupies coastal foredunes and beach ridges (DPE 2023a).

PCT 1231 was selected as the best fit for the Bangalay swamp sclerophyll forest recorded in the study area because it is a low open forest with an open shrub layer and a dense groundcover of sedges and forbs; on drainage lines and depressions on alluvium in low altitude coastal areas. The community at the site does not contain Swamp Mahogany (*Eucalyptus robusta*) however *Eucalyptus botryoides* is also listed as a dominant and characteristic canopy species of PCT 1231 (DPE 2023a). The community at the study area also contains high cover of the characteristic mid storey species Sydney Golden wattle (*Acacia longifolia*), *Leptospermum continentale*; Flax-leaved Paperbark (*Melaleuca linariifolia*); Tantoon (*Leptospermum polygalifolium*) and groundcover species *Baumea juncea*, *Gahnia clarkei* and Bladey Grass (*Imperata cylindrica* (DPE 2023a) and closely related moisture-loving species such as Black Fruit Saw-sedge (*Gahnia melanocarpa*), *Cassytha glabella*, *Lepyrodia scariosa* and *Ptilothrix deusta*.

The closest matching revised Eastern NSW PCT 4009 Shoalhaven Lowland Flats Wet Swamp Forest is a precise match for this community at the study area comprising ‘a mid-high to very tall swampy sclerophyll open forest with a layered mid-stratum of *Melaleucas* and dense ground cover of tall sedges found on boggy low-lying flats on the South Coast between Sydney and Bodalla. The tree canopy is either dominated by *Eucalyptus botryoides* or *Eucalyptus robusta* (rarely both), occasionally with *Eucalyptus longifolia*. The mid-stratum is typically layered with a taller sparse to mid-dense cover of *Melaleucas* commonly with *Casuarina glauca*. A lower layer of dry shrubs is sparse and commonly includes species such as *Acacia longifolia* and *Leptospermum polygalifolium*. The ground layer is characterised by a high cover of sedges with the taller *Gahnia clarkei* very frequently recorded with an abundance of *Baumea juncea* (DPE 2023a). The revised Eastern NSW PCT 4009 was a complex split from PCT 1231 and represents a *Eucalyptus* botryoides-dominated, Shoalhaven form of the community that is an even more precise match for the vegetation at the study area than the legacy PCT.

Woollybutt grassy woodland

Woollybutt (*Eucalyptus longifolia*) is the dominant canopy species across the grassy woodland community at the site. Within the Sydney Basin Bioregion, two candidate PCTs contain Woollybutt as a dominant species (DPE 2023a):

– PCT 1326 –Woollybutt – White Stringybark – Forest Red gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South east Corner Bioregion
– PCT 1719 – Paperbarks – Woollybutt swamp forest on coastal lowlands of the Central Coast.

Of the two PCTs, 1326 is considered the best fit for the grassy woodland vegetation at the site as it has the best floristic match, with 15 of the 24 (63 percent) of species identified in the BioNet Vegetation Classification database as being characteristic of the community recorded. In addition, PCT 1326 more closely aligns to the geology and

topography of the site as it is described as being restricted to flats below 100 m ASL with sandy loam soils and partially impeded drainage mainly between the Illawarra and Moruya.

PCT 1326 has been mapped within the site by previous studies (OEH 2013).

The dominant flora species listed in the description for PCT 1719 resemble the floristics of the study area, with nine of the 17 species listed as characteristic of this PCT (OEH 2018b) occurring within plots (53 percent). However, this PCT was readily discounted as, in addition to having fewer matching characteristic species than PCT 1326, it is not listed as occurring within the Jervis IBRA subregion and is described as a swamp community, which does not match the partially impeded drainage and grassy understorey within the community found on site.

The closest matching revised Eastern NSW PCT 3330 South Coast Lowland Woollybutt Grassy Forest is also a good match for this community at the study area comprising 'a tall sclerophyll open forest with a dense however patchy mid-stratum and grassy ground layer that is restricted to low-lying flats of below 50 metres asl with sandy loam soils and partially impeded drainage on the south coast. The canopy very frequently includes *Eucalyptus longifolia* and stringybark eucalypts (*Eucalyptus globoidea* or *Eucalyptus eugenioides*), commonly associated with *Eucalyptus tereticornis*. The remaining components of the mid-stratum comprise scattered small trees and shrubs of which *Acacia longifolia* and *Acacia binervata* are most frequent accompanied by *Leucopogon juniperinus* and *Pittosporum undulatum*. A dense ground layer is typically comprised of a diverse suite of grasses and forbs with some twiners and graminoids (DPE 2023a). The revised Eastern NSW PCT 3330 was a complex split from PCT 1326 and represents a Shoalhaven form of the community that is an even more precise match for the vegetation at the study area than the legacy PCT.

Swamp Oak forest

In identifying candidate PCTs for the Swamp Oak forest within the development footprint, IBRA subregional distribution and dominance of *Casuarina glauca* (Swamp Oak) in the canopy were factors used to eliminate a range of potential PCTs. The following candidate PCTs were selected for further evaluation:

– PCT 1232 –Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion.
– PCT 1234 –Swamp Oak Swamp Forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion.
– PCT 1236 – Swamp Paperbark – Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion.

Of the above, PCT 1234 and 1236 are coastal swamp forests characterised by saline and estuarine understorey species. PCT 1234 is likely to occur in a far more estuarine environment than encountered within the development footprint, and is characterised by species of saline, frequently inundated areas like Grey Mangrove (*Avicennia marina*), *Suaeda australis*, *Atriplex australasica* and *Sarcocornia quinqueflora*. This PCT is typically found fringing estuaries and was therefore discounted.

PCT 1236 was also discounted as a suitable PCT because, while the species listed as characteristic are include those detected on site, such as *Entolasia marginata*, Blady Grass (*Imperata cylindrica*) and Ivy-leaved Violet (*Viola hederacea*), many of the remaining species typically occur in areas that are frequently inundated and/or saline such as *Baumea juncea*, Water Ribbons (*Triglochin procera*), Jointed Twig- rush (*Baumea articulata*), Swamp Water Fern (*Blechnum indicum*) and *Lobelia anceps*. This species assemblage suggests an environment that is periodically inundated, consistent with the description of the PCT as occurring on the shores of estuarine lagoons and brackish lakes, wetlands and creek flats. This does not match the landscape of the related community in the higher elevation, western portion of the study area.

PCT 1232 was chosen as the most likely of the above three PCTs due to the characteristic species of its middle and ground strata. This PCT is identified on the NSW VIS as containing grasses, sedges and herbs of moist, but not frequently inundated environments in the understorey, which is similar to what was found on site. While the PCT typically contains species such as Common Couch (*Cynodon dactylon*), Lesser Joyweed (*Alternanthera denticulata*), Tall Sedge (*Carex appressa*), Indian Pennywort (*Centella asiatica*), Native Wandering Jew (*Commelina cyanea*) and Common Reed (*Phragmites australis*), the vegetation within the site contained similar (though not always equivalent species) such as Kidney Weed (*Dichondra repens*), *Polymeria calycina*, *Carex longebrachiata*, *Centella asiatica*, Rough Saw- sedge (*Gahnia aspera*), Black- fruited Saw- sedge (*Gahnia melanocarpa*), Variable Glycine (*Glycine tabacina*), Raspwort (*Gonocarpos teucrioides*), Spiny- headed Mat- rush

(*Lomandra longifolia*), Wiry Panic (*Entolasia stricta*) and Bordered Panic (*Entolasia marginata*). Therefore, this PCT conformed in general grassy and herbaceous understorey to the vegetation detected on site. Similarly, one of the characteristic mid-storey species in the PCT is Boobialla (*Myoporum sp*.), a mesic species. Within this vegetation on site, a similar mesic species Scentless Rosewood (*Synoum glandulosum* subsp. *glandulosum*) was present, making the mid-storey similar to that recorded in the PCT.

PCT 1232 has also been mapped within the site by previous studies (OEH 2013).

Therefore, while PCT 1232 is not an exact floristic match for the vegetation within the development footprint, based on the understorey vegetation composition and position in the landscape, it is the closest matching candidate PCT in the Jervis IBRA sub- region.

The closest matching revised Eastern NSW PCT 4028 Estuarine Swamp Oak Twig-rush Forest is a moderate match for this community at the study area comprising 'a tall to very tall open forest or woodland featuring *Casuarina glauca* occurring on the edges of tidal creek flats along the NSW coast, usually at elevations of below 10 metres asl. A sparse or very sparse small tree or scrub layer of *Melaleuca ericifolia* is occasionally present. The mid-dense ground layer is primarily comprised of sedges, rushes, reeds and grasses that are tolerant of inundation (DPE 2023a). The revised Eastern NSW PCT 4028 was a complex split from PCT 1232 and is probably the closest match of the offspring PCTs but represents a less precise match for the vegetation at the study area than the legacy PCT. An alternative revised Eastern PCT may be a better fit however detailed consideration of candidates beyond those linked to the legacy PCTs that are the subject of this BDAR was beyond the scope of this assessment.

Swamp Oak-paperbark forest and scrub

The same set of candidate PCTs identified for the Swamp Oak forest within the study area were considered for the shorter, shrubbier Swamp Oak-paperbark forest and scrub community that occurs at lower elevations in the eastern portion of the study area. Swamp Oak-paperbark forest and scrub mainly occurs below the mapped 8 m AHD contour as well as localised wet areas without tall tree cover. The current extent of the PCT shown on Figure 5.2 is based on post September 2021 plot data but also considers the pre-fire condition of the community with much higher Swamp Oak cover based on previous plot data, site photos and the abundance of burnt Swamp Oak stems through the community. The community is likely to regenerate into a Swamp Oak scrub with lower shrub and grass cover than currently present as part of a natural succession over the years post fire (pers. obs.).

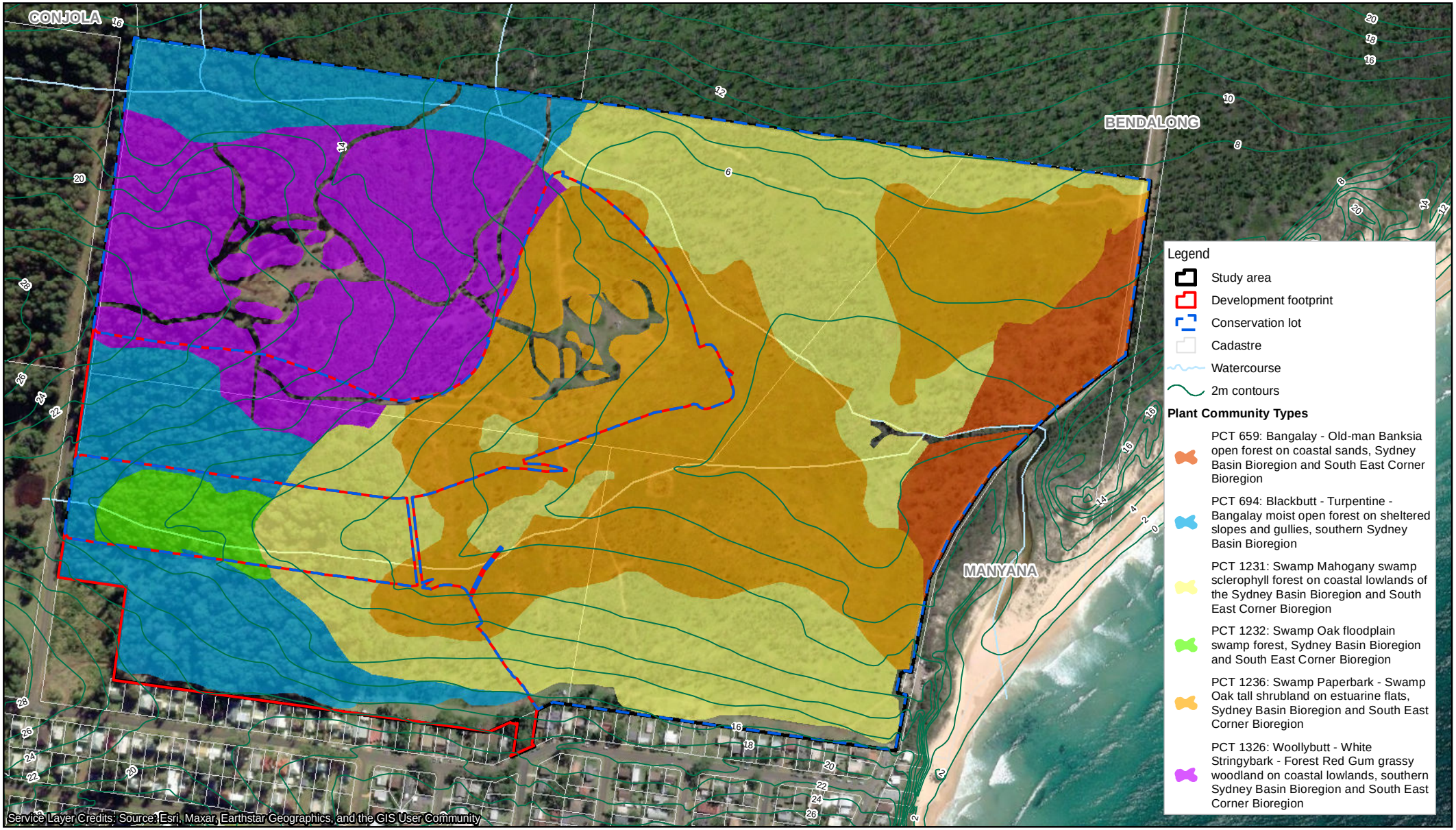
This Swamp Oak-paperbark forest and scrub community was separated from the Swamp oak forest (PCT 1232) described above by the lower canopy height, denser mid storey and, relative abundance of paperbark (*Melaleuca* spp.) and other shrub and small tree species along with Swamp Oak. Of these PCTs, PCT 1234 and 1236 are coastal swamp forests that occur closer to the coast than PCT 1232. PCT 1234 is likely to occur in a more estuarine environment than encountered within the development footprint, and is characterised by species of saline, frequently inundated areas like Grey Mangrove (*Avicennia marina*), *Suaeda australis*, *Atriplex australasica* and *Sarcocornia quinqueflora*. This PCT is typically found fringing estuaries that are more extensive than the small coastal lagoon at the eastern end of the study area and was therefore discounted.

PCT 1236 was selected as the most likely of the above three PCTs due to presence of dense stands of Swamp Paperbark (*Melaleuca ericifolia)* forming a low open to closed wet scrub at elevations below 8 m on periodically inundated flats in the upper reaches of the lagoon that drains the eastern portion of the study area to Inyadda Beach. Distinct from the Swamp Oak forest (PCT 1232) described above, Swamp oak may form a component of the scrub layer, or appear as an emergent layer as isolated individuals or as clumps of trees. The characteristic species of the PCT 1236 middle stratum *Acacia longifolia*, *Glochidion ferdinandi* and *Banksia integrifolia* (DPE 2023a) are present along with *Melaleuca hypericifolia* and *Leptospermum* species. The drier-land representatives of the groundcover species listed as characteristic are present in plots sampled in the development footprint, such as *Entolasia marginata*, Blady Grass (*Imperata cylindrica*), Ivy-leaved Violet (*Viola hederacea*) *Gahnia sieberiana;* and *Gonocarpus micranthus*; however other characteristic species such as *Baumea juncea*, Jointed Twig- rush (*Baumea articulata*), Swamp Water Fern (*Blechnum indicum*) and *Lobelia anceps* are present in contiguous, structurally similar vegetation at slightly lower elevations in the study area.

The mapped extent of PCT 1236 at the study area includes apparently less frequently flooded, ecotonal vegetation at around 6-10 m AHD elevation with lower cover of moisture loving sedges and herbs in the groundcover and occasional Bangalay (*Eucalyptus botryoides)* and Woolybutt (*E. longifolia*) occurring as isolated emergent trees.

PCT was selected as the best fit for these areas given the low forest or scrub structure and high Swamp Oak cover, particularly pre-fire as described above. Areas at similar elevations but with patches of multiple Bangalay and Woolybutt were mapped as PCT 1231.

The closest matching revised Eastern NSW PCT 4056 Southern Estuarine Swamp Paperbark Creekflat Scrub is also a good match for this community at the study area comprising 'A low to mid-high swampy open forest of slightly saline, near-permanently waterlogged margins of estuaries and coastal lagoons. This PCT occurs along the southern and central NSW coast at elevations of below 5 metres asl on deep, organic-rich deposits of mixed estuarine and alluvial sediments. A mid-dense to closed canopy of small trees is almost always dominated by *Melaleuca ericifolia*, commonly with scattered *Casuarina glauca* (DPE 2023a) matching the community at the study area. A dense to mid-dense shrub stratum includes smaller individuals of canopy species. The vine *Parsonsia straminea* is occasionally present and climbs into shrub and canopy plants. The ground layer tends to have low species richness and is very frequently dominated by *Baumea juncea*, commonly with scattered *Phragmites australis* and occasionally *Juncus kraussii*… other rarely occurring species include *Baumea rubiginosa, Cassytha pubescens, Gahnia clarkei* and *Gahnia sieberiana* (DPE 2023a) each of which are present in the community at the study area. This community tends to occur in complex mosaics with many other types along gradients of salinity and soil moisture (DPE 2023a). The revised Eastern NSW PCT 4056 was a complex split from PCT 1236 and represents a south coast form of the community that is a similar match to the vegetation at the study area as the legacy PCT. Both PCT 4056 and legacy PCT 1236 are a more precise match for the lower elevation portions of the study area with the area sampled in the development footprint including less frequently flooded, ecotonal vegetation at around 6-10 m AHD elevation.



Paper Size ISO A4

0 40 80 120 160

Metres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

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North Manyana Subdivision
Biodiversity Development Assessment Report

Project No. 21-27200
Revision No. 1
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Plant community types

Figure 5.1

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Print date: 12 Oct 2023 - 14:28

Data source:ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

5.3 Vegetation zones

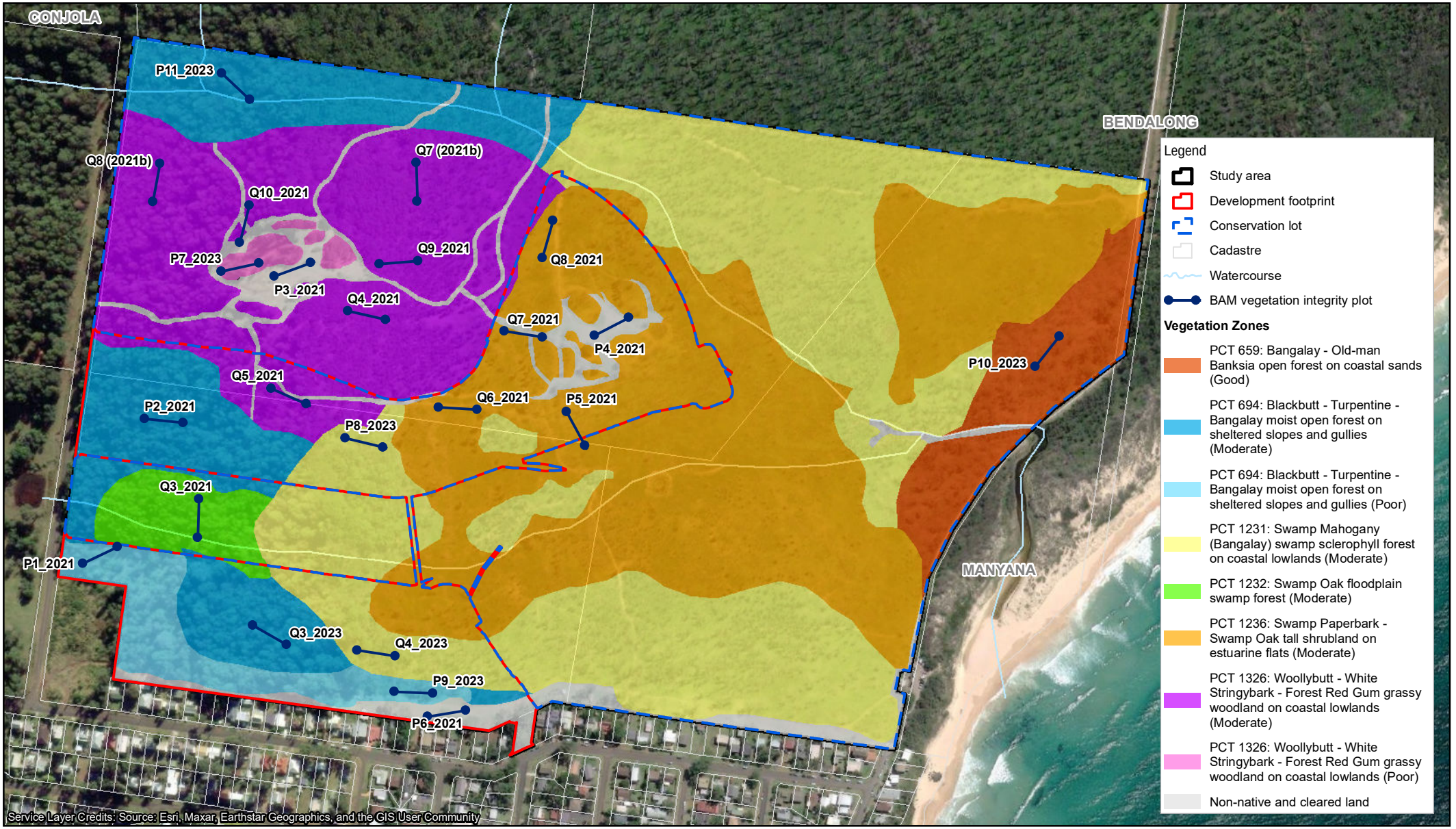
Vegetation zones in the development footprint are mapped on Figure 5.2 and summarised in Table 5.2 along with non-native vegetation and two additional vegetation zones that only occur in the conservation lot at the study area. The structure, species composition and condition of each of the vegetation zones within the development footprint are described in Table 5.4 to Table 5.9 below. Plant species lists are provided in Appendix C. Plot data is provided in Appendix D along with benchmark values for each vegetation type.

Table 5.2 Vegetation zones

Zone_ID	PCT_ID	PCT name	Condition	Vegetation class	Percentage cleared	Area in development footprint (ha)	Patch size class	Vegetation integrity score
1	694	PCT 694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion	Moderate	North Coast Wet Sclerophyll Forests	50	4.62	> 100	58.6
2	694	PCT 694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion	Poor	North Coast Wet Sclerophyll Forests	50	2.36	> 100	45.8
3	1231	PCT1231: Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion	Moderate	Coastal Swamp Forests	50	2.81	> 100	78.3
4	1232	PCT 1232: Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Moderate	Coastal Swamp Forests	95	0.06	> 100	74.3
5	1236	PCT 1236: Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	Moderate	Coastal Floodplain Wetlands	32	6.71	> 100	65.8
6	1326	PCT 1326: Woollybutt – White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	Moderate	Coastal Valley Grassy Woodlands	95	1.38	> 100	65.3
		Total native vegetation				**17.95**		
		Non-native vegetation	N/A	N/A	N/A	1.64	N/A	N/A
		Total				**19.58**		
	659	PCT 659: Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion	Good	South Coast Sands Dry Sclerophyll Forests	50	Conservation lot only	> 100	t.b.c
	1326	PCT 1326: Woollybutt – White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	Poor	Coastal Valley Grassy Woodlands	95	Conservation lot only	> 100	t.b.c

Table 5.3 Vegetation integrity scores

Vegetation zone ID	Vegetation zone	Composition condition score	Structure condition score	Function condition score (where relevant)	Vegetation integrity score	Hollow bearing trees present?
1	PCT 694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (Moderate)	49.9	36.2	87.1	58.6	Yes
2	PCT 694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (Poor)	42.4	46.9	48.4	45.8	Yes
3	PCT1231: Swamp Mahogany (Bangalay) swamp sclerophyll forest on coastal lowlands (Moderate)	91.5	93.6	65.6	78.3	Yes
4	PCT 1232: Swamp Oak floodplain swamp forest (Moderate)	81.6	96.0	52.5	74.3	Yes
5	PCT 1236: Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats(Moderate)	83.1	59.3	40.0	65.8	No
6	PCT 1326: Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands (Moderate)	71.6	86.2	45.2	65.3	Yes



Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

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Vegetation zones

Figure 5.2

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Print date: 12 Oct 2023 - 14:25

Data source:ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

Table 5.4 Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and (Moderate)

Zone 1 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (Moderate)	
Legacy PCT	PCT 694 - Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion
Equivalent Revised PCT	PCT 3154 - Illawarra Blackbutt Moist Forest
Photo	
Survey effort	P2_2021, Q3_2023
Conservation significance	Native, not a TEC.
Estimated percentage cleared (DPE 2023a)	50 percent
Patch size	> 100 hectares
Condition	Moderate – Overall species composition of trees, shrubs and ferns well below benchmark in all plots sampled – Trees, shrubs and ferns and other cover well below benchmark – Grass and grass-like cover well above benchmark – Up to 3 large trees recorded per plot sampled – Fallen logs present in plots sampled in high density (~50 m per plot) and well above benchmark – Up to 62% litter cover recorded, but is highly variable between plots – Hollow-bearing trees recorded – All tree stem classes present – Up to 5.8% high threat exotic (HTE) plant cover present
Vegetation integrity score	58.6

Zone 1 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (Moderate)	
Landscape position	On mid and lower slopes on near coastal foothills and lowlands in the north and west of the study area.
Structure	Open forest
Over-storey	Dominated by Grey Ironbark (*Eucalyptus paniculata*) and Turpentine (*Syncarpia glomulifera*) with less frequent occurrences of White stringybark (*Eucalyptus globoidea*), Woollybutt (*Eucalyptus longifolia*) and Sydney Blue Gum x Bangalay intergrade (*Eucalyptus saligna x botryoides*). One old growth Sydney Blue Gum x Bangalay intergrade tree was recorded in the southern portion of the development footprint.
Mid-storey	The midstorey includes Scentless Rosewood (*Synoum glandulosum* subsp. *glandulosum*), Coffee Bush (*Breynia oblongifolia*), Rough Fruit Pittosporum (*Pittosporum revolutum*), Lilly Pilly (*Acmena smithii*), Black She-oak (*Allocasuarina littoralis)* and Large Mock-olive (*Notelaea longifolia*).
Groundcover	The groundcover was largely dominated by the two sedges Rough Saw-sedge (*Gahnia aspera*) and *Carex longebrachiata.*
Exotic species	Three exotic species were recorded with low projected foliage cover within this vegetation zone. Of the three exotic species, two were high threat weeds: *Senna pendula* var. *glabrata* and Asparagus Fern (*Asparagus aethiopicus).*

Table 5.5 Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (Poor)

Zone 2 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (Poor)	
Legacy PCT	PCT 694 - Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion
Equivalent Revised PCT	PCT 3154 - Illawarra Blackbutt Moist Forest
Photo	 Plot P9_2023
Survey effort	P1_2021, P9_2023
Conservation significance	Native, not a TEC.
Estimated percentage cleared (DPE 2023a)	50 percent
Patch size	> 100 hectares

Zone 2 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (Poor)	
Condition	Poor – Overall species composition of trees, shrubs and ferns and other well below benchmark in all plots sampled – Forb composition on par with benchmark – Tree and shrubs cover well below benchmark – Grass and grass-like, fern and other cover highly variable – Up to one large tree recorded per plot sampled – Fallen logs present in plots sampled with variable density (14-54m) – Up to 53% litter cover recorded, but is highly variable between plots – Hollow-bearing trees recorded – All tree stem classes present except for trees >50cm DBH – Up to 90.4 % high threat exotic (HTE) cover present Evidence of previous clearing, resulting in a highly disturbed patch of vegetation including open areas of exotic grass and dense patches of *Senna pendula* var. *glabrata*.
Vegetation integrity score	45.8
Landscape position	On mid and lower slopes on near coastal foothills and lowlands in the southwest of the study area, including formerly cleared agricultural land and adjoining residential development.
Structure	Open forest along with patches of exotic grassland and scrub
Over-storey	Dominated by *Eucalyptus botryoides x saligna* hybrids, Turpentine, Blackbutt (*Eucalyptus pilularis*) and White Cedar (*Melia azedarach*).
Mid-storey	The midstorey includes Cheese Tree (*Glochidion ferdinandii*), Silver-stemmed Wattle and *Acacia brevifolia*).
Groundcover	Grasses: Wiry Panic (*Entolasia stricta*), Weeping Grass (*Microlaena stipoides*), Kikuyu Grass (*Pennisetum clandestinum*) and Blady Grass (*Imperata cylindrica*) Herbs: Climbing Guinea Flower (*Hibbertia scandens*), Kidney Weed (*Dichondra repens*), Whiteroot (*Lobelia purpurascens*), Indian Pennywort (*Centella asiatica*), Ivy-leaved Violet (*Viola hederacea*) Ferns: Bracken (*Pteridium esculentum*) Other: Variable Glycine (*Glycine tabacina*), Small-leaf Glycine (*Glycine clandestina*), *Cassytha glabella*)
Exotic species	A high density of exotic weeds across groundcover and midstorey strata. Exotic species: Paddy's Lucerne (*Sida rhombifolia*), Wild Tobacco Bush (*Solanum mauritianum*), *Briza subaristata*, Cobbler's Pegs (*Bidens pilosa*) High-threat exotic species: Lantana (*Lantana camara*), *Senna pendula* var. *glabrata*, Panic Veldtgrass (*Ehrharta erecta*), Paspalum (*Paspalum dilatatum*) and Buffalo Grass (*Stenophrum secundatum*).

Table 5.6 Swamp Mahogany (Bangalay) swamp sclerophyll forest on coastal lowlands (Moderate)

Zone 3 – Swamp Mahogany (Bangalay) swamp sclerophyll forest on coastal lowlands (Moderate)	
Legacy PCT	PCT 1231- Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion
Equivalent Revised PCT	PCT 4009 - Shoalhaven Lowland Flats Wet Swamp Forest

Zone 3 – Swamp Mahogany (Bangalay) swamp sclerophyll forest on coastal lowlands (Moderate)	
Photo	
Survey effort	Q4_2023, P8_2023
Conservation significance	Comprises a local occurrence of 'Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions' (Swamp Sclerophyll Forest) which is listed as an EEC under the BC Act. Also comprises a local occurrence of 'Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland', which is listed as an EEC under the EPBC Act.
Estimated percentage cleared (DPE 2023a)	50 percent
Patch size	> 100 hectares
Condition	Moderate – Overall species composition of trees, shrubs, forbs, ferns and other on par with benchmark values – Highly variable shrub and grass cover – Up to one large tree recorded per plot sampled – Highly variable density of fallen logs plots sampled (5-142m) – Up to 67% litter cover recorded, but is highly variable between plots – No hollow-bearing trees recorded in plots sampled, although they are present in low densities in the broader vegetation zone and so a hollow-bearing tree record was manually added to the data for Q4_2020 to ensure compliance with the BAM section 4.3.4 (DPIE 2020a). – All tree stem classes present – Up to 1.3% HTE cover present
Vegetation integrity score	78.3
Landscape position	On poorly drained lower slopes and flats on nearer costal flats in the south and east of the study area.
Structure	Open forest
Over-storey	Bangalay (*Eucalyptus botryoides)* and Swamp Oak (*Casuarina glauca*) with occasional Woolybutt (*Eucalyptus longifolia)*

Zone 3 – Swamp Mahogany (Bangalay) swamp sclerophyll forest on coastal lowlands (Moderate)	
Mid-storey	Cheese Tree, Tantoon (*Leptospermum polygalifolium*), Swamp Paperbark (*Melaleuca ericifolia*), Falx-leaved Paperbark (*Melalueca linarifolia*) and Sydney Golden Wattle (*Acacia longifolia* subsp, *longifolia*)
Groundcover	Grasses: Bordered Panic (*Entolasia marginata*), Blady Grass, Weeping Grass and Wiry Panic Herbs: Kidney Weed, Whiteroot, Indian Pennywort (*Centella asiatica*), Ivy-leaved Violet (*Viola hederacea*) and Poverty Raspwort (*Gonocarpus tetragynus*) Other: Small-leaf Glycine, *Cassytha glabella*) and Hairy Apple Berry (*Billardiera scandens*)
Exotic species	A low density of exotic weeds across groundcover and midstorey strata. Exotic species: Blackberry Nightshade (*Solanum nigrum*) High-threat exotic species: Lantana (*Lantana camara*), *Senna pendula* var. *glabrata*, Asparagus Fern (*Asparagus aethiopicus*) and African Olive (*Olea europaea* subsp. *cuspidata*).

Table 5.7 Swamp Oak Floodplain Swamp Forest (moderate condition)

Zone 4 – Swamp Oak Floodplain Swamp Forest, Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	
Legacy PCT	PCT 1232 - Swamp Oak Floodplain Swamp Forest, Sydney Basin Bioregion and South East Corner Bioregion
Equivalent Revised PCT	PCT 4028 - Estuarine Swamp Oak Twig-rush Forest
Photo	
Survey effort	Q3_2021
Conservation significance	Comprises an occurrence of the BC Act-listed endangered ecological community (EEC) Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. Aligns with the EPBC Act-listed EEC Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community as it meets both the key diagnostic characteristics and at least the minimum thresholds for the EEC provided in the conservation advice (DEE, 2018).
Estimated percentage cleared (DPE 2023a)	95 percent

Zone 4 – Swamp Oak Floodplain Swamp Forest, Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	
Patch size	> 100 hectares
Condition	Moderate – All composition attributes for native vegetation are below benchmark, aside from other groundcovers. – Overall structure attributes for each growth form on par with benchmark values – One hollow- bearing trees recorded in the plot sampled. Very few in the broader vegetation zone as is typical of *Casuarina* dominated communities. – Low amount of fallen logs present – Litter cover is on par with benchmark values. – High- threat weeds were present, though in low numbers. – Regeneration present in this vegetation zone. – No large trees.
Vegetation integrity score	74.3
Landscape position	On poorly drained near-coastal flats adjoining the riparian corridor through the south of the study area. .
Structure	Closed forest
Over-storey	Swamp Oak (*Casuarina glauca*) is the dominant canopy species in a regenerating form. Emergent Woollybutt (*Eucalyptus longifolia*) is also present in some areas.
Mid-storey	Generally sparse, with occasional *Acacia irrorata* subsp. *irrorate,* Tantoon (*Leptospermum polygalifolium*) and Sydney Golden Wattle (*Acacia longifolia*).
Groundcover	The groundcover is fairly sparse, with grasses such as Wiry Panic (*Entolasia stricta*) and *Entolasia marginata* being the most dominant species, with sedges such as Spiny- headed Mat- rush (*Lomandra longifolia*) and Black- fruited Saw- sedge (*Gahnia melanocarpa*) also occurring.
Exotic species	The high- threat weeds Asparagus Fern (*Asparagus asparagoides*), Senna (*Senna pendula*) and Whiskey Grass (*Andropogon virginicus*) were recorded in this community.

Table 5.8 Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (good condition)

Zone 5 – Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats (Moderate)	
Legacy PCT	PCT 1236 - Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion
Equivalent Revised PCT	4056 - Southern Estuarine Swamp Paperbark Creekflat Scrub

Zone 5 – Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats (Moderate)	
Photo	
Survey effort	Q6_2021, Q8_2021, P5_2021 Q7_2021 used to inform PCT definition but not included in BAM-C
Conservation significance	Comprises an occurrence of the BC Act-listed endangered ecological community (EEC) Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. Aligns with the EPBC Act-listed EEC Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community as it meets both the key diagnostic characteristics and at least the minimum thresholds for the EEC provided in the conservation advice (DEE 2018). Legacy PCT 1236 and revised PCT 4056 are not listed as being associated with the EPBC Act-listed EEC (DPE 2023b) however the EPBC Act listing advice for the EEC includes PCT 1236 in Table 2: Map units that may contain Coastal Swamp Oak Forest (DEE 2018).
Estimated percentage cleared (DPE 2023a)	32 percent
Patch size	> 100 hectares
Condition	Moderate – Overall composition attributes for each growth form on par with benchmark values, aside from forbs – Overall structure attributes for each growth form on par with benchmark values, aside from trees – Variable grass-grasslike cover – No hollow- bearing trees detected in the plot or the vegetation zone as is typical of *Casuarina* dominated communities. – Low amount of fallen logs present, well below benchmark – Litter cover well below benchmark values. – High- threat weeds were present, though in low numbers. – Patchy regeneration present in this vegetation zone; dependant on burn severity. – No large trees were present.
Vegetation integrity score	65.8
Landscape position	On poorly drained near-coastal flats in the eastern portion of the study area. .

Zone 5 – Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats (Moderate)	
Structure	Low closed forest or scrub
Over-storey	Dominated by Swamp Oak based on pre-2020 plot data and observations of dead stems of mature trees. Most adult Swamp Oak killed by wildfire and as such the species was present as regenerating seedlings and small trees in plots sampled through 2021 to 2023. Occasional Woolybutt (*Eucalyptus longifolia)*) and Bangalay in small patches. Swamp Paperbark (*Melaleuca ericifolia)* abundant in patches and more dominant in the conservation lot to the east and south of the development footprint.
Mid-storey	Maiden's Wattle (*Acacia maidenii*), *Notelaea longifolia*, Hillock Bush (*Melaleuca hypericifolia*), Black Wattle (*Acacia mearnsii*), Swamp Paperbark, Tick Bush (*Kunzea ambigua*), Sydney Golden Wattle
Groundcover	Grasses: Bordered Panic, Blady Grass, Weeping Grass, Common Couch (*Cynodon dactylon*) and Wiry Panic Sedges: *Carex longebrachiata*, Tall Saw-sedge (*Gahnia clarkei*), Spiny-headed Mat-rush (*Lomandra longifolia*) and Rough Saw-sedge (*Gahnia aspera*) Herbs: Kidney Weed, Pennywort (*Hydrocotyle tripartita*), Germander Raspowrt (*Gonocarpus teucrioides*), Whiteroot and Indian Pennywort Other: Pink Bindweed (*Convulvulus erubescens*), False Sarsparilla (*Hardenbergia violacea*), *Cassytha glabella*) and Hairy Apple Berry (*Billardiera scandens*)
Exotic species	A low density of exotic weeds across groundcover and midstorey strata. Exotic species: Scarlet Pimpernel (*Lysimachia arvensis*), Sweet Venral Grass (*Anthoxanthum odoratum*), Common Centaury (*Centaurium erythraea*), White Clover (*Trifolium repens*) High-threat exotic species: Creeping Buttercup (*Ranunculus repens*) and Chilean Needle Grass (*Nassella neesiana*)

Table 5.9 ***Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion (good moderate)***

Zone 6 – Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands (moderate)	
Legacy PCT	PCT 1326 - Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Equivalent Revised PCT	PCT 3330 - South Coast Lowland Woollybutt Grassy Forest
Photo	
Survey effort	Q5_2021

Zone 6 – Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands (moderate)	
Conservation significance	Comprises an occurrence of BC Act-listed EEC Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion EEC. Also aligns with the related EPBC Act-listed CEEC Illawarra and south coast lowland forest and woodland ecological community as it meets both the key diagnostic characteristics and at least the minimum thresholds for the CEEC provided in the conservation advice (DoEE, 2016).
Estimated percentage cleared (DPE 2023a)	95 percent
Patch size	> 100 hectares
Condition	Moderate – Overall composition attributes for each growth form on par with benchmark values, aside from forbs – Overall structure attributes for each growth form on par with benchmark values, aside from forb cover – No hollow-bearing trees recorded in the plot sampled, although they are present in low densities in the broader vegetation zone and so a hollow-bearing tree record was manually added to the data for Q5_2021 to ensure compliance with the BAM section 4.3.4 (DPIE 2020a). – Fallen logs on par with benchmark values – Litter cover above benchmark values. – High- threat weeds were present, though in low numbers. – Regeneration present in this vegetation zone – No large trees were present in the plot sampled.
Vegetation integrity score	65.3
Landscape position	On mid and upper slopes on low, near coastal hills on soils with partially impeded drainage in the north and west of the study area.
Structure	Open forest or woodland.
Over-storey	Dominated by Woollybutt (*Eucalyptus longifolia*) with Forest red Gum (*Eucalyptus tereticornis),* Rough-barked Apple (*Angophora floribunda*) and White Stringybark (*Eucalyptus globoidea*) as sub-dominant species *Eucalyptus saligna/Eucalyptus botryoides* hybrids and Grey Ironbark (*Eucalyptus paniculata*) are locally abundant forming dense patches of small trees in portions of the local occurrence of this community, probably reflecting regeneration from remnant trees .after historical clearing of the site.
Mid-storey	The mid storey is relatively sparse and consists of Swamp oak (*Casuarina glauca*), Sweet Pittosporum (*Pittosporum undulatum*), Sydney Golden Wattle *(Acacia longifolia*), Prickly Beard-heath (*Leucopogon juniperinus*), Large-leaf Hop-Bush (*Dodonaea triquetra*), Tick Bush (*Kunzea ambigua*) and Wild Yellow Jasmine (*Pittosporum revolutum*).
Groundcover	Grasses: *Oplismenus aemulus*, Weeping Grass, Wiry Panic and Oat Speargrass (*Anisopogon avenaceus*) Sedges: Black Fruit Saw-sedge, Spiny-headed Mat-rush, Variable Sword-sedge (*Lepidosperma laterale*), *Carex longebrachiata* Forbs: Indian Pennnywort, Kidney Weed, Germander Raspwort, Whiteroot, *Oxalis perennans*, Tufted Bluebell (*Wahlenbergia communis*)
Exotic species	Patches of the HTW Senna (*Senna pendula* var *glabrata*).

5.4 Vegetation in the conservation lot

Vegetation zones in the conservation lot are summarised in Table 5.10 and mapped on Figure 5.2. Plant species lists are provided in Appendix C. Plot data is provided in the table of 'Vegetation integrity plot data for plots sampled outside development footprint' in Appendix D along with benchmark values for each PCT. The structure, species composition and condition of each of the vegetation zones within the conservation lot are described in detail in the Vegetation Management Plan included as Appendix G.

Table 5.10 Vegetation within the conservation lot

PCT_ID	PCT name	Condition	Vegetation class	Percentage cleared	Area (ha)
659	PCT 659: Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion	Good	South Coast Sands Dry Sclerophyll Forests	50	3.43
694	PCT 694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion	Moderate	North Coast Wet Sclerophyll Forests	50	4.42
1231	PCT1231: Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion	Moderate	Coastal Swamp Forests	50	18.03
1232	PCT 1232: Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Moderate	Coastal Swamp Forests	95	1.59
1236	PCT 1236: Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	Moderate	Coastal Floodplain Wetlands	32	15.89
1326	PCT 1326: Woollybutt – White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	Moderate	Coastal Valley Grassy Woodlands	95	11.03
1326	PCT 1326: Woollybutt – White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	Poor	Coastal Valley Grassy Woodlands	95	0.5
	Native vegetation				**54.89**
	Non-native and cleared land	N/A	N/A	N/A	2.36
	Total				**57.25**

5.5 Threatened ecological communities

There are occurrences of three EECs listed under the BC Act within the development footprint and surrounding study area:

– Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions
– Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion
– Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

There are occurrences of three related TECs listed under the EPBC Act within the development footprint and surrounding study area:

– The CEEC Illawarra and south coast lowland forest and woodland
– The EEC Coastal Swamp Oak (*Casuarina glauca*) Forest of NSW and South East Queensland
– The EEC Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland.

The occurrence of TECs is shown on Figure 5.3. Mapping and identification of these TECs was based on the comparison of 2021 to 2023 vegetation zone survey data described above with listing advice for relevant communities as well as assessor's use of judgement as to the likely extent and condition of commensurate vegetation pre-fire, building on field surveys completed in 2018 and 2019.

5.5.1 Swamp Oak Floodplain Forest

BC Act

Vegetation at the development site mapped as PCT 1232 and PCT 1236 contains characteristic plant species listed in part of the Final Determination for 'Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions' (NSW Scientific Committee 2014). This community is found on the coastal floodplains of NSW. It has a dense to sparse tree layer in which Swamp oak (*Casuarina glauca*) is the dominant species.

EPBC Act

This community is also listed as endangered under the EPBC Act under the listing of 'Coastal Swamp Oak (*Casuarina glauca*) Forest of NSW and South East Queensland ecological community). Legacy PCT 1236 and revised PCT 4056 are not listed as being associated with the EPBC Act-listed EEC (DPE 2023b) presumably because of the co-dominance of Swamp Paperbark (*Melaleuca ericifolia)* with Swamp Oak. However the EPBC Act listing advice for the EEC includes PCT 1236 in notes " *In more freshwater patches of the ecological community, Melaleuca species, including* Melaleuca ericifolia *(swamp paperbark)…may occur in the canopy, sub-canopy or as emergents. If a mid-layer is present it is typically sparse, but a sub-canopy of smaller trees can often be present, typically composed of canopy species, including juvenile swamp oak"* (DEE 2018 p6). PCT 1236 is also listed in *Table 2: Map units that may contain Coastal Swamp Oak Forest* of DEE (2018).

Under the EPBC Act approved conservation advice for this community vegetation at the development site would be considered a high quality, category A form of this community as non-native-species comprise less than 20 percent of the total understorey vegetation cover and the patch is at least 5 hectares in size.

5.5.2 Illawarra Lowlands Grassy Woodland

BC Act

Areas of vegetation mapped as PCT 1326 fit the floristic description of Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion EEC as outlined in the Final determination for this community (NSW Scientific Committee 2011). The Scientific Committee determination for the EEC as listed under the BC Act states that Illawarra Lowlands Grassy Woodland is restricted to the local government areas of Wollongong City, Shellharbour City, and Kiama Municipality (NSW Scientific Committee 2011). The study area is located in City of Shoalhaven LGA to the

south of the extent listed in the Scientific Committee determination for the EEC (NSW Scientific Committee 2011). However the profile for the EEC maintained by DPE states that there are known records of the EEC in the City of Shoalhaven LGA and maps the known occurrence of Illawarra Lowlands Grassy Woodland through the LGA to south of Batemans Bay (DPE 2023d). Noting the floristic similarity of the vegetation recorded onsite to the listed EEC, a conservative approach was taken, and the vegetation mapped as PCT 1326 was considered to be Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion EEC.

Consultation with the Biodiversity Conservation Division of DPE during earlier phases of planning for the proposal, and with Council and their advisors prior to the preparation of this BDAR, supported the treatment of PCT 1326 at the study area as comprising part of an occurrence of Illawarra Lowlands Grassy Woodland EEC as listed under the BC Act. This approach aligns the extent of the community with the related CEEC listed under the EPBC Act, which is recognized as occurring in the Wollongong, Shellharbour, Kiama, City of Shoalhaven and Eurobodalla LGAs (DoEE 2016).

EPBC Act

This community is listed as a CEEC under the EPBC under the listing of Illawarra and south coast lowland forest and woodland ecological community. An assessment of the quality of this vegetation determined that it meets the category A condition threshold (DoEE 2016) as the patch is at least two hectares, more than 50 percent of its total understorey vegetation cover is comprised of native species and there is at least six native plant species per 0.5 hectare in the ground layer.

5.5.3 Swamp Sclerophyll Forest on Coastal Floodplains

BC Act

Areas mapped as PCT 1231 align with the BC Act-listed EEC Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, as outlined in the Final Determination for this community (NSW Scientific Committee 2011a). This community occurs on clay and sandy loams on the coastal floodplain, and specifically excludes occurrences on sand (DPIE 2021c). About 2.81 ha of vegetation in moderate condition within the development site is commensurate with this community.

EPBC Act

This community is also listed under the EPBC Act as Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland EEC. Vegetation within the site was assessed against the key diagnostics, condition classes, categories and thresholds included in the conservation advice for the community (DAWE 2021), and was found to comprise condition class A as it is a large patch greater than 5 ha in area and <20% of the total groundcover vegetation is exotic.

5.6 Weeds

Priority weeds

Five NSW priority weed species were recorded in the study area. All of these species have a general biosecurity duty under the Biosecurity Act which requires any person who deals with the plant to ensure the biosecurity risk of the weed is prevented, eliminated or minimised, so far as is reasonably practicable. Regional measures for many species include the requirement that land managers should mitigate the risk of new weeds being introduced to their land. Each of the species recorded on site also has the requirement that they must not be imported into the state, sold, bartered, exchanged or offered for sale. Species recorded were:

– Asparagus Fern (*Asparagus aethiopicus*)
– Bridal Creeper (*Asparagus asparagoides*)
– Lantana (*Lantana camara*)
– Chilean Needle Grass (*Nassella neesiana*)
– Blackberry complex (*Rubus fruticosus* sp. agg.).

Weeds of National Significance

Under the *Australian Weeds Strategy 2017 to 2027* (Invasive Plants and Animals Committee 2016), 32 introduced plants have been identified as Weeds of National Significance (WONS). These weeds are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts. Five WONS were recorded in the study area:

– Asparagus Fern (*Asparagus aethiopicus*)
– Bridal Creeper (*Asparagus asparagoides*)
– Lantana (*Lantana camara*)
– Chilean Needle Grass (*Nassella neesiana*)
– Blackberry complex (*Rubus fruticosus* sp. agg.).

High threat weeds

Many weeds are also identified as high threat weeds within the BAM. These are plants not native to Australia that if not controlled will invade and outcompete native plant species.

A total of 15 High Threat Weeds (HTW) were recorded during field surveys within the study area. The majority of vegetation within the site is in good condition with few HTW present, with many of the HTWs concentrated in areas of non-native vegetation, or along edges of the site. The HTW species *Senna pendula* var*. glabrata* has the highest cover across the site forming localised, very dense infestations in PCT 694 in poor condition and other parts of the southern portion of the development footprint. There are small patches of the HTW Lantana (*Lantana camara*), and other HTWs such as Asparagus Fern (*Asparagus asparagoides*), Mickey Mouse Plant (*Ochna serrulata*) and Whiskey Grass (*Andropogon virginicus*) are scattered in places. HTW grasses appear to have become established in the cleared areas that are exposed to regular and ongoing disturbance, potentially transported into site on vehicles or in rubbish and garden waste dumped on site.

There is evidence of Chilean Needle Grass (*Nassella neesiana*) becoming established in disturbed areas adjacent or within patches that were severely burnt in the clearing in the northern portion of the development footprint.

5.7 Groundwater dependent ecosystems

The NSW Groundwater Dependent Ecosystem (GDE) Policy defines GDEs as ecosystems, which have their species composition, and their natural ecological processes determined by groundwater (DLWC 2002). The Policy defines groundwater as the water beneath the earth's surface that has filtered down to the zone where the earth or rocks are fully saturated (DLWC 2002). Ecosystems vary dramatically in the degree of dependency of groundwater, from having no apparent dependence through to being entirely dependent on it (DLWC 2002).

The Australian Government Atlas of Groundwater Dependent Ecosystems (BOM 2023b) was used to identify any previously mapped GDEs that occur in or near the development footprint. This atlas identifies GDEs reliant on surface groundwater (rivers, springs and wetlands) and subsurface groundwater (vegetation). The Atlas was reviewed to ascertain whether any GDEs are likely to occur in the development footprint.

The Atlas indicates that the following terrestrial GDEs that rely on the subsurface presence of groundwater are present on site, and also provides information on whether they are an inflow dependant ecosystem (IDE):

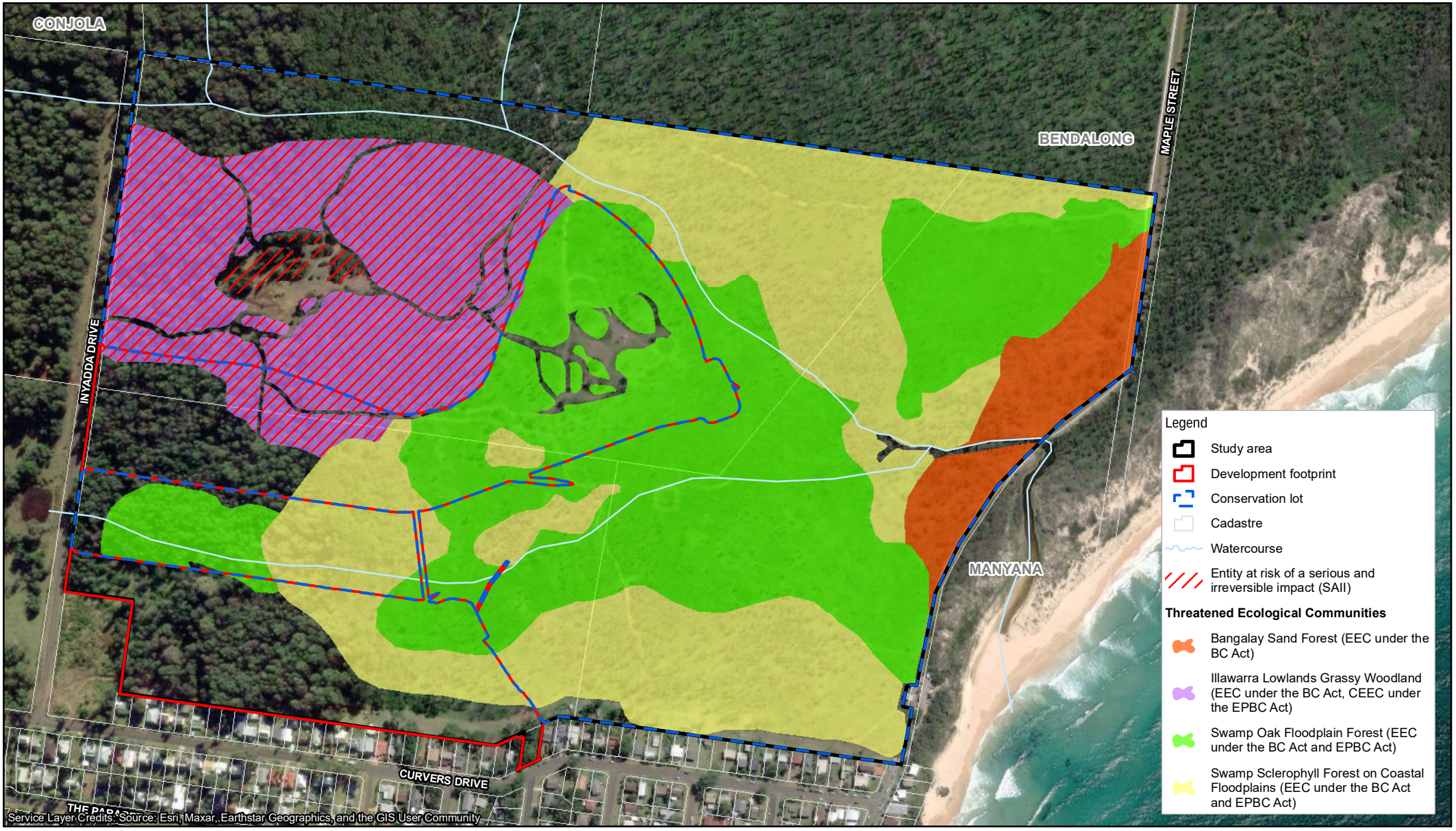
– Coastal Sand Forest – low to moderate potential GDE, with an IDE of between 6 – 10
– Coastal Sandplain Heath – low potential GDE, with an IDE of 10
– Floodplain Swamp Forest – high potential GDE, with an IDE of 7
– Coastal Wet Heath Swamp Forest - *Casuarina glauca* / *Melaleuca ericifolia* – moderate potential GDE with an IDE of 10 (BOM 2023b).

IDE refers to a likelihood between 6 (low) and 10 (high) that the ecosystem is accessing water in addition to rainfall i.e. from overland surface water flows or groundwater.

While these vegetation types do not align perfectly with the vegetation zones and PCTs mapped within the site, it is likely that portions of the PCTs at the study area are GDEs that at least partially rely on groundwater inflow to

persist. Based on the site-scale vegetation surveys and habitat assessments conducted for this BDAR the development footprint aligns with the GDE mapping as follows:

– Coastal Sand Forest – low potential GDE, with an IDE of 6 and non-GDE (BOM 2023b) over the areas mapped as PCT 694: Blackbutt - Turpentine - Bangalay moist open forest and PCT 1326: Woollybutt – White Stringybark - Forest Red Gum grassy woodland that would not be dependent on surface water flows or groundwater and are likely to be maintained by accessing local rainfall and near-surface soil moisture flows. n.b. these PCTs are not 'sand forests' and occur on heavy clay and clay loam soils at the study area however this map unit aligns with the higher elevation portions of the study area containing these PCTs and is the closest fit of the GDE map units in the local area.
– Floodplain Swamp Forest – high potential GDE, with an IDE of 7 (BOM 2023b) over the areas mapped as PCT1231: Swamp Mahogany swamp sclerophyll forest on coastal lowlands which would be maintained by surface water associated with the two drainage lines through the study area, local flooding and probably also groundwater in addition to local rainfall.
– Coastal Wet Heath Swamp Forest - *Casuarina glauca* / *Melaleuca ericifolia* – high potential GDE with an IDE of 10 (BOM 2023b) over the areas mapped as PCT 1232: Swamp Oak floodplain swamp forest and PCT 1236: Swamp Paperbark - Swamp Oak tall shrubland which would be maintained by surface water associated with the two drainage lines through the study area, local flooding and potentially also groundwater in addition to local rainfall.



Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Heir Asquith Pty. Ltd.
North Manyana Subdivision
Biodiversity Development Assessment Report

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Threatened ecological communities

Figure 5.3

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Print date: 12 Oct 2023 - 14:26

Data source: ERSI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

5.8 Fauna species and habitat resources

5.8.1 Fauna species

A full list of fauna species recorded within the study area is provided in Appendix C. The faunal assemblage comprises at least five frog species, 83 bird species, 28 mammal species and four reptile species. Two exotic species were directly observed (Rabbit and Black Rat), however the ecologists who completed the November 2021 survey noticed lots of dog droppings along the tracks and cleared areas of the site, indicating that dogs are present on the site on occasion.

The faunal assemblage included a large number of birds, with species from 37 families recorded across the study area. Of this, the most represented family is Meliphagidae (the honeyeater group).

5.8.2 Important habitat

For a small number of species, the habitat constraint information in the TBDC refers to an important habitat map (BAM section 5.1.3). Important habitat maps identify areas that are considered essential to support critical life stages of the species, e.g. breeding areas or locations important for foraging/over-wintering for migratory species. There is no important habitat for any species within the proposal site.

5.8.3 Habitat features and resources

The following specific geographic and habitat features were identified within the development footprint and indicate the potential presence of threatened species that could contribute to the credit calculations:

– Fallen/standing dead timber, including logs
– Semi-permanent/ephemeral wet areas
– Land within 1 km of wet areas / swamps
– Land within 1 km a waterbody
– Land containing swamps
– Swamp margins or creek edges
– Hollow-bearing trees
– Land within 500 meters of swamps
– Within 200 metres of riparian zone
– Dense ground cover in a variety of habitats
– Dense shrub layer or alternatively high canopy cover exceeding 70%
– Land within 5 km of the coast
– waterbodies with pools/ stretches 3m or wider on or within 200m of the subject land.

The following specific geographic and habitat features are not present within the development footprint and as such are constraints to the presence of associated threatened species:

– Land containing caves, tunnels, mines, culverts or other structure known or suspected to be used for microbat breeding habitat.
– Moss gardens
– Headlands within 500 m of the coast
– Cliff lines or ledges.

The development footprint is a mixture of open woodland, closed forest and thick regenerating vegetation. The floristic composition of the site and subsequent habitat has been influenced by historical impacts associated with human disturbance and wildfire. A relatively small number of mature hollow-bearing trees occur across the site, largely because much of the development area is situated within previously disturbed and/or regenerating vegetation. Regeneration of most canopy species was evident before the 2019-2020 bushfires and there is evidence of regeneration of canopy species across much of the site post-fire.

All lands with the development footprint are relatively contiguous with vegetated land to the north, west and east (see Figure 4.1). The site's connectivity within the surrounding landscape is likely to contribute to the presence/suitability for a range of threatened fauna that are dependent on more extensive patches of vegetation. Such species that were recorded or that have the potential to occur include *Artamus cyanopterus* (Dusky Woodswallow), *Petaurus norfolcensis* (Squirrel Glider), *Cercartetus nanus* (Eastern Pygmy Possum), *Tyto tenebricosa* (Sooty Owl) and *Calyptorhynchus lathami* (Glossy Black-Cockatoo).

Food resources

The dominant overstorey trees include *Eucalyptus longifolia* (Woollybutt), and *Angophora floribunda* (Rough-barked Apple). These trees provide suitable foraging resources for nectivorous fauna, including honeyeaters, possums, gliders, lorikeets and potentially threatened species such as *Petaurus norfolcensis* (Squirrel Glider) and *Cercartetus nanus* (Eastern Pygmy Possum).

Myrtaceae species, including all of the overstorey species, as well as shrub and understorey trees like *Kunzea ambigua* and the *Melaleuca* species respectively, would provide an important foraging resource (particularly at the end of summer and into autumn) for marsupial gliders and the Grey-headed Flying Fox (*Pteropus poliocephalus*).

The Black and Swamp Oaks found distributed through the site were recorded as likely to provide a foraging resource for the threatened bird Glossy Black Cockatoo (*Calyptorhynchus lathami*). This species was recorded by OMVI Ecological in January 2018 (see Section 6.2.2), while evidence of the species foraging (chewed cones) was detected within the site during field surveys in December 2018.

Hollow resources

There are relatively few hollow-bearing trees within the development footprint presumably due to historical land clearing and subsequent regeneration resulting in generally younger canopy species across the site. Hollow-bearing trees are mapped on Figure 6.1. Swamp Oak (*Casuarina glauca*) is a dominant canopy species over much of the study area and rarely forms hollows unless the trees are very old growth. PCT 1232: Swamp Oak floodplain swamp forest at the study area contains a single hollow-bearing tree and none were observed in PCT 1236: Swamp Paperbark - Swamp Oak tall shrubland. The majority of the hollow-bearing trees that were recorded were detected within the southwestern portion of the development footprint within the Grey Ironbark-Turpentine Forest (PCT 694). This aligns with the area of remnant vegetation apparent on aerial imagery from 1970 in Plate 2, which shows that the majority of the tree cover at the study area had been removed prior to this date. The distribution of hollow-bearing trees on Figure 6.1 is generally aligned with tree cover on Plate 2, which shows that native vegetation had been cleared from the study area other than a narrow strip along the northern boundary, the patch of PCT694 in the southwest, dune vegetation in the far east and occasional paddock trees.

Of the hollow-bearing trees present, the majority of the hollow resource comprises small and medium hollows (see Table 5.11). The majority were small and medium with a few larger hollows (>20cm entrance diameter) observed, mainly in the southwest of the site in PCT 694.

The small to medium hollows observed within the site may provide roosting, refuge and breeding habitat for a range of fauna, including small scansorial mammals (eg. *Antechinus*), microbats, arboreal herpetofauna (eg tree frogs, monitor lizards, snakes), gliders (eg Sugar and Squirrel Gliders), birds (eg parrots, tree creepers, lorikeets), and possums (eg Brushtail, Ringtail and Pygmy Possums). Other tree and shrub species on site contain cracks and fissures that may also support roosting habitat for microbats, reptiles and frogs.

Of the threatened fauna species that could occur at the study area, the Squirrel Glider and Eastern Pygmy Possum (which was recorded at the site, see Section 6.2.2) could potentially use hollows at the site and any individual would frequent many within their home range, as would numerous hollow-dependent bats, including the Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*) and Eastern Falsistrelle (*Falsistrellus tasmaniensis*). A number of threatened birds may also utilise these hollows, particularly the Little Lorikeet.

The tree hollows recorded within the development footprint are unlikely to be suitable breeding habitat for large forest owl species, including Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Powerful Owl (*Ninox strenua*). These species require hollows that have a minimum diameter of 30 cm but prefer deep, large hollows up to 50 cm diameter, most frequently located in sheltered locations in large tracts of vegetation that are remote from human disturbance (Wallis *et al.* 2002; Neasbey 2008; LMCC 2014; Lewis 2015, September 18 OEH,

2017g; Powerful Owl Coalition 2018). None of the hollows observed were sufficiently large or appropriately sited to support likely breeding habitat for large forest owl species, however a conservative approach was adopted and threatened forest owls were included as candidate species for the assessment (see section 6.1.2). No known or potential hollow-bearing trees that could be candidate nest trees for threatened cockatoos or forest owls were recorded in the development footprint despite multiple rounds of targeted survey.

The primary hollow-bearing tree survey was completed pre-fire in September 2018 as part of a systematic nest tree census of the development footprint and adjoining areas. The 2019-202 fires are not believed to have destroyed any of the hollow-bearing trees within the development footprint, and so the numbers presented in the table below are also considered accurate post fire. A systematic hollow bearing tree and nest tree census has not been undertaken over the entire conservation lot. There may be additional hollow bearing trees in the conservation lot, particularly along the far north-eastern and eastern portions of the study area that are greater than 300 m from the development footprint and as such were not surveyed intensively for candidate species credit matters.

Groundcover habitat

The amount of groundcover across the site is extremely varied between vegetation communities. Within the forested communities, ground cover is approximately 65 per cent, consisting mostly of grasses and sedges. However, within the Swamp Oak forest, ground cover is approximately 38 per cent, consisting of mostly sedges. There is therefore a fair amount of bare earth and open ground within the site, particularly in areas cleared for tracks.

Where the groundcover is dense, particularly where sedges and grasses and thick, it is likely to provide sheltering and foraging habitat ground- dwelling mammals potentially including the threatened species *Isoodon obesulus obesulus* (Southern Brown Bandicoot).

Wetland and aquatic habitat

The initial 2018 and 2019 field surveys were conducted during a prolonged dry period. At that time there were no obvious permanent wetlands or streams present, nor were there any areas of understory vegetation indicating frequently inundated wetlands. Human-made wetlands (i.e. farm dams) were observed however at this time the dams did not support any fringing aquatic or wetland vegetation.

A supplementary wetland and aquatic habitat assessment was undertaken in October and December 2022 and January 2023 during a prolonged wet period and after significantly above average rainfall events earlier in 2022 (see Table 3.6). A frog breeding habitat assessment was undertaken including identification of potential breeding habitat for the Green and Golden bell Frog, other candidate threatened frog species and for threatened wetland birds and shorebirds. Systematic traverses were conducted of low-lying areas and ‘potential wetland frog breeding habitat’ was identified and mapped to inform targeted frog survey effort as described in section 3.4.3 and shown on Figure 3.5. Wetland and aquatic habitat associated with drainage line, dams and saline lagoons within the study area is shown on Figure 6.1 and described below.

There are no waterbodies or associated frog breeding habitat or aquatic fauna habitat in the development footprint. Lower lying areas in the eastern portions of the PCT 1231 and PCT 1236 in the development footprint are poorly draining swamp forest and scrub communities with dense understories of sedges and moisture-loving shrubs such as *Melaleuca* and *Leptospermum* species. These areas contain shallow water in flooded depressions after heavy rainfall events but would not persist long enough to support aquatic fauna species or frog breeding. These treed wetlands would provide shelter and foraging habitat for wetland birds and for frog populations that may breed in nearby areas.

Two small un-named ephemeral drainage lines merge to form Inyadda Creek in the eastern portion of the study area and drain east into an Intermittently Closed and Open Lake / Lagoon (ICOLL) at Inyadda Beach. The northern of the two drainage lines is a second order stream and the southern drainage line is a first order stream. Inyadda Creek is a second order stream where it meets the ICOLL. All reaches of these drainage lines through the study area are ephemeral, channel confined streams that contain discontinuous pools of water even after heavy rain. They feature clay beds with occasional silt deposits, good quantities of in-stream woody debris and habitat resources associated with overhanging banks and tree roots. The northern drainage line features localised severe erosion and deposition associated with intensive use of 4WD and trail bike tracks. The southern drain line and lower reaches of Inyadda Creek are largely free of such impacts. Under above average rainfall conditions these drainage lines featured dense instream aquatic vegetation and fringing sedges. Deeper, more persistent pools are

mapped as ‘potential wetland frog breeding habitat’ shown on Figure 6.1. These areas contained relatively abundant, calling populations of common and widespread frog species such as Common Eastern Froglets (*Crinia signfiera)*, Striped Marsh Frogs (*Limnodynastes peronii)* and Southern Green Stream Frogs (*Litoria nudidigita)* during the Summer 2022-23 surveys. Based on a high level assessment of the aquatic environment, these drainage lines are likely to contain an abundant and species rich population of macroinvertebrates including smooth crayfish, molluscs and insect larvae.

The study area does not contain any fast flowing, rocky, sand or gravel-bedded or permanent streams and does not contain any potential breeding habitat for threatened frog species associated with these types of streams (see Appendix B).

There is a large, permanently inundated farm dam in partially cleared grazing land to the west of Inyadda Drive that features an expansive area of deep, open water and dense fringing macrophyte beds (Dam 1). Dam 2 is a small but near-permanent farm dam in an area of Swamp Oak forest (PCT 1232) that contains small areas of shallow, open water and is densely vegetated with *Gahnia* species. Dam 3 in the north of the study area is shallow but apparently permanently inundated and contains open water along with dense macrophyte beds and is surrounded by wet sclerophyll forest (PCT694) and grassy forest (PCT1326). Dam 4 is a deep, but apparently frequently dry depression with little wetland vegetation surrounded by swamp sclerophyll forest (PCT 1231). Dams 5, 6 and 7 are each small but deep, frequently inundated waterbodies that contain very dense macrophyte beds and are surrounded by very dense shrubby wetlands (PCT1231 and PCT 1236). Each of these waterbodies provide shelter and foraging habitat for wetland birds and frog populations as well as potential frog breeding habitat and habitat for aquatic fauna during wet periods. These areas contained relatively abundant, calling populations of common and widespread frog species such as Common Eastern Froglets, Striped Marsh Frogs and tree frogs (*Litoria vereauxii, L. peronii, L fallax*) during the Summer 2022-23 surveys. Based on a high level assessment of the aquatic environment, these waterbodies are likely to contain an abundant and species rich population of macroinvertebrates including smooth crayfish, molluscs and insect larvae similar to nearby reaches of the natural drainage lines through the study area.

The ICOLL is up to 1.5 m deep, with brackish water, a sandy bed and dense fringing macrophyte beds. The ICOLL opens to the ocean infrequently and is rapidly closed as wave action builds up the sand berm across Inyadda Beach (Horton Coastal Engineering 2023). It contains good quantities of in-stream woody debris and habitat resources associated with overhanging banks and tree roots and is surrounded by dune forest (PCT 659) and very dense shrubby wetlands (PCT1231 and PCT 1236). The ICOLL contains high quality shelter and foraging habitat for wetland birds and frog populations as well as habitat for aquatic fauna of estuarine environments. Deeper, downstream reaches of the ICOLL contain brackish water and populations of large, predatory saltwater fish species and do not comprise frog breeding habitat. Higher reaches that would be less frequently inundated with brackish water contain potential frog breeding habitat as described for Inyadda Creek above.

The berm and sandy foreshore habitats adjoining the ICOLL also provide foraging habitat and potential nesting habitats for shorebirds. Notably the berm may provide nesting habitat for local populations of the Eastern Hooded Dotterel (*Thinornis cucullatus cucullatus*, also known as Hooded Plover) and Pied Oystercatcher (*Haematopus longirostris*) in certain years (pers. obs.; NPWS signage).

The pools, dams and upper reaches of the ICOLL described above are potential breeding habitat for the Green and Golden Bell Frog and other frog species that breed in wetlands and ponds (as distinct from fast-flowing stream-breeding frogs).The ‘potential wetland frog breeding habitat’ shown on Figure 6.1 was targeted with frog aural visual surveys in accordance with relevant guidelines and under appropriate weather conditions in December 2022 and January 2023. These surveys did not reveal any Green and Golden Bell Frogs or any other threatened frog species. The development footprint does not contain breeding habitat for any candidate species credit-type threatened frogs.

As described above, the majority of the reaches of the drainage lines through the study area are ephemeral, with occasional discontinuous pools present only after prolonged or very heavy rain. Pools associated with these drainage lines and the small dams in the study area do not contain Southern Myotis (*Myotis macropus)* foraging habitat as defined in the survey guide for ‘species credit’ threatened bats and their habitats microbats (i.e. waterbodies with pools/ stretches 3 m or wider) (OEH 2018). There is Southern Myotis foraging habitat within 200 m of the subject land associated with dam 1 to the west of Inyadda Drive, dam 3 in the northern portion of the study area, and the upper reaches of the ICOLL that drains the study area east towards Inyadda Beach. Each of the other dams at the study area feature shallow pools <3 m wide or were heavily vegetated with macrophytes and

do not contain Southern Myotis foraging habitat. Anabat detectors were deployed over six nights in December 2018 and March 2019, positioned over potential Southern Myotis foraging habitat in waterbodies and adjoining flyways. The species was not recorded and as such there is no confirmed Southern Myotis foraging habitat at or within 200m of the development footprint.

*Table 5.11 Summary of hollow bearing trees recorded at the study area**

Zone	Easting	Northing	Species	No. large hollows (>20cm)	No. medium hollows (5-20cm)	No. small hollows (<5cm)	DBH (m)	Development footprint[1]	Earthworks[2]
56	274157	6096216	*Angophora floribunda*	1			0.5	Yes	No
56	274203	6096029	*Eucalyptus botryoides*			1	0.6	No	N/A
56	274186	6095943	*Eucalyptus botryoides x saligna*	1		1	1	Yes	No
56	274113	6095895	*Eucalyptus botryoides x saligna*		1	1	0.4	Yes	No
56	274176	6095944	*Eucalyptus botryoides x saligna*			2	1.3	Yes	No
56	274016	6095897	*Eucalyptus botryoides x saligna*			2	1.1	Yes	Yes
56	274133	6095968	*Eucalyptus botryoides x saligna*	2	3	5	1.2	Yes	No
56	274061	6095878	*Eucalyptus paniculata*			2	0.7	Yes	No
56	274144	6095872	*Eucalyptus botryoides x saligna*		1	1	0.7	Yes	No
56	273976	6096048	*Eucalyptus longifolia*	1			0.7	No	N/A
56	274065	6095889	*Eucalyptus longifolia*	1		1	0.7	Yes	No
56	274116	6095909	*Eucalyptus longifolia*			2	0.7	Yes	No
56	274129	6095900	*Eucalyptus longifolia*			1	0.7	Yes	Yes
56	274111	6095982	*Eucalyptus paniculata*	0	1	7	1.8	Yes	No
56	274094	6095892	*Stag*			3	0.6	Yes	Yes
56	274133	6095956	*Syncarpia glomulifera*		1	1	0.95	Yes	No
56	274026	6095967	*Syncarpia glomulifera*			2	1.2	Yes	Yes
56	274067	6096145	*Syncarpia glomulifera*	1	2	3	1.1	Yes	No
56	274093	6095957	*Syncarpia glomulifera*			2	0.8	Yes	No
56	274406	6096528	*Eucalyptus longifolia*	1	6	5	0.5	No	N/A
56	274162	6096182	*Eucalyptus longifolia*	2	4	5	0.6	Yes	No
56	274130	6095976	*Eucalyptus longifolia*		1		0.9	Yes	No

Zone	Easting	Northing	Species	No. large hollows (>20cm)	No. medium hollows (5-20cm)	No. small hollows (<5cm)	DBH (m)	Development footprint[1]	Earthworks[2]
56	274137	6095974	*Eucalyptus longifolia*		1	2	0.8	Yes	No
56	274150	6096208	*Eucalyptus botryoides x saligna*	1	1	1	1	Yes	Yes
56	274177	6096131	*Eucalyptus botryoides x saligna*		1		1.1	Yes	No
56	274099	6096078	*Casuarina glauca*			1	0.5	No	N/A

Notes: DBH – diameter at breast height.
Development footprint -'Yes' indicates that the HBT falls within the mapped development footprint and has been included in impact calculations; 'No' indicates that the HBT falls within the conservation lot and would be retained.
Earthworks – 'Yes' – indicates that the HBT falls within the mapped development footprint and would be removed for earthworks or construction of infrastructure.; 'No' indicates HBTs to be retained in the proposed subdivision, that are outside of the extent of earthworks, building envelopes or infrastructure footprints and would be conserved through a Section 88B restriction on title; N/A indicates that the HBT falls within the conservation lot and would be retained.

6. Habitat suitability for threatened and migratory species

6.1 Identification of threatened species for assessment

6.1.1 Predicted threatened species (ecosystem credit entities)

Based on the bioregional context for the assessment and the PCTs, patch size, vegetation cover and habitat resources present at the project site, the BAM-C generates a list of threatened fauna species that are predicted to utilise the project site (that is, potential 'predicted threatened species', or potential 'ecosystem credit entities'). The potential for these predicted threatened species to occur within the site was further refined based on the desktop assessment, habitat resources observed during field surveys, records during the surveys, and the knowledge and experience of the assessor. Targeted surveys are not required under the BAM for these species as they are assumed to be present in the PCTs at the site. Impacts and offsets for these species are liked to ecosystem credits.

Predicted threatened species generated by the BAM calculator for the development footprint are listed in Table 6.1. For each predicted threatened species, the sensitivity class rating and the associated vegetation type(s) are also provided.

The Sooty Owl was manually added as a confirmed predicted species requiring assessment for ecosystem credits (foraging habitat), as it was recorded during a past survey (EMM 2014). The Little Bent-winged Bat (*Miniopterus australis*) was also manually added as a confirmed predicted species (foraging habitat), as it was detected during surveys for this BDAR.

None of the predicted species listed in Table 6.1 were excluded in accordance with BAM Subsections 5.2.1 and 5.2.2 (DPIE 2020a) based on geographic limitations or habitat constraints.

Table 6.1 Predicted threatened species (ecosystem credit species)

Common name	Scientific name	Sensitivity class[1]	Associated vegetation type(s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Regent Honeyeater[2] (foraging)	*Anthochaera phrygia*	High	All	Yes	-
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	Moderate	All	Yes	Recorded in the study area
Australasian Bittern	*Botaurus poiciloptilus*	Moderate	1231, 1232, 1236	Yes	-
Gang-gang Cockatoo[2] (foraging)	*Callocephalon fimbriatum*	Moderate	1326, 694, 1231	Yes	Recorded in the study area
Glossy Black-Cockatoo[2] (foraging)	*Calyptorhynchus lathami*	High	All	Yes	Recorded in the study area. *Allocasuarina* and *Casuarina* habitat constraints are present within the development footprint and wider study area.
Spotted Harrier	*Circus assimilis*	Moderate	1232, 1236	Yes	-
Varied Sittella	*Daphoenositta chrysoptera*	Moderate	All	Yes	Recorded in the study area
Spotted-tailed Quoll	*Dasyurus maculatus*	High	All	Yes	-
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	High	1326, 694, 1231	Yes	Recorded in the study area (EMM 2014)
Little Lorikeet	*Glossopsitta pusilla*	High	All	Yes	Recorded in the study area
White-bellied Sea-eagle[2] (foraging)	*Haliaeetus leucogaster*	High	1231, 1232, 1236, 1326	Yes	-
Little Eagle[2] (foraging)	*Hieraaetus morphnoides*	Moderate	All	Yes	-
White-throated Needletail	*Hirundapus caudacutus*	High	All	Yes	-
Black Bittern	*Ixobrychus flavicollis*	Moderate	1231, 1232, 1236	Yes	-.
Swift Parrot (foraging)[2]	*Lathamus discolor*	Moderate	All	Yes	-
Square-tailed Kite[2] (foraging)	*Lophoictinia isura*	Moderate	All	Yes	Recorded in the study area

Common name	Scientific name	Sensitivity class[1]	Associated vegetation type(s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	High	All	Yes	Recorded in the study area
Little Bent-winged Bat[2] (foraging)	*Miniopterus australis*	High	All	Yes	Recorded in the study area
Large Bent-winged Bat[2] (foraging)	*Miniopterus orianae oceanensis*	High	All	Yes	Recorded in the study area
Turquoise Parrot	*Neophema pulchella*	High	1236	Yes	-
Barking Owl[2] (foraging)	*Ninox connivens*	High	1232, 1326, 659, 1231	Yes	-
Powerful Owl[2] (foraging)	*Ninox strenua*	High	All	Yes	-
Eastern Osprey[2] (foraging)	*Pandion cristatus*	Moderate	1231, 1232, 1236	Yes	Recorded in the study area (EMM 2014)
Yellow- bellied Glider	*Petaurus australis*	High	1231, 1326, 694	Yes	Habitat constraints of hollow-bearing trees, including trees with hollow entrances > 25 cm diameter, have been recorded in all vegetation zones except for PCT 1326_good (veg zone 3). For this reason, the species is a confirmed predicted species for all vegetation zones except veg zone 3.
Scarlet Robin	*Petroica boodang*	Moderate	1326	Yes	-
Flame Robin	*Petroica phoenicea*	Moderate	1326	Yes	-
Koala[2] (foraging)	*Phascolarctos cinereus*	High	659, 1326, 694	Yes	-
Golden-tipped Bat	*Phoniscus papuensis*	High	694, 1231	Yes	-
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*	High	1231, 1232	Yes	-
New Holland Mouse	*Pseudomys novaehollandiae*	High	1231, 1236	Yes	-
Grey-headed Flying-fox[2] (foraging)	*Pteropus poliocephalus*	High	All	Yes	-
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	High	All	Yes	-

Common name	Scientific name	Sensitivity class[1]	Associated vegetation type(s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Greater Broad-nosed Bat	*Scoteanax rueppellii*	High	All	Yes	Recorded in the study area (EMM, 2014)
Freckled Duck	*Stictonetta naevosa*	Moderate	1232	Yes	-
Masked Owl[2] (foraging)	*Tyto novaehollandiae*	High	All	Yes	-
Sooty Owl[2] (foraging)	*Tyto tenebricosa*	High	All	Yes	Previously recorded near the northern boundary of the study area (EMM, 2014)
Rosenberg's Monitor	*Varanus rosenbergii*	High	All	Yes	

[1] Sensitivity to gain class – High = high sensitivity to potential gain, Moderate = moderate sensitivity to potential gain.
[2] These species are predicted ecosystem credit species due to foraging habitat within the site (they may also be species credit species if known breeding habitat occurs within the site).

6.1.2 Candidate threatened species (species credit entities)

Threatened species that cannot be reliably predicted to occur based on vegetation surrogates or landscape features are called species credit species. Targeted survey is required for candidate species to confirm presence / absence in the development footprint and thus to determine whether further assessment is required for species credits.

A number of threatened fauna species can be confidently predicted to forage in a development footprint based on vegetation surrogates but cannot be confidently predicted to breed in a development footprint because breeding activity relies on particular habitat components or identified important habitat areas. For these 'dual credit' species, foraging habitat is assessed for ecosystem credits but targeted survey is undertaken and breeding habitat assessed for species credits.

The list of species that may be considered species credit species are generated by the BAM calculator. In addition, the assessor is required to review previous records and consider habitat features on site and add any additional species that may qualify as species credit species. This list is referred to as the confirmed Candidate threatened species list. Candidate threatened species for the development footprint are listed in Table 6.2.

The Sooty Owl is a dual credit species and was manually added as a confirmed candidate species in accordance with the BAM (DPIE 2020b), as it was recorded near the northern boundary of the study area during a past survey (EMM 2014).

The Little Bent-winged Bat (*Miniopterus australis*) is a dual credit species that was detected during surveys for the current study. Initially considered as a candidate species, it was subsequently excluded from assessment for species credits because the habitat constraints required for breeding (i.e. caves, tunnels etc.) are not present in the development footprint.

In accordance with the BAM (DPIE 2020b) those candidate species that were generated by the BAM calculator that are excluded from further assessment for species credits and the reasons for exclusion are presented in Table 6.2.

There are no mapped areas of important habitat area for Migratory Shorebirds, the Regent Honeyeater or the Swift Parrot at the site or surrounding area (DPE 2023c) and so these species were therefore assessed as ecosystem credit species only.

The development footprint is not within an Area of Regional Koala Significance (ARKS). The Koala Likelihood Map v2.0 (Aug 2019) also predicts the likelihood of finding a Koala within the study area to be around nil, with a confidence rating of 'High'. Targeted surveys found no evidence of use of the site by Koalas and a review of threatened species databases indicated there are only two records within a 10 km radius of the site and only a low density of feed trees present (limited to PCT 1326). Based on this information, the Koala has been excluded from further assessment for species credits.

Table 6.2 Candidate threatened species (species credit species)

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
Regent Honeyeater (important habitat)	*Anthochaera phrygia*	No			n/a	Although not a confirmed candidate species, bird surveys were undertaken in September and December 2018, March and August 2019	No	Mapped important areas for this species is a habitat constraint. The development footprint does not contain land that is mapped as an important habitat area for this species (DPE 2023c). No further assessment required for species credits; the species is only assessed for ecosystem credits.
Bush Stone-curlew	*Burhinus grallarius*	Yes	1232, 1236, 1326		All year	Call playback, spotlighting and camera trap surveys undertaken in December 2018 Additional spotlighting in December 2022 and January 2023	No	No further assessment required for species credits.
Thick Lip Spider Orchid	*Caladenia tessellata*	No	Nil in development footprint 659 in conservation area	1231	September, October	Although not a confirmed candidate species, systematic targeted surveys of marginal habitat in potentially associated PCTs conducted in October 2023 Targeted threatened flora surveys in September 2018	No	The species is not associated with any of the PCTs at the development site in the TBDC (2023a) and a species expert has concluded that the development site does not contain potential habitat (see Appendix E). As a precautionary approach systematic survey of marginal habitat was undertaken. The species was not recorded. No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
Gang- gang Cockatoo (breeding)	*Callocephalon fimbriatum*	Yes. Eucalypt tree species with hollows greater than 9 cm diameter is a breeding habitat constraint that is present	694		October - January	Diurnal bird surveys and nest tree census undertaken in breeding season in September 2018, and December 2018 during breeding season Additional nest tree census undertaken in December 2022 and January 2023	No breeding activity recorded.	No further assessment required for species credits.
Glossy Black Cockatoo (breeding)	*Calyptorhynchus lathami*	Yes. Living or dead tree with hollows greater than 15cm diameter and greater than 5m above ground is a habitat constraint that is present	694, 1231, 1232, 1326		April - August	Diurnal bird surveys and nest tree census undertaken in breeding season in March 2019, and August 2019 during breeding season	No breeding activity recorded.	No further assessment required for species credits.
Eastern Pygmy Possum	*Cercartetus nanus*	Yes	694, 1231, 1326	1236	October - March	Terrestrial and arboreal trapping completed in December 2018	Yes, recorded in PCT 1326 in the eastern portion of the study area.	Assessed further for species credits. Species polygon has been prepared; see section 6.3 and Figure 6.1.
Large-eared Pied Bat	*Chalinolobus dwyeri*	No	694, 1231, 1326		November - January	Although not a confirmed candidate species, anabat detectors	No	Land within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or land

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
						were deployed in December 2018 and March 2019		within two kilometres of old mines or tunnels is a habitat constraint. The development footprint does not contain land that meets the above habitat constraint. No further assessment required for species credits.
Leafless Tongue Orchid	*Cryptostylis hunteriana*	Yes	1231 659 in conservation area	694, 1326	November - January	Systematic targeted surveys conducted in December 2022 and January 2023 Targeted threatened flora surveys in January 2018 and December 2018	No	Excluded through systematic targeted surveys. No further assessment required for species credits.
Tangled Bedstraw	*Galium australe*	No	Nil in development footprint 659 in conservation area	1231	October - February	Considered in general in targeted threatened flora surveys in targeted threatened flora surveys in January 2018 and December 2018	No	No further assessment required for species credits.
White-bellied Sea-eagle (breeding)	*Haliaeetus leucogaster*	Yes	694, 1231, 1232, 1236, 1326		July - December	Diurnal bird surveys and nest tree census undertaken in breeding season in in September 2018 and December 2018. Additional nest tree census undertaken in December 2022	No nests or breeding activity recorded	No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
Square Raspwort	*Haloragis exalata* subsp. *exalata*	No	1236, 1326		All year	Considered in general in targeted threatened flora surveys in January and September 2018, December 2018 and March 2019, December and January 2022 and April 2023	No	No habitat constraints present at the development footprint: - Waterbodies - Edges of coastal lakes after flooding has removed other vegetation, creek banks within flood zone, areas close to these features subject to human disturbance including road verges and powerline easements or within 100m No further assessment required for species credits.
Giant Burrowing Frog	*Heleioporus australiacus*	Yes	694, 1232, 1326		September - May	Targeted surveys undertaken in December 2018 Supplementary frog aural visual surveys in an above average rainfall season undertaken in December 2022 and January 2023	No	No further assessment required for species credits.
Little Eagle (breeding)	*Hieraaetus morphnoides*	Yes			August - October	Diurnal bird surveys and nest tree census undertaken in breeding season in September 2018 and August 2019	No large stick nests or breeding activity recorded	No further assessment required for species credits.
Southern Brown Bandicoot	*Isoodon obesulus obesulus*	Yes	1231, 1232, 1236		All year	Terrestrial trapping completed in December 2018 Additional spotlighting in	No	No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
						December 2022 and January 2023		
Swift Parrot (important habitat)	*Lathamus discolor*	No	694, 1231, 1232, 1326		n/a	Although not a confirmed candidate species, bird surveys were undertaken in September and December 2018, March and August 2019	No	Mapped important areas for this species is a habitat constraint. The development footprint does not contain land that is mapped as an important habitat area for this species (DPE 2023c). No further assessment required for species credits; the species is only assessed for ecosystem credits.
Green and Golden Bell Frog	*Litoria aurea*	Yes	694, 1231, 1232, 1236		November - March	Call playback and targeted surveys undertaken in December 2018 Supplementary frog aural visual surveys in an above average rainfall season undertaken in December 2022 and January 2023	No	No further assessment required for species credits.
Square-tailed Kite (breeding)	*Lophoictinia isura*	Yes	694, 1231, 1232, 1236, 1326		September - January	Field surveys in September 2018 and December 2018 Additional nest tree census undertaken in December 2022 and January 2023	No large stick nests or breeding activity recorded	No further assessment required for species credits.
Biconvex Paperbark	*Melaleuca biconvexa*	Yes	694, 1232, 1326	1236	All year	Systematic targeted surveys conducted in December 2022 and January 2023	No	No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
						Targeted threatened flora surveys in September 2018 and March 2019		
Little Bent-winged Bat (breeding)	*Miniopterus australis*	No	694, 1231, 1232, 1236, 1326		December - February	Although not a confirmed candidate species, anabat detectors were deployed in December 2018 and March 2019	No	Cave, tunnel, mine, culvert or other structures known or suspected to be used for breeding is a habitat constraint. The development footprint does not contain land that meets the above habitat constraint. No further assessment required for species credits.
Large Bent-winged Bat (breeding)	*Miniopterus orianae oceanensis*	No	694, 1231, 1232, 1236, 1326		December - February	Although not a confirmed candidate species, anabat detectors were deployed in December 2018 and March 2019	No	Cave, tunnel, mine, culvert or other structures known or suspected to be used for breeding is a habitat constraint. The development footprint does not contain land that meets the above habitat constraint. No further assessment required for species credits.
Stuttering Frog	*Mixophyes balbus*	Yes	694		September - March	Targeted surveys undertaken in December 2018 Supplementary frog aural visual surveys in an above average rainfall season undertaken in December 2022 and January 2023	No	No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
Southern Myotis	*Myotis macropus*	Yes	694, 1231, 1232, 1236, 1326		October - March	Anabat detectors deployed for over 160 recording-hours over six nights in December 2018 and March 2019, positioned over potential foraging habitat in waterbodies and adjoining flyways	No	No further assessment required for species credits.
Orange-bellied Parrot	*Neophema chrysogaster*	Yes	1232, 1236		All year	Diurnal bird surveys undertaken in September and December 2018, March and August 2019	No	No further assessment required for species credits.
Barking Owl (breeding)	*Ninox connivens*	Yes	1231, 1232, 1236, 1326	694	May - December	Field surveys in September 2018 targeting candidate nest trees with large hollows. Targeted diurnal and nocturnal surveys were undertaken in August 2019 Supplementary spotlighting surveys and nest tree census undertaken in December 2022 and January 2023	No breeding activity recorded. No candidate nest trees with suitably sized or located hollows observed.	No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
Powerful Owl (breeding)	*Ninox strenua*	Yes	694, 1231, 1232, 1326	1236	May - August	Field surveys in September 2018 targeting candidate nest trees with large hollows. Targeted diurnal and nocturnal surveys were undertaken in August 2019 Supplementary spotlighting surveys and nest tree census undertaken in December 2022 and January 2023	No breeding activity recorded. No candidate nest trees with suitably sized or located hollows observed.	No further assessment required for species credits.
Eastern Osprey (breeding)	*Pandion cristatus*	Yes	1231, 1232, 1236		April - November	Field surveys in September 2018 targeting large stick nests. Supplementary nest tree census undertaken in December 2022 and January 2023	No large stick nests and no breeding activity recorded	No further assessment required for species credits.
Greater Glider	*Petauroides volans*	Yes	694, 1231, 1326		All year	Arboreal trapping completed in December 2018 Supplementary spotlighting surveys undertaken in December 2022 and January 2023	No	No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
Greater Glider population in the Eurobodalla local government area	*Petauroides volans - endangered population*	No			All year	n/a	No	The development footprint is not in the Eurobodalla LGA. No further assessment required for species credits.
Squirrel Glider	*Petaurus norfolcensis*	Yes	694, 1231		All year	Arboreal trapping completed in December 2018 Supplementary spotlighting surveys and nest tree census undertaken in December 2022 and January 2023	No	No further assessment required for species credits.
Pink Robin	*Petroica rodinogaster*	Yes	694		All year	Diurnal bird surveys were undertaken in September and December 2018, March and August 2019	No	No further assessment required for species credits.
Brush-tailed Phascogale	*Phascogale tapoatafa*	Yes	694, 1231, 1326		December - June	Arboreal trapping completed in December 2018	No	No further assessment required for species credits.
Koala (breeding)	*Phascolarctos cinereus*	Yes	694, 1231, 1232, 1236, 1326		All year	SAT tests undertaken in December 2018 Supplementary spotlighting surveys undertaken in December 2022 and January 2023	No	No further assessment required for species credits. In addition to the survey effort employed, the development footprint is not within an Area of Regional Koala Significance (ARKS). The Koala Likelihood Map v2.0 (Aug 2019) also predicts the likelihood of finding a Koala within the

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
								study area to be around nil, with a confidence rating of High.
Long-nosed Potoroo	*Potorous tridactylus*	Yes	1231, 1236		All year	Six baited infra-red motion cameras were set up in December 2018 Supplementary spotlighting surveys undertaken in December 2022 and January 2023	No	No further assessment required for species credits.
Villous Mint-bush	*Prostanthera densa*	No	Nil in development footprint 659 in conservation area	1231	All year	Targeted threatened flora surveys in December 2022, January 2023, September 2018 and March 2019	No	No further assessment required for species credits.
Grey-headed Flying- fox (breeding)	*Pteropus poliocephalus*	Yes			October - December	Targeted surveys in September and December 2018 Supplementary searches for evidence of roost camps undertaken in December 2022 and January 2023	No flying-fox camps recorded	No further assessment required for species credits.
Illawarra Greenhood	*Pterostylis gibbosa*	Yes	1326		September - October	Systematic targeted surveys conducted in October 2023 Targeted threatened flora	No	No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
						surveys in September 2018		
-	*Pterostylis ventricosa*	Yes	694		March - May	Systematic targeted surveys conducted in April 2023 Targeted threatened flora surveys in March 2019	No	No further assessment required for species credits.
-	*Pterostylis vernalis*	No	1326		August - October	No Although not a confirmed candidate species, systematic targeted surveys of marginal habitat in potentially associated PCTs conducted along with surveys for other terrestrial orchids in October 2023	n/a	This species is excluded as a candidate species on the basis of missing habitat constraints on site – there are no moss gardens over shallow or outcropping rock within the study area or development footprint. No further assessment required for species credits.
Scrub Turpentine	*Rhodamnia rubescens*	Yes	694		All year	Systematic targeted surveys conducted in December 2022 and January 2023 Targeted threatened flora surveys in September and December 2018, and March 2019	No	No further assessment required for species credits.
Coast Groundsel	*Senecio spathulatus*	No	Nil in development footprint		All year	No	n/a	This species is excluded as a candidate species on the basis

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
			659 in conservation area					of missing habitat constraints on site. Land containing headlands within 500 metres of the coast is a habitat constraint. This species is a dune specialist and grows on frontal dunes. The study area and development footprint do not contain land with habitat constraints as described above and therefore, no further assessment is required for species credits.
Magenta Lilly Pilly	*Syzygium paniculatum*	Yes	1231 659 in conservation area	694	April - June	Systematic traverses in April 2023	No candidate *Syzygium* spp. recorded (only *Acmena smithii*).	No further assessment required for species credits. On the south coast the species occurs on grey soils over sandstone and is restricted mainly to remnant stands of littoral rainforest. Littoral rainforest habitat has not been recorded within the study area or the development footprint.
Masked Owl (breeding)	*Tyto novaehollandiae*	Yes	694, 1231, 1232, 1236, 1326		May - August	Field surveys in September 2018 targeting candidate nest trees with large hollows. Targeted diurnal and nocturnal surveys were undertaken in August 2019 Supplementary spotlighting surveys and nest tree census undertaken in	No breeding activity recorded. No candidate nest trees with suitably sized or located hollows observed.	No further assessment required for species credits.

Common name	Scientific name	Confirmed candidate species	Associated PCTs[1]	Potentially associated PCTs[2]	Survey timetable	Targeted survey undertaken[3]	Recorded within development footprint	Reason for exclusion from candidate species list or assessed for species credit.
						December 2022 and January 2023		
Sooty Owl (breeding)	*Tyto tenebricosa*	Yes	694		April – August	Field surveys in September 2018 targeting candidate nest trees with large hollows. Targeted diurnal and nocturnal surveys were undertaken in August 2019 Supplementary spotlighting surveys and nest tree census undertaken in December 2022 and January 2023	No breeding activity recorded. No candidate nest trees with suitably sized or located hollows observed.	No further assessment required for species credits.
Round-leafed Wilsonia	*Wilsonia rotundifolia*	Yes	1231, 1236		All year	Systematic targeted surveys conducted in December 2022, January 2023 and April 2023 Targeted threatened flora surveys in September and December 2018, and March 2019	No	No further assessment required for species credits. The development footprint contains only marginal habitat for this species of saltmarsh and estuary margins (DPE 2021d). The species would be more likely to occur in the conservation area, nearer the coast.

Notes: 1) Associated PCTs as listed in the Threatened Biodiversity Data Collection accessed via the 'bionet-threatened-species-to-plant-community-types-association-data (2).xls' power query
2) Potentially associated PCTs that are floristically similar and/or occur in adjoining landscape positions to associated PCTs and may occur as ecotonal forms with associated PCTs
3) 'Systematic targeted surveys' comprise systematic traverses with 5-10m wide spacing through all areas of suitable habitat in associated PCTs. Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as dumped fill, dense weed infestations, edges of water bodies or dense patches of non-target species within associated PCTs.

6.2 Threatened species survey results

6.2.1 Threatened flora

No threatened flora species were recorded within the development footprint during field surveys for the BCAR or BDAR. Notably, concurrent with the habitat assessment, the author of the threatened orchid habitat assessment report and preliminary species expert advice participated in targeted surveys for *Pterostylis ventricosa* (April 2023) and *Caladenia tessellata* (October 2023). As such the species have been assessed through survey and no expert reports have been prepared. The results of the literature review and habitat assessment for these species is included as Appendix E to help inform the consideration of the subject species and provide additional certainty that the proposal would not result in a SAII.

No species credits have been calculated for any threatened flora species.

A BCD officer has advised that the critically endangered species *Rhodamnia rubescens* (Scrub Turpentine) has previously been recorded at the site (Vanessa Allen, BCD, *pers. comm*.). This species is a shrub or small tree which typically occurs in warm rainforests and rainforests margins but may also be associated with wet sclerophyll forests in coastal areas. There is a small area of potential habitat for the species at the site associated with moist, long-unburnt areas of PCT 694 containing other mesic species. A review of OEH database records shows several records in close proximity of the site, although none fall within the development footprint, and attempts to locate the previous record were unsuccessful. *Rhodamnia rubescens* is a count type species according to the BAM and is not cryptic or dependent on specific seasonal survey conditions to detect. This species was not recorded during the present or any past surveys (ERM 2004; EMM 2014). Noting the sensitivity of this species to fire and to the disease Myrtle Rust it is likely that the previous record of the species no longer occurs and that the survey results are considered a reliable indicator that *Rhodamnia rubescens* does not occur at the development site and does not require calculation of species credits.

6.2.2 Threatened and migratory fauna

A number of threatened fauna species have been consistently detected within the study area (EMM; Ecological 2014; OMVI and GHD 2018 and 2019). Table 6.3 provides a summary of the threatened fauna species recorded within or near the study area.

The Eastern Pygmy-possum (*Cercartetus nanus*) was trapped in open grassy forest habitat in the western portion of the study area in the conservation lot and so species credits have been calculated for this species. No additional species credit-type species were recorded despite targeted survey. No potential or occupied nests for dual-credit species, or evidence of breeding was noted despite multiple rounds of targeted survey (refer Table 6.2 and Table 6.3).

EMM (2014) also recorded the Hooded Plover (*Thinornis rubricollis*), Pied Oystercatcher (*Haematopus longirostris*) and Sooty Oystercatcher (*Haematopus fuliginosus*) in dunes to the east of the study area. These shorebird species are associated with the foreshore habitats of Inyadda Beach and are unlikely to reside or forage within the development footprint.

Of the remaining threatened species, the Sooty Owl (*Tyto tenebricosa*) were detected at the margins of the study area and outside of the development footprint. Sooty Owls use moist eucalypt forests and heavy vegetation and may forage and/or roost within the wet sclerophyll forest habitat associated with the northern and southern drainage lines. The Sooty Owl was not recorded during the current surveys (including during its breeding season) and no potential nests were recorded but was heard calling from near the northern boundary of the study area during previous surveys (ERM 2014). No caves are present in the study area.

Numerous Glossy Black-cockatoo sightings and/ or chewed *Allocasuarina* or *Casuarina* cones were recorded within the study area, within both the development footprint and the conservation lot, however, the majority of sightings and activity were associated with Swamp Oak forest within the conservation lot including both the southern and northern drainage lines.

One vulnerable species listed under the EPBC Act, the White-throated Needletail (*Hirundapus caudacutus*), was detected flying over the study area. It is also a migratory species listed under the EPBC Act. It is not listed under

the BC Act. Three additional migratory species listed under the EPBC Act (but not listed as threatened under the EPBC Act or BC Act) were also detected within the study area.

Table 6.3 Threatened and migratory species detected within the study area

Class	Family	Scientific Name	Common Name	NSW Status	EPBC Status	EMM (2014)	Current study (GHD and OMVI Ecological)
Threatened Species							
Aves	Accipitridae	*Lophoictinia isura*	Square-tailed Kite	Vulnerable	-	Present	Observed, no large stick nests present in the development footprint despite nest tree census in appropriate season and multiple rounds of targeted surveys. No evidence of breeding activity noted.
Aves	Accipitridae	*Pandion cristatus*	Eastern Osprey	Vulnerable	-	Present	Not recorded. No large stick nests present in the development footprint despite nest tree census in appropriate season and multiple rounds of targeted surveys. No evidence of breeding activity noted.
Aves	Artamidae	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	Vulnerable	-	-	Observed, eastern study area boundary, development footprint.
Aves	Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-cockatoo	Vulnerable	-	Present	Observed, foraging. No evidence of occupation of candidate hollow-bearing nest trees in the development footprint despite nest tree census in appropriate season and multiple rounds of targeted surveys. No evidence of breeding activity noted.
Aves	Cacatuidae	*Callocephalon fimbriatum*	Gang-gang Cockatoo	Vulnerable	-	Present	Observed, foraging. No evidence of occupation of candidate hollow-bearing nest trees in the development footprint despite nest tree census in appropriate season and multiple rounds of targeted

Class	Family	Scientific Name	Common Name	NSW Status	EPBC Status	EMM (2014)	Current study (GHD and OMVI Ecological)
							surveys. No evidence of breeding activity noted.
Aves	Charadriidae	*Thinornis rubricollis*	Hooded Plover	Critically endangered	Vulnerable	Recorded, dunes to east of study area	-
Aves	Haematopodidae	*Haematopus fuliginosus*	Sooty Oystercatcher	Vulnerable	-	Recorded, dunes to east of study area	-
Aves	Haematopodidae	*Haematopus longirostris*	Pied Oystercatcher	Endangered	-	Recorded, dunes to east of study area	-
Aves	Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	Vulnerable	-	-	Observed
Aves	Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	Vulnerable	-	Present	Heard
Aves	Tytonidae	*Tyto tenebricosa*	Sooty Owl	Vulnerable	-	Heard, northern study area boundary	-
Mammalia	Burramyidae	*Cercartetus nanus*	Eastern Pygmy-possum	Vulnerable	-	-	Trapped
Mammalia	Molossidae	*Micronomus norfolkensis*	Eastern Coastal Free-tailed Bat	Vulnerable	-	ERM (2004) record	Definite (anabat)
Mammalia	Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	Vulnerable	-	Present	-
Mammalia	Vespertilionidae	*Miniopterus australis*	Little Bent-winged Bat	Vulnerable	-	Present	Definite (anabat)
Mammalia	Vespertilionidae	*Miniopterus orianae oceanensis*	Eastern Bent-winged Bat	Vulnerable	-	Present	Probable (anabat)
Mammalia	Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	Vulnerable	-	Present	-
Migratory species							
Aves	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	-	Vulnerable Migratory	-	Observed, eastern study area boundary
Aves	Monarchidae	*Myiagra cyanoleuca*	Satin Flycatcher	-	Migratory	-	Observed
Aves	Monarchidae	*Monarcha melanopsis*	Black-faced Monarch	-	Migratory		Observed
Aves	Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail	-	Migratory	-	Observed

6.3 Threatened species polygons

One confirmed candidate threatened species, the Eastern Pygmy Possum, has been assessed for species credits.

The Eastern Pygmy-possum is listed as a vulnerable species under the BC Act. The Eastern Pygmy-possum was recorded in better condition grassy woodland in the study area and is likely to occur in woodland and forest with appropriate shelter and foraging resources throughout the development site.

The species is associated with PCT 694 Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, PCT1231: Swamp Mahogany swamp sclerophyll forest on coastal lowlands and PCT 1326 Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands according to the TBDC and species profile (DPE 2023a). The Eastern Pygmy-possum is not known to be associated with PCT 1232 Swamp Oak Floodplain Swamp Forest or PCT 1236: Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats (DPIE 2023a).

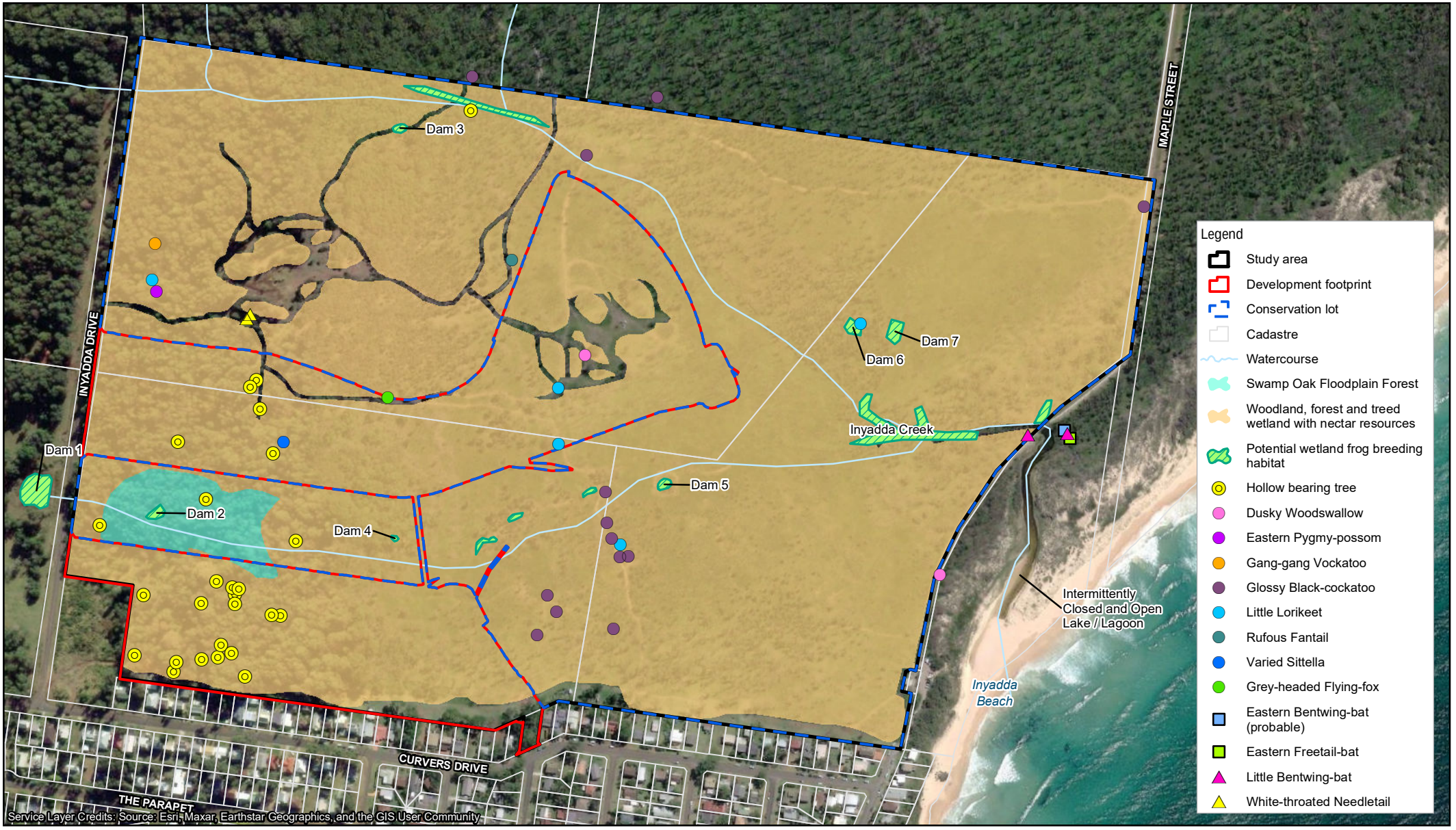
The Eastern Pygmy-possum feeds primarily on nectar and pollen collected from flowering trees and shrubs that produce reliable quantities of these resources such as banksias, eucalypts, callistemons and melaleucas. The species prefers habitat with a rich shrub understory, such as heath and shrubby woodland, however they are also known to occur in wet forest and grassy woodlands and the presence of eucalypts alone is sufficient to support populations in low densities (DPIE 2021b). PCT 694, PCT 1231 and PCT 1326 at the development site each feature a canopy dominated by eucalypts as well as various nectar-bearing species in the Myrtaceae and Proteaceae families in the mid storey or shrub layer (see section 5.3) consistent with the association of the species with these PCTs in the TBDC (DPE 2023a).The poor condition PCT 694 at the development footprint features high exotic plant cover and lower native shrub cover but would still contain sufficient Eucalyptus canopy cover and mid storey species such as Acacias to comprise habitat for the species.

Additionally, the PCT 1236 at the development footprint features a dense mid storey of various nectar-bearing species in the Myrtaceae and Proteaceae families in the mid storey and occasional emergent Eucalyptus. This PCT is likely to provide sufficient nectar resources to comprise habitat for the eastern Pygmy-possum, particularly in its current post-fire condition with relatively high cover of these flowering species and low cover of Swamp Oak.

The species is mainly arboreal and favours tree hollows for nesting. However, females may also nest under the bark of eucalypts and in shredded bark in tree forks and non-breeding individuals may shelter in stumps, disused ringtail possum or bird nest, hollow logs, (i.e. shelters in rotten stumps) holes in the ground or dense groundcover vegetation (DPIE 2021b). As such, the presence of tree hollows is not a limiting resource for the species and moderate condition areas of these PCTs that feature sub-mature regeneration would still comprise suitable habitat for the Eastern Pygmy-possum. The extent of nectar bearing forest, woodland and swamp forest habitat for the species is shown on Figure 6.1.

PCT 1232 at the development site is dominated by Swamp Oak with minimal cover of nectar-bearing species and does not comprise suitable Eastern Pygmy-possum habitat. Non-native and cleared land at the development site does not contain shelter or foraging resources for the species.

Based on the above considerations a 17.88 ha Eastern Pygmy-possum species polygon has been mapped, encompassing PCT 694, PCT 1231, PCT 1236 and PCT 1326 at the development footprint as shown on Figure 6.2.



Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Heir Asquith Pty. Ltd.
North Manyana Subdivision
Biodiversity Development Assessment Report

Threatened **and migratory** fauna and habitat resources

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 6.1

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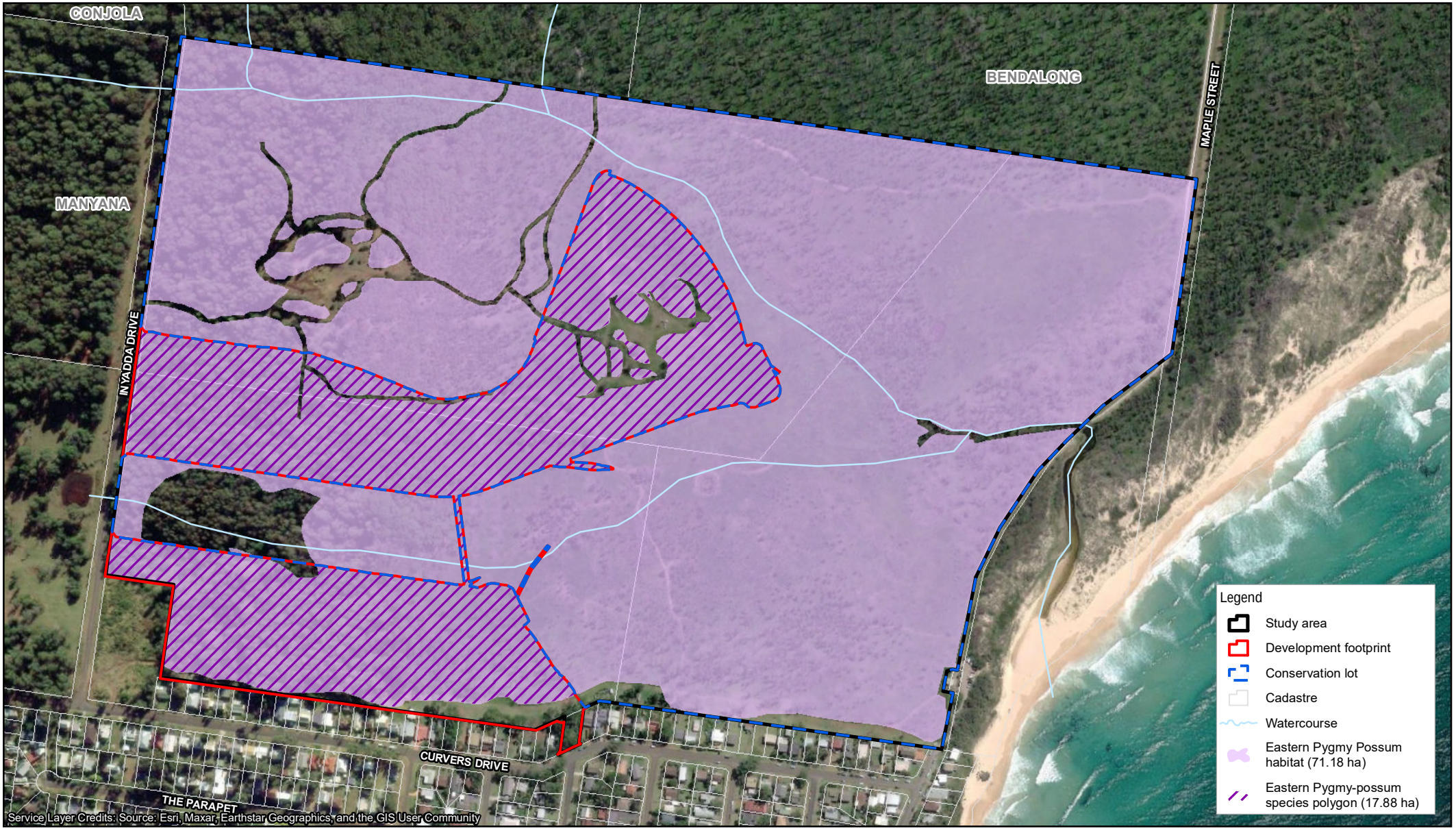
Print date: 12 Oct 2023 - 14:26

Data source: ERSI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay



Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Heir Asquith Pty. Ltd.
North Manyana Subdivision
Biodiversity Development Assessment Report

Threatened species polygon
- Eastern Pygmy-possum

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 6.2

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Print date: 12 Oct 2023 - 14:26

Data source: ERSI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

7. Matters of National Environmental Significance

7.1 Threatened ecological communities

Vegetation mapped as PCT 1326: Woollybutt – White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion in good and moderate condition is commensurate with the CEEC Illawarra and south coast lowland forest and woodland, as listed under the EPBC Act. Vegetation on site meets both the key diagnostic characteristics and the minimum condition thresholds for the community, as per the conservation advice for the CEEC (DoEE 2016).

Vegetation mapped as PCT 1232 –Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion in good and moderate condition is commensurate with the CEEC Coastal Swamp Oak (*Casuarina glauca*), forest of NSW and South East Queensland. Vegetation on site meets both the key diagnostic characteristics and the minimum condition thresholds for the community, as per the conservation advice for the CEEC (DEE, 2018).

Vegetation mapped as PCT 1231 – Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion in moderate condition is commensurate with the EEC Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland. Vegetation on site meets both the key diagnostic characteristics and the minimum condition thresholds for the community, as per the conservation advice for the EEC (DAWE 2021a).

7.2 Threatened species

No threatened flora species listed under the EPBC Act were identified within the proposal site, despite targeted surveys.

The White-throated Needletail (*Hirundapus caudacutus*), listed as a vulnerable and migratory species under the EPBC Act, has been flying over the study area. The Hooded Plover (*Thinornis rubricollis*), listed as a vulnerable species under the EPBC Act, has been recorded on the dunes and shoreline of Inyadda Beach to the east of the study area.

7.3 Migratory biota

The following migratory species have been recorded on or flying over the study area:

– White-throated Needletail (*Hirundapus caudacutus*)
– Black-faced Monarch (*Monarcha melanopsis*)
– Satin Flycatcher (*Myiagra cyanoleuca*)
– Rufous Fantail (*Rhipidura rufifrons*).

Important habitat for these migratory birds is defined in the significance criteria for listed migratory species (DotE 2013) as follows:

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

Habitat in the study area is unlikely to be important habitat for migratory species as it would not support an ecologically significant proportion of the population, is not critical to the lifecycle of these species and is not at the limit of these species' range. While these species may occur on occasion, they would not rely on the habitats present for their survival in the locality.

8. Impact assessment

The proposal would result in direct impacts on native biota and their habitats within the development footprint (Figure 9.1). There is also the potential for indirect impacts on areas of native vegetation adjacent to the development footprint, both during construction and from the resulting residential development.

Specific mitigation measures are recommended to minimise likely impacts on biodiversity values. These measures are presented according to the hierarchy of avoidance and mitigation of impacts, and the provision of offsets to counter residual impacts of the proposal that cannot be avoided or mitigated.

8.1 Avoidance of impacts

8.1.1 Overview

Section 6.4 of the BC Act establishes a requirement to take all feasible steps to avoid or minimise impacts on biodiversity values and to offset residual impacts. The proposal has aimed to avoid and minimise impacts to native vegetation and habitat values by amending the original subdivision layout for the development. Various iterations of the subdivision layout have been developed and then amended in response to detailed understanding of the site's biodiversity values and offset requirements as the BDAR and a previous biocertification proposal and development applications were prepared.

The discussion of measures to avoid impacts should be mainly based on the 'readily developable area', noting that if land use zoning or other environmental planning instruments restricts development in an area then there can be no genuine avoidance of an impact of a development that could not otherwise be carried out. The readily developable area at the site is shown on Figure 8.1 and comprises Land zoned R1 General Residential, R2 Low Density Residential and R5 Large Lot Residential in the Shoalhaven Local Environment Plan (LEP); but generally excludes

– Land zoned C3 Environmental Management and RE1 Public Recreation; and
– Land within riparian corridors that would be subject to restrictions to development under the *Water Management Act 2000* and or comprise flood prone land with an annual exceedance probability of greater than 1:100 (Egis Consulting 2023b); and
– Land that is inaccessible based on the restrictions listed above and related constraints such as bushfire hazard.

The readily developable area at the study area shown on Figure 8.1 encompasses 36.54 hectares of land, with the remaining 40.24 hectares at the site comprising land that is generally inconsistent with establishment of a residential subdivision.

It should also be noted that under the current planning controls, Schedule 1(no. 6) – 1.15 to Shoalhaven LEP 2014, the following additional permitted land uses are permitted in the C3 zone on the subject property:

"6 Use of certain land at Manyana

(1) This clause applies to land identified as "Sch 1.15" on the ***Clauses Map****, being Lot 2, DP 1121854, Sunset Strip, Manyana, that part of Lot 106, DP 755923, (Portion 106), Inyadda Drive, Manyana that is in Zone E3 Environmental Management; and that part of Lot 2, DP 1161638, Inyadda Drive, Manyana that is in Zone E3 Environmental Management.*

(2) Development for the purposes of advertising structures, amusement centres, community facilities, food and drink premises, function centres, helipads, heliports, recreation facilities (indoor), recreation facilities (major), recreation facilities (outdoor) and registered clubs is permitted with development consent."

Therefore, the readily developable land at the study area could also include the C3 land if the proposed development was for the purposes of the activities listed in Schedule 1(no. 6) – 1.15 to

Shoalhaven LEP. The applicant/owner is prepared to surrender the additional permitted land uses on the property as there is no intention to conduct such activities and the land would instead be set aside for conservation.

The proposal has aimed to further avoid impacts to native vegetation and habitat values by amending the subdivision layout. As described below, various iterations of the subdivision layout have been developed and then amended in response to detailed understanding of the site's biodiversity values and with particular focus on avoiding a SAII on Illawarra Lowlands Grassy Woodland. The proponent has identified a reduced impact subdivision layout based on consideration of biodiversity values and other factors. A discussion of measures to further avoid and minimise impacts associated with the reduced impact subdivision layout is provided in section 8.1.2. This discussion includes consideration of the readily developable area at the site based on land use zoning and other constraints.

8.1.2 Subdivision options assessment

A subdivision options assessment was completed to meet the requirements of Section 6.4 of the BC Act to take all feasible steps to avoid or minimise impacts on biodiversity values. The assessment included:

– Consultation with the proponent and their planning, bushfire, traffic and flood management advisors to identify alternative subdivision layout options
– Consideration of land use zoning, riparian setbacks, practical residential lot and perimeter road layouts, bushfire hazard and other development constraints to confirm the potentially developable area at the site
– Consideration of the potential to regenerate previously degraded patches of Illawarra Lowlands Grassy Woodland as part of a functional patch of the community with a greater extent and improved condition and security than the baseline condition
– Review and GIS analysis of subdivision layout options and other spatial data to calculate the relative quantum of impact to Illawarra Lowlands Grassy Woodland and other biodiversity values.

Table 8.1 presents a comparison of the development footprint impacts and land that would be conserved in the conservation lot adjacent to the development footprint, subject primarily to the Vegetation Management Plan at Appendix G, and which may also be converted to a biodiversity stewardship site (BSS) for the following subdivision layout options:

1. The proposed 100 residential lot subdivision layout included in the 2021 DA (i.e. the full impact on Illawarra Lowlands Grassy Woodland presented in the 2021 DA and BDAR)
2. An alternative 65 residential lot, 'reduced impact' subdivision layout as shown on Figure 1.2 which has been adopted for the proposal in order to substantially avoid impacts to Illawarra Lowlands Grassy Woodland and other biodiversity values.

As shown in Table 8.1, the reduced impact subdivision layout would achieve a substantial reduction in the quantum of impact to biodiversity values and especially to the local occurrence of Illawarra Lowlands Grassy Woodland EEC at the study area and the risk of an SAII. Note that these impact and avoidance calculations are based on the updated vegetation zone mapping included in this report and differ slightly from the areas presented in the 2021 BDAR (GHD 2021a).

Table 8.1 Comparison of 2021 DA and reduced impact (2023 DA) subdivision layouts

Feature	2021 DA development footprint	2021 DA conservation lot	Reduced impact development footprint	Reduced impact conservation lot
Number of lots	100 residential	1 community title / conservation	65	1 community title / conservation
Total area (ha)	28.44	48.34	19.58	57.25
Total area of native vegetation (ha)	25.68	47.14	17.95	54.89
Total area of the Illawarra Lowlands Grassy Woodland EEC (ha)	9.32	3.59	1.38	11.53
Percentage of the local occurrence of Illawarra Lowlands Grassy Woodland EEC at the study area	72.18%	27.82%	10.71%	89.29%
Non-native and cleared land (ha)	2.76	1.20	1.64	2.36

Notes: EEC – endangered ecological community.

Egis Consulting Pty Ltd also produced a draft subdivision layout with a development footprint that restricted all residential lots to the southern portion of the subject site, avoiding all impacts to the local occurrence of Illawarra Lowlands Grassy Woodland. The 'nil impact' subdivision layout would not be acceptable from Planning for Bushfire purposes (Mills, P. Egis Consulting, pers. comm.). Therefore, the nil impact subdivision layout was not considered further as part of this process and the proponent intends to proceed with the 65-lot reduced impact subdivision layout shown on Figure 1.2.

8.1.3 Reduced impact subdivision layout

The reduced impact subdivision proposal shown in Figure 1.2 would remove 17.95 ha of native vegetation for a 19.58 ha subdivision containing 65 residential lots within the total readily developable area of 36.54 hectares. The reduced impact subdivision proposal includes a conservation lot around 57.25 ha in area over the remainder of the study area, including 17.98 ha of the readily developable area. Figure 8.2 shows the reduced impact subdivision development footprint along with the 2021 DA development footprint and previous development proposals for context.

A total of 1.01 ha of the development footprint is outside the readily developable area in land zoned C3 Environmental Management. The development proposed within the C3 zoned land comprises of perimeter roads, bioretention basins and fire trails, which is considered permissible in the C3 zone given that the works can be defined as 'environmental protection works'. Environmental protection works are consistent with the permissibility and objectives of the C3 zone.

As a complying development, the current proposal is consistent with the Shoalhaven Local Environment Plan (LEP) and, in general, more consistent with the intended economic and environmental uses of the subject site. A conservative approach has been adopted in this BDAR and it is assumed that the total area of the development footprint would be cleared (see section 8.3). However, construction of dwellings within fewer, larger residential lots than the previous proposal is likely to result in a lower quantum of direct impacts. Some habitat resources for native biota would be retained in vegetation and soil profiles outside of infrastructure footprints and the extent of cut and fill required to comply with construction and stormwater management requirements. Avoidance of impacts based on the limited extent of earthworks and by locating building envelopes away from features of higher biodiversity value such as hollow-bearing trees is shown on Figure 8.3. Post construction, fewer lots and associated occupied dwellings would be expected to have reduced potential for indirect impacts such as noise and light generation, vehicle collisions and edge effects.

The proposed subdivision provides for large lot residential development with lot sizes ranging from 2,000m^2 to 3,129m^2. The subject land is zoned R1 General Residential, with a minimal lot size of 500m^2; and R5 Large Lot residential, with a minimal lot size of 2,000m^2. Based on the minimum lot size the site has potential for some 299 Lots under the zoning. The utilisation of this potential development was seen as inappropriate for the study area, considering the environmentally sensitive of the site. The proposed development yield of 65 lots (compared to the 100 lots considered in 2021)

was identified as a conservative option that minimises the environmental impacts, while achieving economic feasibility. The residential lot layout was designed allowing for fewer, larger residential lots which was likely to result in a lower quantum of direct impacts.

The current proposal does not include the establishment of any roads connecting the northern and southern development areas at the site, and instead established a six metre wide pedestrian shareway, to reduce impacts on habitat connectivity. Road design also integrated design requirements to comply with the Rural Fire Service (RFS) *Planning for Bushfire Protection* (2019) Guidelines. The 2021 DA was modified during its design phase to improve compliance with these guidelines through the provision of a perimeter road and inclusion of additional vehicular access points to Inyadda Drive at the western boundary of the site and to Curvers Drive at the southern boundary of the site. In addition, the proposal incorporates a fire trail along the boundary of the conservation lot and adjoining residential lots in the eastern portion of Curvers Drive, to mitigate the risk of bushfire to existing residential dwellings and provide beach access to Inyadda Beach for the future community.

To avoid impacts on biodiversity, the design team incorporated the following avoidance measures within the readily developable area:

– Focusing development on parts of the site which have been subject to historic clearing for agriculture and ongoing disturbance associated with 4WD-ing and other unregulated activities and areas of dense exotic weed infestations and/or sub-mature, regenerating vegetation with fewer habitat resources
– Adjusting the development footprint to avoid impacts to higher quality Illawarra Lowlands Grassy Woodland and other vegetation in the western portion of the study area and including this area in the conservation lot. Note that in this context ‘high quality’ refers to the extent and integrity of this patch as against areas in the central portion of the study area that are fragmented by tracks and previous clearing.

The reduced impact subdivision layout represents additional avoidance of impacts in the readily developable land at the study than originally proposed, which had avoided impacts considered in the previous planning proposals. To further avoid and minimise impacts on biodiversity, the design team incorporated the following avoidance measures within the readily developable area for the reduced impact subdivision layout:

– Reducing the number of residential lots from 100 to 65 including reducing the extent of native vegetation removal from 25.71 ha to around 17.95 ha. The additional 57.25 ha of land outside of the revised subdivision layout would be conserved and maintained in the conservation lot
– Adjusting the subdivision layout to avoid impacts to Illawarra Lowlands Grassy Woodland. The area of removal of the community (1.38 ha**) is now less than the area that would be regenerated** (1.64 ha of non-native vegetation and clearings within the overall patch of the community and a further 0.5 ha of poor condition PCT 1326). Additional areas of the community would be retained in the conservation lot, as well as areas of non-native vegetation in the central portion of the study area that are fragmented by tracks and previous clearing and would be regenerated to increase the extent and integrity of Illawarra Lowlands Grassy Woodland.
– The extent of cut and fill has been minimised as far as possible within stormwater management and constructability constraints. Building envelopes have been defined within each residential lot to support the conservation of hollow-bearing trees within the development footprint. The hollow-bearing trees mapped for retention would be conserved through a Section 88B restriction on title. It is likely that some additional canopy trees space, native groundcover vegetation and soil profiles would be retained in the areas shown outside infrastructure envelopes and cut and fill areas on Figure 8.3.

Hollow-bearing trees recorded in the development footprint and adjoining portions of the conservation lot are summarized in Table 5.11.

Of the 26 hollow-bearing trees recorded:

– Five fall within the mapped development footprint and would be removed for earthworks or construction of infrastructure

– 17 are intended to be retained in the proposed subdivision, and are outside of the planned extent of earthworks, building envelopes or infrastructure footprints and would be conserved through a Section 88B restriction on title
– Four fall within the conservation lot and would be retained.

A systematic hollow bearing tree and nest tree census has not been undertaken over the entire conservation lot. There may be additional hollow bearing trees in the conservation lot, particularly along the far north-eastern and eastern portions of the study area that are greater than 300 m from the development footprint and as such were not surveyed intensively for candidate species credit matters.

The reduced impact proposal would also contribute to conservation of biodiversity values in general through the implementation of a VMP, which may be replaced, in the longer term by the establishment of a BSA over the majority of the study area including:

– Retention of intact and contiguous vegetated corridors within the study area to maintain connectivity throughout the development and with surrounding habitats including coastal and marine environments. These areas will be conserved and managed for conservation in perpetuity
– Retaining high quality habitat resources for threatened species known to occur in the study area within the conservation lot.

Although the eastern portion of the study area is outside of the readily developable land the proposal would help avoid impacts in general, as management under a VMP and potentially a replacing BSA in the longer term, would ensure development is excluded in perpetuity. Management of this land would mitigate impacts such as weed infestation and unregulated clearing and use of tracks that are currently affecting the study area.

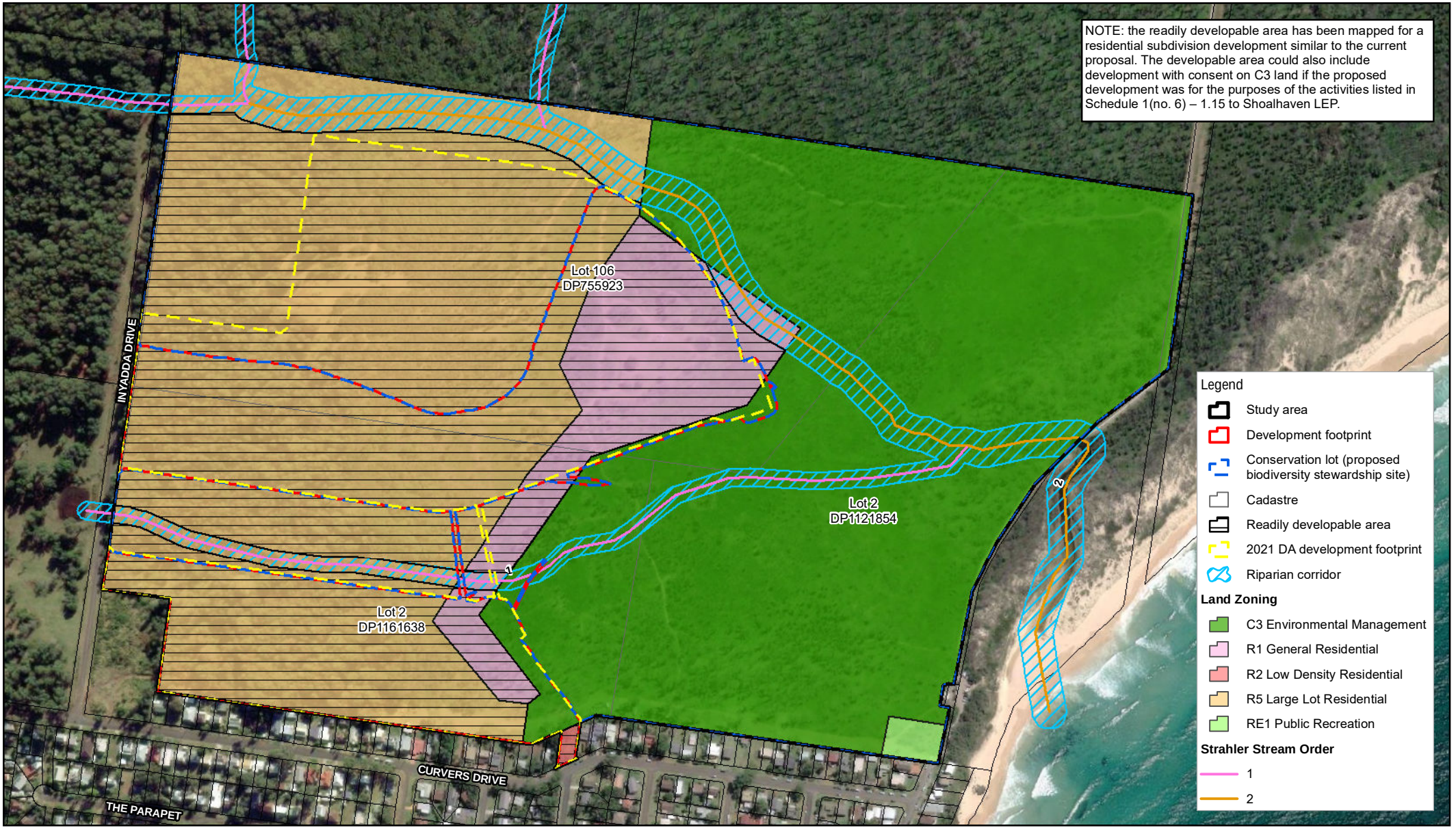
Section 7.1.2 of the BAM requires that 1. The BDAR or BCAR must document the *reasonable measures* taken by the proponent to avoid or minimise clearing of native vegetation and threatened species habitat during proposal design, including placement of temporary and permanent ancillary construction and maintenance facilities. The reduced impact subdivision layout is the result of *reasonable measures* undertaken through the design process. Other potential design changes that were considered in the development of the proposed layout included a design with nil impacts on Illawarra Lowlands Grassy Woodland (see below). An option with a northern perimeter road farther south than currently proposed and with around nine fewer residential lots was also considered with the aim of further reducing impacts on the community. Further reduction of impacts was constrained by practical limitations to a viable subdivision layout, including requirements for the minimum separation of entrance roads from Inyadda Drive to the site.

Impacts would be further minimised through the implementation of mitigation measures. A Construction Environmental Management Plan (CEMP) would be required for the construction phase of the proposal and would be prepared prior to issue of the Construction Certificate. The CEMP would include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures. The proposed mitigation measures would include environmental safeguards for protection of neighbouring properties and waterways in accordance with relevant policy documentation and Government guidelines. In order to address the potential impacts of the proposal on biodiversity the mitigation and management measures outlined in Table 8.2 would be implemented as part of the CEMP for the site. Additional or updated mitigation measures would be included in an updated BDAR as required.

8.1.4 Nil impact on Illawarra Lowlands Grassy Woodland subdivision layout

Assessment of development proposal options in a BDAR should, in general, not be limited to options that propose greater levels of clearing that the proposed development. Discussion of measures to avoid impacts would also be insufficient if analysis is restricted to options which apply development yield as a constant, rather than focusing on different degrees of impact to biodiversity values. Therefore, the subdivision options assessment included options with reduced residential lot yield and impact avoidance options for the proposal have included consideration of a development footprint with ‘nil impact’ on the Illawarra Lowlands Grassy Woodland community.

Egis Consulting Pty Ltd produced a draft subdivision layout with a development footprint that restricted all residential lots to the southern portion of the subject site, avoiding all impacts to the local occurrence of Illawarra Lowlands Grassy Woodland. This development outcome would not be acceptable from Planning for Bushfire purposes as it would create isolated pockets of residential development surrounded by areas of fire hazard associated with retained native vegetation (Mills, P. Egis Consulting, pers. comm.). Therefore, the nil impact subdivision layout was not considered further as part of this process.



Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

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North Manyana Subdivision
Biodiversity Development Assessment Report

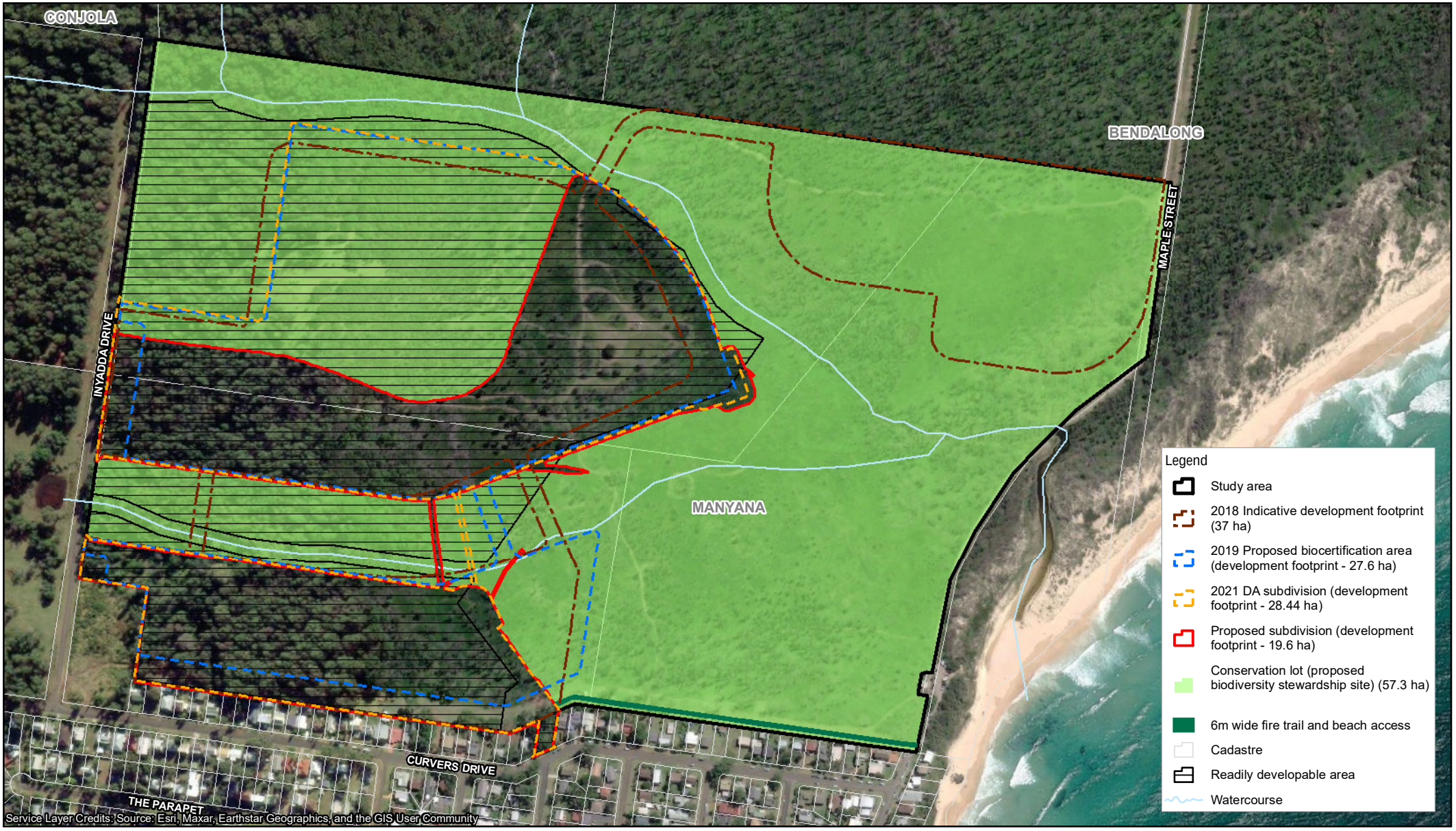
Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Readily developable area

Figure 8.1

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR018_DevelopableArea.mxd
Print date: 12 Oct 2023 - 14:29

Data source: Calibre Group: Development footprint, 2021; AE: Proposed subdivision. 2020; ESRi: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017; DPE: Land zoning, 2022. Created by: fmackay



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Biodiversity Development Assessment Report

Avoidance of impacts - subdivision location

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 8.2

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR012_ImpactAvoidance.mxd
Print date: 12 Oct 2023 - 14:27

Data source: Calibre Group: Development footprint, 2021; AE: Proposed subdivision. 2020; ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

NOTE:
Hollow-bearing trees to be retained in the proposed subdivision are outside of the extent of earthworks, building envelopes or infrastructure footprints and would be conserved through a Section 88B restriction on title.

Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

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Biodiversity Development Assessment Report

Avoidance of impacts - subdivision design

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 8.3

N:\AU\PortMacquarie\Projects\21\27200\GIS\Maps\Deliverables\BDAR\2127200_BDAR017_Impacts_SubdivisionDesign.mxd
Print date: 12 Oct 2023 - 14:28

Data source: Calibre Group: Development footprint, 2021; AE: Proposed subdivision. 2020; ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

8.2 Minimisation of impacts

8.2.1 Construction phase

Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) would be required for the construction phase of the proposal and would be prepared prior to issue of the Construction Certificate. The CEMP would include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures, including the procedures outlined below. The proposed mitigation measures would include environmental safeguards for protection of neighbouring properties and waterways in accordance with relevant policy documentation and Government guidelines.

In order to address the potential impacts of the proposal on biodiversity as discussed in Section 8.3, the mitigation and management measures outlined in Table 8.2 would be implemented as part of the CEMP for the site.

Table 8.2 Mitigation measures (construction)

Impact	Mitigation	Timing	Responsibility
General	All workers are to be provided with an environmental induction prior to starting work on site. This would include information on the ecological values of the site, protection measures to be implemented to protect biodiversity and penalties for breaches.	Prior to clearing/construction works	Construction contractor
	Prepare a flora and fauna management sub-plan as part of the CEMP, incorporating recommendations below, and expanding on specific details where necessary.	Prior to clearing/construction works	Construction contractor
	Measures to suppress dust implemented during clearing and construction.	Throughout clearing and construction phases	Construction contractor
Vegetation clearing	Prior to the commencement of any work in or adjoining areas of native vegetation, a survey would be carried out to mark the construction impact boundary. The perimeter of this area will be fenced using high visibility fencing and clearly marked as the limits of clearing. All vegetation outside this fence line will be clearly delineated as an exclusion zone to avoid unintended vegetation and habitat removal. Fencing and signage must be maintained for the duration of the construction period. Fencing should be designed to allow fauna to exit the site during clearing activities.	Prior to clearing Daily inspections of exclusion zones during works in area	Construction contractor and qualified ecologist
	Limit disturbance of vegetation to the minimum necessary to undertake the project.	Prior to clearing/construction works	Construction contractor
	Stockpiles of fill or vegetation should be placed within existing cleared areas (and not within areas of adjoining native vegetation).	Prior to clearing/construction works	Construction contractor
	Sediment fences should be installed to prevent transfer of sediments into adjacent vegetation or drainage lines.	Prior to clearing/construction works	Construction contractor
Introduction of Weeds and Pathogens	Develop a weed and pest species management sub-plan as part of the CEMP to manage weeds and pathogens during the construction and operational phase of the proposal.	Prior to clearing/construction works	Construction contractor
	The location and extent of any priority and/or high threat environmental weeds within the site will be identified by a suitably qualified ecologist during pre-clearance surveys. The introduction and spread of weed species will be minimised by restricting access to areas of native vegetation and communicating the responsibilities of all proposal personnel at site inductions and during regular toolbox meetings. All priority weeds identified on the site will be controlled and removed in accordance with the requirements of the *Biosecurity Act 2015* and relevant advice on control methods for individual species as available on the NSW Weedwise website.	Prior to clearing/construction works	Construction contractor and qualified ecologist

Impact	Mitigation	Timing	Responsibility
	All priority and high threat weeds will be cleared and stockpiled separately to all other vegetation, removed from site and disposed of at an appropriately licenced disposal facility. When transporting weed waste from the site to the waste facility, trucks must be covered to avoid the spread of weed-contaminated material. Disposal must be documented, and evidence of appropriate disposal must be kept.		
	All machinery entering the site must be appropriately washed down and disinfected prior to work on site to prevent the potential spread of weeds, Cinnamon Fungus (*Phytophthora cinnamomi*) and Myrtle Rust (*Pucciniales fungi*) in accordance with the *Protocols to protect priority biodiversity areas in NSW from Phytophthora cinnamomi, myrtle rust, amphibian chytrid fungus and invasive plants* (DPIE 2020b).	Prior to any plant or machinery being brought onto the site	Construction contractor
	Incorporate control measures in the design of the proposal to limit the spread of weed propagules downstream of development footprint. Sediment control devices, such as silt fences, would assist in reducing the potential for spreading weeds.	Prior to clearing/throughout construction works	Construction contractor
Removal of fauna habitat	Protocols to prevent introduction or spread of chytrid fungus should be implemented in accordance with the *Protocols to protect priority biodiversity areas in NSW from Phytophthora cinnamomi, myrtle rust, amphibian chytrid fungus and invasive plants* (DPIE 2020b).	Prior to clearing/throughout construction works	Construction contractor
	A trained ecologist should be present during the clearing of native vegetation or removal of potential fauna habitat to minimise impacts on resident fauna and to salvage habitat resources as far as is practicable.	Prior to and during clearing works	Qualified ecologist
	Staged vegetation clearing, commencing in the south of the site near the existing residential areas, and progressing northwards to increase the opportunity for fauna to vacate the site and disperse into areas of adjoining habitat to the north or east, to evade injury. It is preferable for the clearing of hollow-bearing trees to occur outside of the breeding season of bats, hollow- dependent birds and other arboreal mammals known to occur at the site (typically during September-December), and periods when some species (microbats) are in torpor (typically during June-August).	During clearing phase	Construction contractor
	Pre-clearance fauna surveys, undertaken in accordance with the following procedure: – An initial pre-clearance survey of the site will be undertaken by a suitably qualified ecologist prior to the commencement of any clearing activities. During the initial survey all hollow-bearing trees and significant habitat features such as fallen logs, will be identified with a “H” in high visibility spray paint. Significant high threat or priority weed infestations would also be identified and communicated to the contractor. – A daily pre-clearance fauna survey is also to be undertaken by a suitably qualified ecologist each day prior to the clearing of native vegetation. – Surrounding vegetation (i.e. non-hollowing bearing trees and understory plants) will be inspected by the ecologist for the presence of fauna.	Prior to and during clearing works	Qualified ecologist

Impact	Mitigation	Timing	Responsibility
	– If animals are found, procedures outlined in the protocol for capture and relocation (below) will be followed. Surrounding vegetation can then be cleared. – If no fauna are found, then surrounding non-hollow-bearing vegetation can be cleared. This process will be monitored by the ecologist in case fauna are found to be at risk. – The ecologist will document the outcomes of this process (e.g. number and species encountered/rescued). – As discussed above clearing of hollow-bearing trees and logs is to take place outside the breeding and torpor periods for the majority of species that may potentially occur.		
	A suitably qualified and appropriately licenced ecologist under the NSW *National Parks and Wildlife Act 1974* is to be present during clearing of all native vegetation to ensure felling of trees is carried out in an appropriate manner, and that any fauna present can be rescued and relocated. All trees marked with an "H" are to be felled in accordance with the procedure detailed below. When clearing within the approved construction area, all vegetation surrounding a hollow-bearing tree (excluding other hollow-bearing trees and logs) will be removed at least 24 hours prior to the hollow-bearing tree or log being removed. At least 24 hours after the removal of surrounding (non "H" marked) vegetation, the hollow-bearing tree or log can be removed (in accordance with the technique outlined below). Appropriate fauna 'capture and release' techniques will be implemented (see procedure below). During the removal of any identified sensitive habitat or hollow-bearing trees: A suitably qualified and experienced ecologist will be present, with appropriate animal-handling equipment and holding containers. **For hollow-bearing trees:** Prior to felling or removal, clearing machinery will be used to gently shake or 'bang' the habitat tree for a period of 2-3 minutes (dependant on tree health and structural integrity) to encourage any resident fauna to vacate hollows. Sticks, poles or other similar hand-held objects will also be used to hit the trunk of the tree or log at various points, to encourage animals to vacate the tree. The tree will be observed for at least 5 minutes prior to completing this action. After the observation period, trees will be gently lowered/felled using an excavator bucket or dozer blade for support if possible. The ecologist will observe the tree felling and ensure that any hollows are not blocked by being placed against the ground. Once deemed safe by the plant operator, the ecologist will inspect each tree and hollows for fauna that may be present (uninjured, injured or deceased). Use of fibre-optic cameras to assist this process is recommended. The ecologist will document this process using the tree hollow inspection register.	During clearing phase	Qualified ecologist

Impact	Mitigation	Timing	Responsibility
	Felled habitat trees with any occupied hollows will be left on the ground overnight or up to 24 hours to allow the animal to exit the hollow. Habitat trees can then be cut into appropriate sections according to the protocol for habitat salvage and relocation (described below). Felled habitat trees with hollows would be salvaged and relocated within retained areas of vegetation under the direction of the supervising ecologist. **For any hollow logs:** Prior to removal hollow logs should be gently knocked with an excavator for a short time while the log is observed by the supervising ecologist. Any fauna leaving the log will be rescued by the ecologists according to the protocol for fauna capture and relocation (described below). If no fauna emerge after an appropriate time (>5 min), the ecologists will inspect the hollow and instruct the plant operator to salvage hollows or translocate the log in accordance with the protocol for habitat salvage and relocation (described below).		
	A suitably qualified and appropriately licenced ecologist under the NSW *National Parks and Wildlife Act 1974 will* be present during the clearance of all native vegetation and/or fauna habitats. Animals that require handling must not be approached or handled until the ecologist is present, unless in an emergency (e.g. when there are both no authorised persons present and where the failure to immediately intervene would place the animal at significant risk). In such an emergency, the site manager may obtain over the phone instructions from the project ecologist to ameliorate the situation. A wildlife rescue organisation (e.g. WIRES) should be made aware of operations in case any injured fauna are found. All animals encountered will be treated humanely, ethically, and in accordance with relevant codes under the NSW *Prevention of Cruelty to Animals Act 1979*, including: – Code of practice for the welfare of wildlife during rehabilitation (DPI Victoria 2001). – Animal ethics considerations and protocols outlined in this document. If the project ecologist considers an animal is at risk of injury or undue stress, it is to be gently directed into secure adjoining habitat. Where deemed necessary by the project ecologist, the animal may be required to be captured and released. Capture and release operations will proceed via the following protocols: – All construction activities that are considered by the project ecologist be likely to increase the risk of injury, mortality or stress to the animal will be halted until the animal has been removed, which will be enforced with the co-operation of the Contractor. Construction activities that do not contribute to the risk of injury, mortality or stress to the animal can continue (as determined by the project ecologist). – Only qualified ecologists or wildlife carers are authorised to handle animals.	During clearing	Qualified ecologist

Impact	Mitigation	Timing	Responsibility
	– Animals will be captured (if required) by the project ecologist using a safe and ethical technique, as is appropriate for the particular species (see below). Native animals that are unable to depart of their own accord will be captured and held in a receptacle appropriate for that species until release. All captive-held animals will be provided with food, water and warmth as is appropriate for the species. Each receptacle will only hold one animal at a time and will be cleaned and disinfected between use to avoid the spread of disease. – Details of any fauna relocated from hollows would be recorded on the tree hollow inspection register. Any other fauna relocated from trees, shrubs or other areas would also be recorded.		
	The construction contractor is to contact the Project ecologist for advice if any unexpected fauna are found during the construction period (i.e. following clearing of native vegetation when the Project ecologist is no longer on site).	During clearing	Construction contractor
	Natural hollows and fallen timber will be salvaged during clearing. Plant operators will be instructed to maximise the salvage of habitat resources. The following protocol is recommended for the salvage of hollows and subsequent habitat enhancement in the adjacent conservation lot: – Significant hollows (as determined by the project ecologist) will be salvaged during clearing. Following felling, hollow-bearing trees will be left in place for a period of 24 hours. During this period, the Ecologist will identify and mark any hollows to be salvaged. – Felled habitat trees and logs can be cut into sections after at least 24 hours on the ground/post clearing to permit the recovery of hollow resources. The project ecologist is to direct an appropriately accredited chainsaw operator in these works. – Hollow trunks and limbs should be inspected using a fibre-optic camera and/or tapped by the ecologists prior to being cut to check that fauna have departed. – Following clearing operations, salvaged hollows are to be relocated in the adjacent BSS, under direction from the project ecologist. – Any stockpiled hollow sections of trunks or branches should be placed on their ends (with the hollow opening against the ground) to minimise the chance of fauna entering hollows while they are stockpiled. – Vegetation in the adjacent BSS is not to be damaged during relocation habitat features. Appropriately, sized machinery should be used to relocate hollow trunks and limbs and will use existing tracks or disturbed areas only.	During clearing	Construction contractor Project Ecologist
	A post-clearing report will be prepared documenting all animals that are handled, or otherwise managed, within the site. Data to be recorded includes: – Date and time of the sighting and details of the observer – Species	Post clearing	Construction contractor/ Qualified ecologist

Impact	Mitigation	Timing	Responsibility
	– Number of individuals recorded – Adult/juvenile – Condition of the animal (living/dead/injured/sick) – Management action undertaken (e.g. captured, handled, taken to vet) – Results of any management actions (e.g. released, placed in a nest box, euthanised, placed with carer) – An inventory of hollows and fallen timber salvaged and relocated will be maintained		
Water Quality and aquatic habitats	Erosion and sediment control plans should be prepared in accordance with Volume 2D of Managing Urban Stormwater: Soils and Construction (DECC 2008c). The erosion and sediment control plans would be established prior to the commencement of construction and be updated and managed throughout as relevant to the activities during the construction phase.	Prior to construction commencing	Construction contractor
	Erosion and sediment controls would be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality.	Weekly during construction phase or after any significant rainfall event	Construction contractor
	Stabilised surfaces should be reinstated as quickly as practicable after construction.	Immediately following clearing	Construction contractor
	Appropriate speeds for all construction and contractor vehicles are to be enforced to limit dust generation and minimise chances of fauna mortality through vehicle strike during the construction phase of the project.	During construction	Construction contractor
	All stockpiled material should be stored in bunded areas and kept away from waterways to avoid sediment or contaminants entering the waterway.	During construction	Construction contractor
	Spill kits would be made available to construction vehicles. A management protocol for accidental spills would be put in place.	During construction	Construction contractor

8.2.2 Operation phase

The following mitigation measures would be implemented during the operational phase of the proposed development (i.e. the use of the indicative development footprint as a residential area):

– Signposting and enforcement of appropriate speed limits along internal roads to reduce the likelihood of vehicle strike and mortality of native fauna.
– Appropriate management of bushfire asset protection zones (APZ) to prevent the spread of weeds and/or soil into adjacent areas of retained vegetation.
– Water Sensitive Urban Design (WSUD) infrastructure, perimeter roads and housing setbacks would be included in APZ. These design features would act as a buffer between the built form and conservation lot.
– Use of perimeter roads where possible to maintain public line of sight to neighbouring vegetation to reduce dumping.
– Appropriate fencing to be erected at interface between residential lots and adjoining native vegetation to restrict domestic animals accessing these areas.
– Enforcement of legal obligations to control priority weeds within residential areas to prevent the spread of propagules into retained areas of native vegetation.
– Street lighting to be designed to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats.
– Legal restrictions to be established preventing the owners or tenants of new residential areas from having cats, to limit the potential for cats to roam into retained bushland.

In addition to the above mitigation measures, areas of vegetation outside the development footprint would be conserved and managed under a VMP until such time any BSA was established and replaced the VMP. This vegetation would be managed in accordance with the VMP (and any future Site Management Plan (SMP) that is attached to any BSA) which would include weed control and other biodiversity rehabilitation and conservation measures which will assist in improving and maintaining the biodiversity values within these areas. To assist with the effective management of these lands, an education package would also be developed for residents that focusses on management and interaction with these neighbouring conservation lands. This package would also include, but not be limited to, information regarding matters such as establishment of bike tracks, illegal 4WD use, responsible pet ownership, rubbish disposal, wood collection and fire management.

8.3 Direct impacts

8.3.1 Removal or modification of vegetation

The proposed subdivision would require the removal or modification of native vegetation within the development footprint as summarised in Table 8.3.

All of the future values of the composition condition scores, structural condition score and function condition score have been entered as 0 for each vegetation zone within the development footprint. The extent of cut and fill, building envelopes and other infrastructure within the development footprint is shown on Figure 8.3. As described in section 8.1.3 cut and fill has been minimized as far as possible and building envelopes have been defined to support the conservation of hollow-bearing trees within the development footprint. The hollow-bearing trees mapped for retention would be conserved through a restriction on title. It is likely that some additional canopy trees, native groundcover vegetation and soil profiles would be maintained in the areas shown outside infrastructure envelopes and cut and fill areas on Figure 8.3. As the retention of these biodiversity values across multiple lots cannot be guaranteed a conservative approach has been adopted and BAM-C calculations are based on complete clearing of the development footprint. This conservative approach means that additional biodiversity credits have been included as part of this assessment to compensate for things such as indirect impacts even though the development will be adopting a range of mitigation measures (outlined in section 8.2) and managing adjoining vegetation in the conservation lot under a VMP (GHD 2023) to minimise such impacts as far as possible.

Table 8.3 Proposed removal of vegetation within the development footprint

Vegetation Community	PCT ID	Condition	Area within the development footprint (hectares)	Start VI score	Future VI score with development
Swamp Oak Floodplain Forest, Sydney Basin and South East Corner Bioregions	1232	Moderate	0.06	74.3	0
Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	1236	Moderate	6.71	65.8	0
White Stringybark – Forest Red gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	1326	Moderate	1.38	65.3	0
Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion	694	Moderate	4.62	58.6	0
Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion	694	Poor	2.36	45.8	0
Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion	1231	Moderate	2.81	78.3	0
Total			**17.95**		

8.3.2 Removal of habitat and habitat resources

The vegetation that would be removed provides habitat resources for native fauna species, including threatened species. The proposal would result in direct impacts on habitat for the threatened fauna species that which are assumed to use resources within the development footprint as listed in Table 6.1 and recorded at the development footprint as listed in Table 6.3.

The proposal would remove up to 17.95 hectares of habitat resources for these species including the removal of a number of mature and maturing trees. Mature trees have value for fauna populations as sources of foraging resources such as leaves, nectar, sap or seed and substrate for invertebrate prey. In the context of the extensive areas of native vegetation surrounding the site, the proposal would remove a small proportion of available foraging resources for local populations of native fauna.

The further loss of the habitat within the development footprint will increase this slightly, accounting for 2.86% of the native vegetation in the 1500 m buffer area, however the retention and management of the conservation lot immediately adjacent to the development footprint would include the regeneration of cleared land and non-native vegetation that would offset this reduction in vegetation cover.

The development footprint consists mainly of relatively young forest, there are however a small number of large habitat trees within the development footprint. These trees provide potential nesting sites for threatened gliders among other species. They may also be utilised as a roost or nest site by hollow-roosting microbats or smaller bird species. No known or potential hollow-bearing trees that could be candidate nest trees for threatened cockatoos or forest owls were recorded in the development footprint despite multiple rounds of targeted survey. Known hollow bearing trees to be removed and those mapped for retention outside infrastructure envelopes and cut and fill areas are shown on Figure 8.3 and summarised in Table 5.11 Summary of hollow bearing trees recorded at the study area*Table 5.11.

Based on the habitat tree surveys conducted to date:

– Five fall within the mapped development footprint and would be removed for earthworks or construction of infrastructure

– 17 are intended to be retained in the proposed subdivision, and are outside of the planned extent of earthworks, building envelopes or infrastructure footprints and would be conserved through a Section 88B restriction on title
– At least four fall within the conservation lot and would be retained (Table 5.11).

There may be additional hollow-bearing trees in the conservation lot, particularly in the far eastern and northeast portions which have not been intensively surveyed. There are also large numbers of hollow-bearing trees associated with several thousand hectares of habitat in Conjola N.P. to the north and west of the study area.

8.3.3 Fauna injury and mortality

As described above, the development footprint provides a variety of habitat resources for native fauna species, including foraging, roosting and shelter resources for threatened species as well as common native fauna. Groundcover vegetation, leaf litter and woody debris would provide shelter and foraging substrate for reptiles, frogs and invertebrates. Construction is likely to result in the injury or mortality of some individuals of these less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the development footprint during clearing activities. There is a relatively low density of hollow-bearing trees in the development footprint, and therefore there is a fairly low potential risk of injury or mortality of arboreal mammals or hollow-nesting birds. The potential for impacts on fauna utilising hollows would be further reduced through pre-clearance surveys of any habitat trees. Alternative habitat resources and refuge from construction activities is available in retained native vegetation adjoining the site. More mobile native fauna such as native birds, bats, terrestrial and arboreal mammals that may be sheltering in vegetation in the development footprint are likely to evade injury during construction activities.

Recommendations have been made in section 8.2 above to help minimise the risk of vegetation clearing activities resulting in the injury or mortality of resident fauna.

8.4 Indirect impacts

Indirect impacts resulting from construction are discussed in Table 8.4.

Table 8.4 Indirect impacts

Impact	Description
Weed invasion and edge effects	'Edge effects' can include increased noise and light or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Edge effects would result from construction activities and then continue to affect vegetation and habitats adjoining the development footprint. Altered environmental conditions along new edges can allow invasion by pest animals specialising in edge habitats and/or change the behaviour of resident animals. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators. The proposal would result in an increase in the number of new edges being established within areas of relatively intact native vegetation. Vegetation within and adjoining the site is in relatively good condition with very few weed species present. There is therefore a high risk that construction activities may increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via erosion (wind and water) and via workers shoes and clothing and through construction vehicles. The risk of introduction of weeds would continue during operation of the proposal as member of the public may enter adjoining vegetation. Management measures including the development of a weed management sub-plan as part of the proposal CEMP would be implemented to mitigate these potential impacts (refer to section 8.2). These measures would be extended to the conservation lot and the implementation of this VMP where applicable such as during management actions such as removal of waste, erosion mitigation, topsoil translocation and track decommissioning works, noting that these activities will require access for vehicles and transport of heavy materials. Weed control in the conservation lot would be implemented under the VMP (GHD 2023) and would mitigate edge effects from the proposed subdivision. The creation of new edges within areas of native vegetation also has the potential to introduce impacts associated with noise and light into areas of adjacent vegetation. This could in turn result in disruptions to fauna utilising vegetation adjacent to the site (as described below). Other relevant mitigation measures to reduce the impacts of edge effects include the establishment and management of APZs which would act as a buffer from development footprint to the proposed conservation lands, lighting design to minimise light spill as well as dust suppression and erosion and sediment measures during construction.

Impact	Description
	Measures for excluding unauthorised access to the conservation lot and mitigating these threats are presented in section 5.2.2 of the VMP and the locations for key management actions such as closing of trails and erection of exclusion fencing are shown on Figure 5.2 of the VMP (GHD 2023).
Introduction and spread of weeds, pests and pathogens	Disturbance associated with vegetation clearing, vehicle traffic and general day to day operations of the proposal during construction and operation of the proposal would increase the potential for the spread, introduction and establishment of weed and pest species, and diseases and pathogens. Weed species are effective competitors for habitat resources and have the potential to exclude native species and modify the composition and structure of vegetation communities. Construction activities within the development footprint also have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into adjacent native vegetation through vegetation disturbance and increased visitation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can wipe out entire populations once introduced into an area. The potential for impacts associated with these pathogens is high, given the condition of vegetation within the development footprint. Diseases and pathogens can be introduced or spread to site via dirt or organic material attached to machinery, vehicles, equipment and employees. To help mitigate the risk of pathogens being brought onto and/or spread through the site all machinery brought to site will be washed down and inspected to be free of soils, seeds and other organic material in accordance with Section 8.2.
Noise and light impacts on fauna	The majority of the proposed construction works would be undertaken during standard, daytime construction hours. Exemptions and approval for works outside of the above standard construction hours may be required during certain circumstances. Construction noise would be temporary and generally confined to daylight hours for the duration of the establishment of the new residential areas. There would be a substantial increase above existing background levels, given there is currently very little background noise in the local area. This may result in impacts on fauna that occur in the development footprint, however any such impacts are unlikely to be significant. Once the residential development is in operation there is likely to be indirect impacts resulting from increased noise and light around the periphery of the site. To help mitigate these impacts lighting within the development footprint will be designed to direct light inward to limit the light spill into adjoining vegetation.
Aquatic disturbance and impacts on fish habitat	The introduction of pollutants from the proposal into the surrounding environment, if uncontrolled, could potentially impact on water quality further downstream or in the lagoon or ocean to the east of the proposal site. The potential for water quality impacts on the unnamed drainage lines and lagoon adjacent to the site are considered to be low to moderate given the buffer of vegetated land along the drainage lines and the use of mitigation measures during construction. Potential water quality impacts would be managed through the implementation of mitigation measures, including the provision of sedimentation basins, silt fences and other structures to intercept runoff. No endangered aquatic communities, aquatic fauna or marine vegetation listed under the FM Act or EPBC Act occur in the development footprint and no significant impacts on riparian vegetation or habitats downstream of the study area are anticipated as a result of the proposal. There would be no impact on Key Fish Habitat as a result of the proposal.

Impacts on biodiversity values would be largely restricted to the construction phase of the proposal. There are however a number of potential impacts to surrounding vegetation that may occur as a result of the operation of the proposal. These include:

– Generation of additional light and noise
– Erosion and sedimentation as a result of runoff from hard stand areas
– Introduction of weed propagules by vehicle and/or residents
– Fauna mortality as a result of collision with vehicles
– Fauna mortality as a result of domesticated animals
– Increased risk of fire
– Rubbish dumping.

These potential impacts are linked to human occupation of the site and are likely to persist indefinitely. Mitigation measures to be implemented to minimise these potential impacts are discussed in Section 8.2.

8.5 Assessment of serious and irreversible impacts (SAII)

1.3.1 Identification of SAII entities

The assessment of serious and irreversible impacts (SAII) is a central component of the NSW Biodiversity Offsets Scheme (BOS). The purpose of considering SAII is to protect threatened species and threatened ecological communities most at risk from extinction from potential development impacts or activities. It is the responsibility of approval authorities to determine whether or not an impact on biodiversity values is likely to be a SAII. Under the BC Act, a determination of whether an impact is serious and irreversible must be made in accordance with the principles in Section 6.7 of the BC Regulation.

The principles are aimed at capturing impacts which are likely to contribute significantly to the risk of extinction of a threatened species or ecological community in New South Wales. These include impacts that will:

> Principle 1 - Cause a further decline of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline.
>
> OR
>
> Principle 2 - Further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size.
>
> OR
>
> Principle 3 - Impact on the habitat of a species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution.
>
> OR
>
> Principle 4 - Impact on a species or ecological community that is unlikely to respond to measures to improve habitat and vegetation integrity and is therefore irreplaceable.

Threatened biota that meet the criteria under one or more of the above principles have been identified as potential SAII entities and are listed in the Threatened Biodiversity Data Collection (TBDC) (DPIE 2021b).

A set of criteria have been developed and are included in the DPIE *Guidance to assist a decision-maker to determine a SAII* (OEH, 2017f). The BAM 2020 (DPIE 2020a) includes additional impact assessment provisions for threatened ecological communities at risk of an SAII that must be included in a BDAR.

One potential SAII entity (as identified in OEH, 2017f and the TBDC) would be impacted by the proposal: Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion EEC.

Illawarra Lowlands Grassy Woodland is included as an SAII entity as it meets Principles 1, 2 and 3 described in *Guidance to assist a decision-maker to determine a serious and irreversible impact* (OEH 2017):

> Principle 1 – ecological community currently in a rapid rate of decline

Principle 2 – ecological community has a very small population size

Principle 3 – ecological community has a very limited geographic distribution.

Further assessment of the potential for an SAII on this EEC is provided below. Detailed information of the extent of the community and its regional occurrence is provided in section 8.5.1 and analysis against the criteria set out in section 9.1.1 of the BAM is provided in Table 8.5.

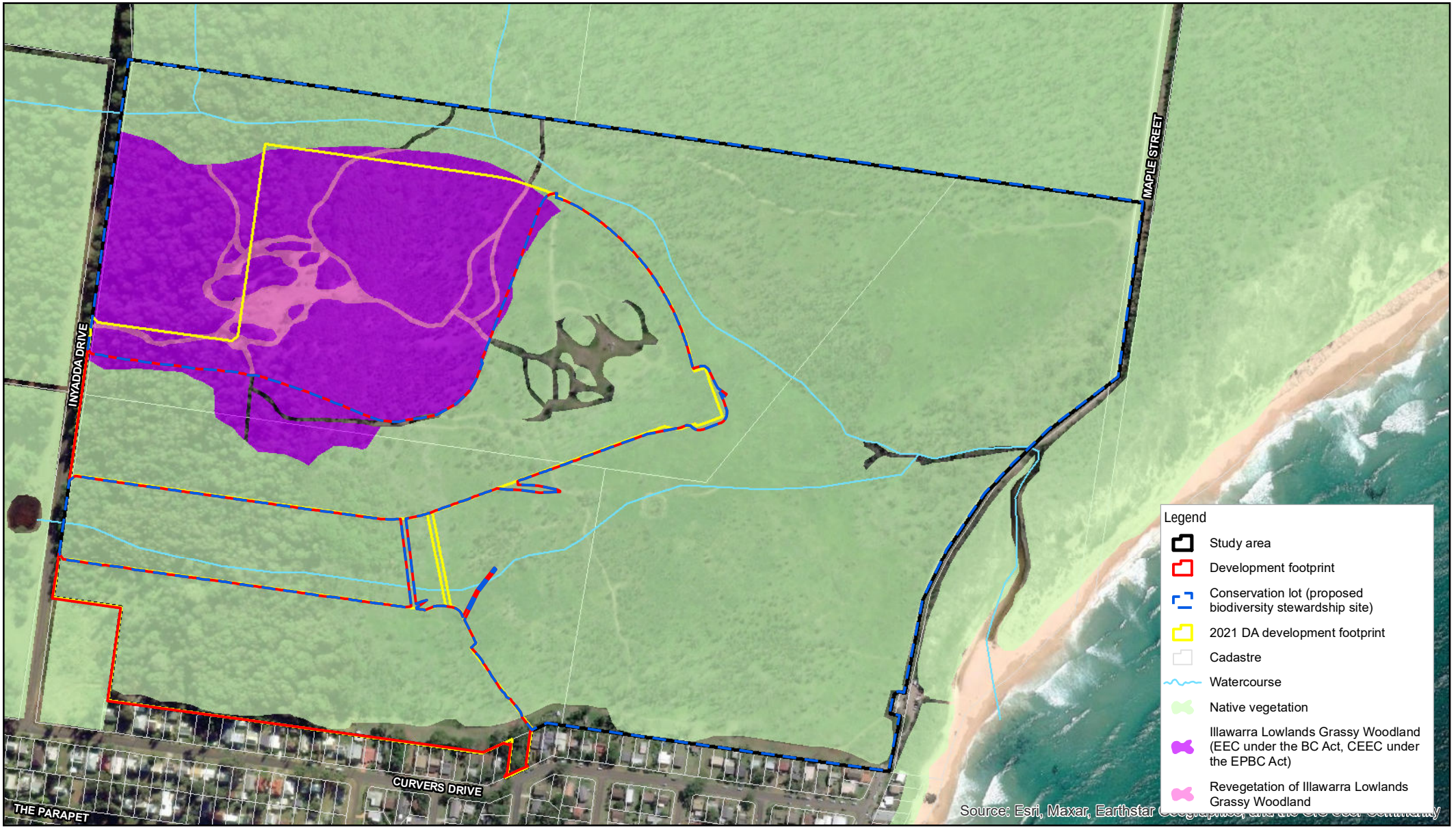
8.5.1 SAII assessment for Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Extent of the community

Study area

Vegetation within the study area that is mapped as Woollybutt – White Stringybark - Forest Red Gum grassy woodland on coastal lowlands (PCT 1326, revised PCT 3330) is recognised as part of a local occurrence of the Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion EEC. This vegetation also corresponds with the related community 'Illawarra and south coast lowland forest and woodland' which is listed as a CEEC under the EPBC Act. The occurrence of the community within the study area meets the 'category A' condition threshold under the EPBC Act approved conservation advice for this community (DoEE 2016) as the patch is at least 2 hectares, more than 50 percent of its total understorey vegetation cover is comprised of native species and there are at least six native plant species per 0.5 hectares in the ground layer.

About 12.91 hectares of vegetation commensurate with Illawarra Lowlands Grassy Woodland occurs across the study area, of which 1.38 ha (10.71%) would be removed for a proposed 65-lot subdivision and 11.53 hectares (89.29%) would be permanently protected within the conservation lot within the avoidance footprint for the reduced impact subdivision layout. All vegetation within the conservation lot is connected around the development footprint via vegetated riparian corridors that will be maintained, and forms part of a larger patch that extends out from the site to the north.



Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Heir Asquith Pty Ltd
North Manyana Subdivision
Biodiversity Development Assessment Report

Extent of Illawarra lowland grassy woodland at the site

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 8.4

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Print date: 12 Oct 2023 - 14:29

Data source: ESRI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by:

Regional occurrence

Total extent of the community

Illawarra Lowlands Grassy Woodland is generally restricted to within 30 km of the coast and in coastal valleys and low-laying foothills. This community mostly occurs at elevations between 10 and 150 m above sea level (Tozer *et al* 2010). It is known to occur within four IBRA subregions; Illawarra, Ettrema, and Jervis within the Sydney Basin Bioregion and also within the Bateman IBRA subregion within the Southeast Corner bioregion (DoEE 2016). The proposal is located in the Jervis IBRA subregion.

The original extent of this community is estimated to have been between 17,700 - 42,700 hectares (Tozer *et al* 2010). At the time the conservation advice for the community was published, 10 - 24% (approximately 4,200 hectares) was thought to remain (DoEE 2016). The total mapped extent of the TEC (identified as PCTs 1326 and 838) throughout NSW is 4,565 hectares, based on publicly available regional vegetation mapping of the regions where it occurs (OEH 2013; DPIE 2016). PCT 838 occurs between Wollongong and Milton, while PCT 1326 occurs between the Illawarra and Moruya.

In mid-2022 the NSW Department of Planning and Environment (DPE) published a revised PCT classification for coastal NSW and the associated State Vegetation Type map (SVTM) (DPE 2022). The following revised PCTs are associated with Illawarra Lowlands Grassy Woodland:

– 3269 Shoalhaven Lowland Spotted Gum-Paperbark Forest
– 3330 South Coast Lowland Woollybutt Grassy Forest
– 4052 South Coast Low Hills Red Gum Grassy Forest
– 3327 Illawarra Lowland Red Gum Grassy Forest.

Of the above PCTs, 3269, 3330 and 4052 occur in the Jervis IBRA subregion (DPE 2022). Revised PCT 3330 is equivalent to the legacy PCT 1326 that comprises the occurrence of Illawarra Lowlands Grassy Woodland at the study area.

Illawarra Lowlands Grassy Woodland is generally highly fragmented, with 92% of patches less than 10 hectares in area, and most patches being less than one hectare (DoEE 2016). The NSW Scientific Committee (2011) final determination also indicates that most remnants of this community are now small and fragmented. This threatens their long-term viability, with specific threats including further clearing, grazing, weed invasion, selective logging, rubbish dumping, residential and agriculture developments, and damage from recreational activities. Some remnants are known to consist of regrowth after past clearing or other disturbance has occurred.

Given a considerable portion of south coast of NSW was affected by the 2019/2020 bushfires, a proportion of the remaining occurrences of the ecological community may exist as burnt patches with varying degrees of regeneration.

Information provided by BAM Support during completion of the BDAR for the 2021 DA (GHD 2021a) indicated that the estimated current extent of the listed ecological community was 2,284 hectares. This is less than the estimated extents of Illawarra Lowlands Grassy Woodland based on the extent of associated PCTs, noting extents of 4,565 hectares in regional mapping of associated legacy PCTs (OEH 2013; DPIE 2016) and 10,628 hectares in the SVTM mapping of associated revised Eastern PCTs (DPE 2022) respectively. The reason for this difference is probably because the BAM Support calculation was based only on the extent of PCTs associated with Illawarra Lowlands Grassy Woodland “plant community from the local government areas of Wollongong City, Shellharbour City, and Kiama Municipality (within the Sydney Basin Bioregion…” consistent with the Scientific Committee determination for the EEC as listed under the BC Act (NSW Scientific Committee 2011). The study area and much of the recognised regional occurrence of the community is located in City of Shoalhaven LGA to the south of the extent listed in the Scientific Committee (NSW Scientific Committee 2011). As noted in section 5.5.2, the approach taken in this BDAR is to treat PCT 1326 at the study area as comprising part of an occurrence of Illawarra Lowlands Grassy Woodland EEC as listed under the BC Act. This approach aligns the extent of the community with the related CEEC listed under the EPBC Act, which is recognised as occurring in the Wollongong, Shellharbour, Kiama, City of Shoalhaven and Eurobodalla LGAs (DoEE 2016).

Estimates of the extent of ecological communities may, in general, fail to account for clearing of the community since the mapping was prepared, or model patches of the PCT in certain landscape positions or condition states that would not comprise the listed community as representative of the EEC. Conversely, regional scale estimates

of community extents may omit small, fragmented or atypical patches of Illawarra Lowlands Grassy Woodland that would still comprise an occurrence of the community based on the scientific committee determination and related Commonwealth listing advice (DoEE 2016). Notably the occurrence at the study area was mapped over a smaller area in OEH (2013) and was not identified at all in the SVTM (DPE 2022). Accordingly a GHD accredited assessor completed an assessment of the local and regional occurrence of Illawarra Lowlands Grassy Woodland to help inform the assessment of a potential SAII included in this report.

Local area

The desktop assessment of regional vegetation mapping datasets described above was further refined with an inspection of the locality and region surrounding the study area on 29 September and 30 2022. The purpose of the inspection was to help confirm the extent and condition of Illawarra Lowlands Grassy Woodland in the locality surrounding the study area. The local and regional occurrences of the community are shown on Figure 8.5 and Figure 8.6 and summarised below:

– The occurrence of Illawarra Lowlands Grassy Woodland at the study area is the only intact patch observed within a 500 m radius of the proposal. A number of remnant trees representative of the community such as Forest Red Gum (*Eucalyptus tereticornis*), Blue Box (*E. baueriana*) and Woollybutt (*Eucalyptus longifolia*) were observed in the suburbs of Bendalong and Manyana but did not form part of any functional patches of native vegetation. It is likely that the community once occupied a larger extent in this area associated with flatter, more fertile land that has been cleared for agriculture and subsequently developed for housing
– There are extensive areas of native vegetation to the north and west of the study area associated with Conjola National Park and other reserves. These areas are dominated by Blackbutt (*Eucalyptus pilularis)* dominated communities of less fertile sedimentary landscapes such as PCTs 694 and 1283 and do not form part of a local occurrence of Illawarra Lowlands Grassy Woodland. These areas would support many of the fauna species and certain plant species that comprise part of the Illawarra Lowlands Grassy Woodland at the study area and would contribute to the maintenance of source populations and other ecological process as part of an extensive patch of native vegetation
– There are patches of the community mapped near Swan Lake in Conjola National Park to the north of the study area and in Narrawallee Nature Reserve to the south (OEH 2013). These areas were not able to be accessed and inspected but have been mapped at the reserve scale and would comprise secure, remnant patches of the community
– The site inspection revealed patches of the community in the upper reaches of Conjola Creek and confirmed patches mapped in the SVTM (DPE 2022) on low lying, partially cleared land in the area around Conjola and Fisherman's Paradise. The patches of the community in this area are relatively small, fragmented remnants. The SVTM mapped relatively extensive additional patches of the community on steeper terrain in the Conjola area including in State forests and national parks to the west of the Princes Highway (DPE 2022) however these areas supported Blackbutt dominated communities of less fertile sedimentary landscapes such as PCT 694 and do not form part of a local occurrence of Illawarra Lowlands Grassy Woodland
– The majority of the Illawarra Lowlands Grassy Woodland in the locality is located in the Yatte Yattah area and on agricultural land to the north of Milton. This area includes smaller, fragmented remnants mapped in the SVTM (DPE 2022) as well as more substantial 5-10 hectare patches including in Yatte Yattah Nature Reserve. These patches are dominated by Forest Red Gum with a predominantly grassy groundcover in varying condition and are mainly PCT 838 (equivalent to the revised PCT 4052, DPE 2022) in contrast to the PCT 1326 (revised PCT 3330) at the study area
– There are small 1-2 hectare remnants of the community in the Mollymook area and in partially cleared agricultural land to the east of Milton as revealed by OEH (2013) mapping and/or the site inspection.

Based on the above the estimated local extent of Illawarra Lowlands Grassy Woodland comprises:

– 12.91 hectares of the community in a 500 m radius, all of which is the PCT 1326 located at the study area
– 130.01 hectares of the community in a 10 km radius, comprising an estimated 15.19 of PCT 1326 and 114.82 ha of PCT 838.

As described above, the majority of this extent is Forest Red Gum-dominated patches of the community located as fragmented remnants in the Yatte Yattah-Milton area around 8 km to the southwest of the study area. In this context the Illawarra Lowlands Grassy Woodland at the study area and that would be removed for the proposal is a floristically atypical and relatively isolated patch of the community.

The majority of the patches of Illawarra Lowlands Grassy Woodland in the locality did not appear to have been severely burnt (if at all) in the 2019/2020 bushfires. This is notable given the extensive areas of wet and dry sclerophyll forest that were burnt across Conjola National Park and other vegetated areas and is probably because most patches of Illawarra Lowlands Grassy Woodland occur as isolated remnants in a matrix of cleared agricultural or residential land. A proportion of the remaining occurrences of the TEC exist as burnt patches with varying degrees of regeneration including in Yatte Yattah Nature Reserve and the surrounding area. In late September 2022 these patches featured full overstorey vegetation cover, a dense mid storey of regenerating Acacia species and dense ground cover. The 2019/20 wildfires did not appear to have had an adverse effect on the extent or condition of the community (pers. obs.).

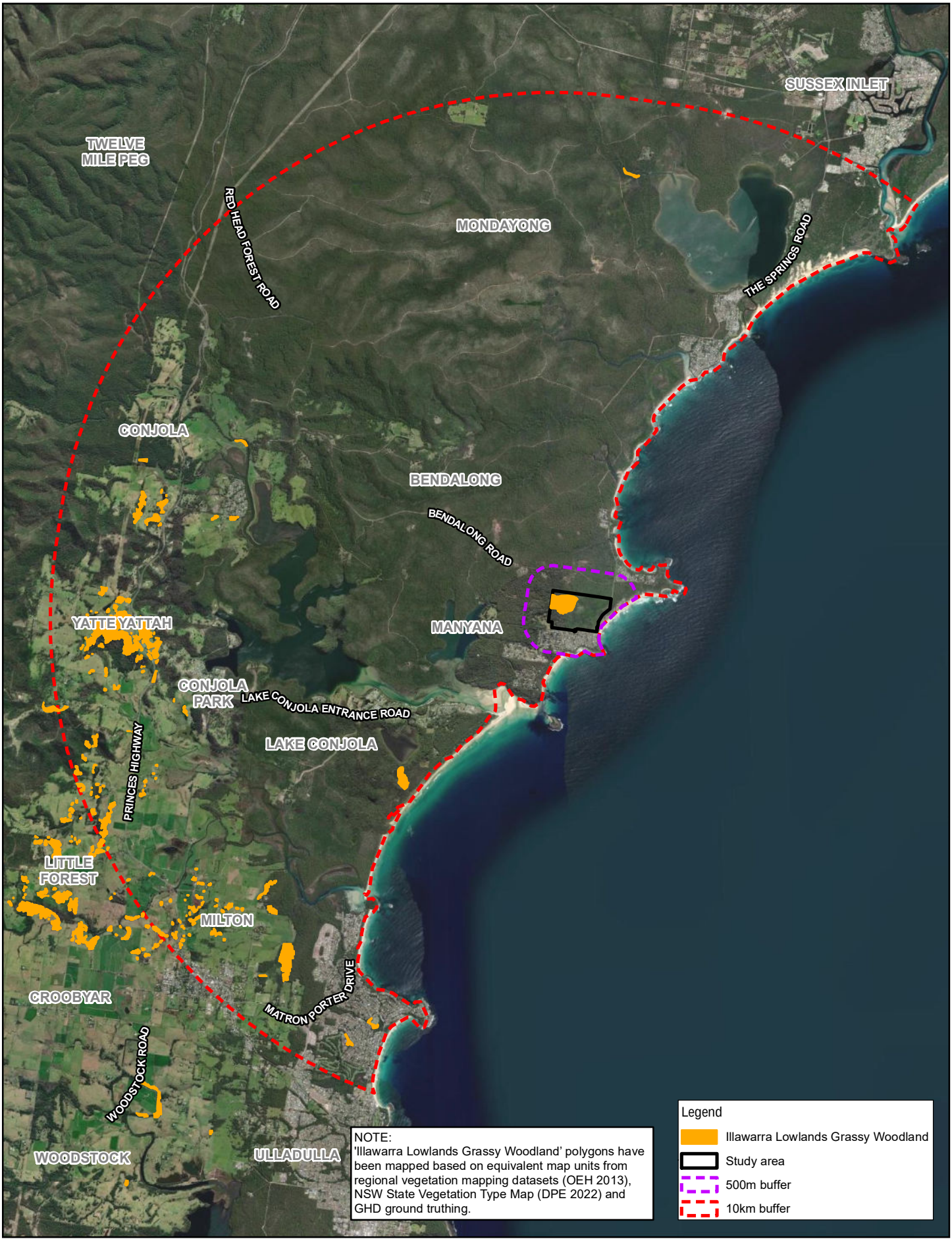
Based on the estimated local extent of the community as shown on Figure 8.5, the reduced impact subdivision layout proposal would result in a reduction of the total extent of this ecological community in the locality of about 1.06 % in the short term, through the removal of 1.38 ha of the community. The proposal includes the regeneration of 1.93 hectares of the community in the conservation lot as part of a functional patch of the community with a greater extent and improved condition and security than the baseline condition. This 1.93 ha area is made up of 0.5 ha of PCT 1326 in poor condition that would be regenerated and 1.43 ha of non-native vegetation that occurs as gaps in the patch of PCT 1326 in the conservation lot that would be revegetated. As such in the medium term the proposal would not reduce the extent of Illawarra Lowlands Grassy Woodland.

It should be noted that this mapping of Illawarra Lowlands Grassy Woodland was completed at a broad scale with reference to available regional-scale vegetation mapping datasets. Many of the previously mapped patches of the community are located on private land and could not be accessed and inspected on foot. In most cases, patches were assessed based on the presence of mature over storey species that are characteristic of the community, rather than detailed assessment of plant species composition or other factors. Regional scale mapping systems are based on modelled or extrapolated data (OEH 2013; DPIE 2016) and may over-map the extent of a given patch, wrongly classify PCTs and/or include patches of PCTs that do not feature soil types, landscape positions or condition states that are representative of the EEC. Conversely, these estimates of community extents may omit small, fragmented or atypical patches of Illawarra Lowlands Grassy Woodland that would still comprise an occurrence of the community based on the scientific committee determination and related Commonwealth listing advice (DoEE 2016).

Jervis IBRA subregion

The Jervis subregion extends from Culburra Beach in the north to South Durras in the south, along a coastal strip within about 20 km of the coastline. Based on partially ground-truthed vegetation mapping there is an estimated 809.87 ha of Illawarra Lowlands Grassy Woodland in the Jervis subregion including 664.26 ha mapped by OEH (2013), an additional 126 hectares mapped in the SVTM (DPE 2022) and/or by GHD ecologists including the 12.91 hectares within the study area. The estimated regional extent of the community is shown on Figure 8.6.

Based on OEH (2013) regional vegetation mapping, the reduced impact subdivision layout proposal would result in a reduction of the total extent of this ecological community in the Jervis IBRA subregion of about 0.17 %. The SVTM (DPE 2022) appeared to substantially over-map the PCTs associated with the Illawarra Lowlands Grassy Woodland in the locality and so it is likely that the total area of 3,255 hectares of the component PCTs mapped in the Jervis IBRA sub region is an overestimate. Accordingly, the regional extent of the community as mapped in the SVTM (DPE 2022) is not considered further in this assessment.



Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Heir Asquith Pty Ltd
North Manyana Subdivision
Biodiversity Development Assessment Report

Local occurrence of
Illawarra lowlands grassy woodland

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Figure 8.5

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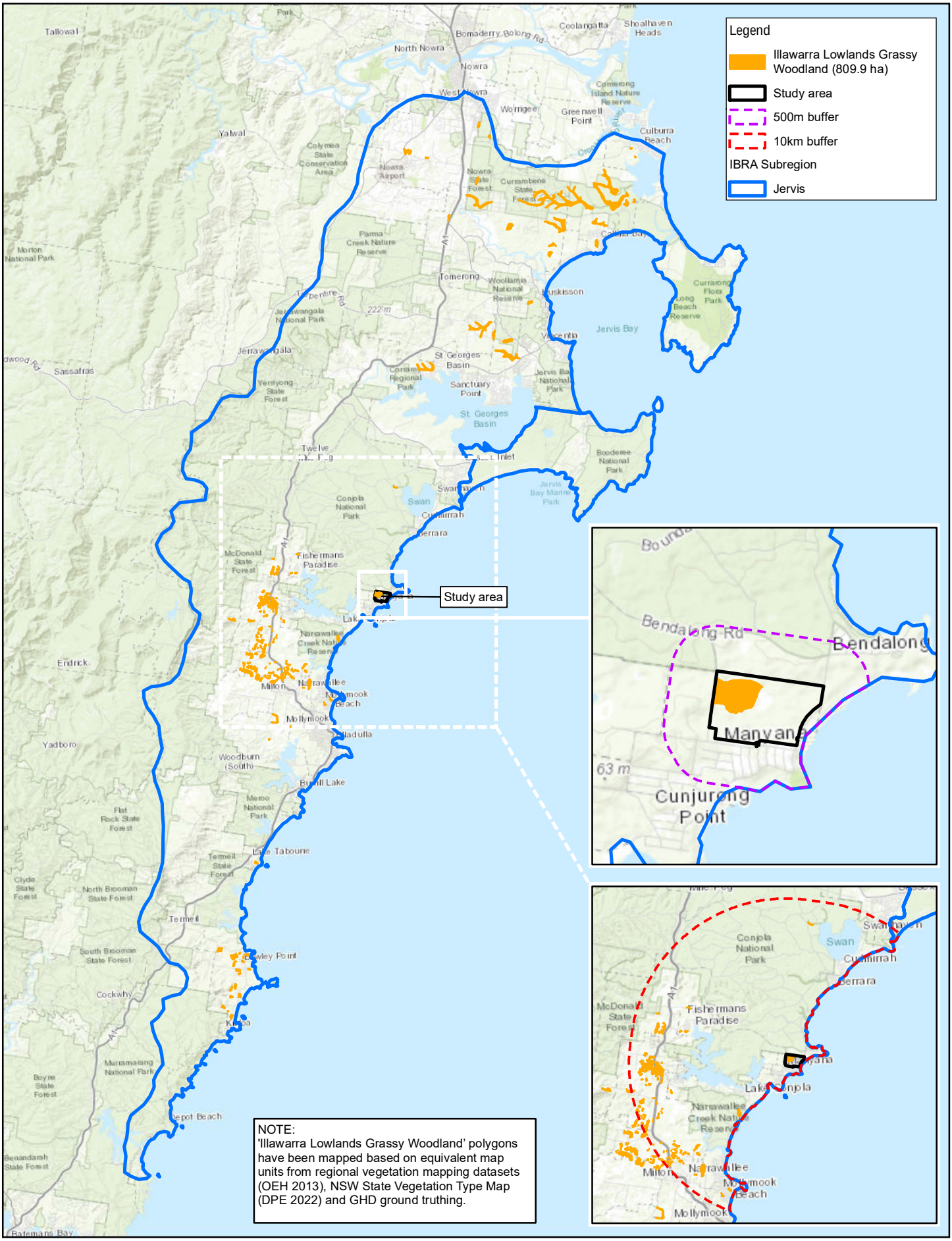
Print date: 12 Oct 2023 - 14:30

Data source: SPE: NSW SVTM, 2022; OEH: Vegetation E3900 V2, 2021; LPI: DTDB, 2017; Aerial Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: fmackay



Paper Size ISO A4

0 2.5 5 7.5 10

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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North Manyana Subdivision
Biodiversity Development Assessment Report

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Regional occurrence of Illawarra lowlands grassy woodland

Figure 8.6

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Print date: 12 Oct 2023 - 14:30

Data source: DPE: NSW SVTM, 2022; OEH: Vegetation E3900 V2, 2021 Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community.
Created by: fmackay

Assessment of potential serious and irreversible impacts

The proposal has aimed to avoid impacts to native vegetation and habitat values by amending the subdivision layout. As described in section 8.1, the subdivision layout has been amended in response to the study area's biodiversity values and with particular focus on avoiding a SAII on Illawarra lowlands Grassy Woodland. The proponent has identified a proposed 'reduced impact subdivision layout' based on consideration of biodiversity values and other factors.

The proposal shown in Figure 1.2 would remove 17.95 hectares of native vegetation for a 19.58 hectare subdivision containing 65 residential lots within the total readily developable area of 36.54 hectares. The proposal includes a conservation lot, to be managed by a VMP (and potentially in the longer term under a BSA) around 57.25 ha in area over the remainder of the study area, including 17.98 ha of the readily developable area.

The revised subdivision layout reduces impacts to the occurrence of Illawarra Lowlands Grassy Woodland at the study area. The revised proposal would remove a total of 1.38 hectares of vegetation that corresponds with this ecological community as shown in Figure 5.3. This would remove or modify around 10.71 % of the 12.91 hectares of the ecological community at the study area, with the remaining 11.53 hectares (89.29%) within the avoidance footprint to be conserved within the conservation lot.

Table 8.5 presents an assessment of the potential for an SAII to Illawarra Lowlands Grassy Woodland ('the TEC') in accordance with the requirements of Section 9.1.1 of the BAM 2020. Data relating to the assessment of SAII entity has been requested and obtained from BAM Support (Cambell H, DPIE pers. comm. 2021). For the purposes of this assessment, it is assumed that PCT 1326 (which occurs in the development footprint) and PCT 838 are the only two PCTs that which may comprise Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion, based on the data provided in the TBDC (DPIE 2021b). The revised Eastern PCTs as mapped in the SVTM (DPE 2022) are not directly considered in this assessment because of the apparent over-mapping of the community described above.

The proposal would reduce the extent of this ecological community in the locality in the short term, through the removal of 1.38 ha of the occurrence at the development footprint (see Figure 8.5). The proposal includes the regeneration of 1.93 hectares of the community in the conservation lot. Plate 2 below shows the Illawarra Lowlands Grassy Woodland revegetation area at P3_2021, looking northeast and showing a 50m transect through exotic grassland and bare earth that would be revegetated. Extensive patches of the PCT1326_moderate vegetation zone with intact native overstorey and midstorey, and dense, species rich native groundcover can be seen to the right and background of the plate. This shows the proximity of resilient native vegetation to the revegation area that would form part of the same patch of the community and enhance restoration through natural recruitment.

A patch of derived Swamp Oak scrub within the PCT1326_moderate vegetation zone can be seen to the left of the plate that would be subject to Swamp Oak thinning and other active restoration management actions to increase native species richness and structural diversity. Restoration of the ecological community would be enhanced through the use of translocated topsoil with associated soil seed bank and microhizae and habitat resources such as woody debris salvaged from better condition patches of the community in the development footprint. In this context and with the active revegetation and ongoing management prescribed in the VMP, the proposal is likely to achieve an ecologically functional patch of Illawarra Lowlands Grassy Woodland over the 1.93 hectares of non-native and poor condition vegetation in the conservation lot.

Photo 11 *Illawarra Lowlands Grassy Woodland revegetation area in the conservation lot*

The proposal has included purposeful design of the subdivision within the readily developable land at the study area to substantially avoid and minimise impacts to the community, resulting in residual impacts to just 1.38 ha of the community and regeneration of 1.93 hectares as part of a functional patch with a greater extent and improved condition and security than the baseline condition. As such the proposal is likely to avoid the risk of a SAII to Illawarra Lowlands Grassy Woodland.

Table 8.5 *Assessment of potential serious and irreversible impacts for Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion ('the TEC') for reduced impact subdivision layout*

Criteria	Assessment
(1) the action and measures taken to avoid the direct and indirect impact on the potential entity for a SAII	The development footprint is 19.58 hectares within a readily developable area of 36.54 hectares that was defined based on land use zoning and other constraints (see section 8.1.1. As outlined in sections 8.1.2, the reduced impact subdivision proposal aims to avoid impacts to native vegetation and habitat values by amending the original subdivision layout for the development and reducing the number of lots. The reduced impact subdivision proposal would remove 17.95 ha of native vegetation for construction of 65 residential lots. The proposal has aimed to avoid impacts on the SAII entity by reducing the development footprint and retaining areas of Illawarra Lowlands Grassy Woodland. As shown on Figure 8.4, approximately 57.25 ha at the study area would be set aside as a proposed BSS, including 17.98 ha of the readily developable area. The majority (11.53 ha out of 12.91 ha) of the local occurrence of the TEC will be conserved within the proposed BSS.
(2). The assessor must consult the TBDC and/or other sources to report on the current status of the TEC including:	

Criteria	Assessment
a). evidence of reduction in geographic distribution (Principle 1, clause 6.7(2)(a) BC Regulation) as the current total geographic extent of the TEC in NSW AND the estimated reduction in geographic extent of the TEC since 1970 (not including impacts of the proposal)	The total mapped extent of the TEC (identified as PCTs 1326 and 838) throughout NSW is 4,565 ha, based on publicly available regional vegetation mapping of the regions where it occurs (OEH 2013; DPIE 2016). PCT 838 occurs between Wollongong and Milton, while PCT 1326 occurs between the Illawarra and Moruya. Information provided by BAM Support suggests the extent of the TEC is 2,284 ha with the apparent disagreement probably because the BAM Support estimate is restricted to the certain LGAs in accordance with the Scientific Committee determination for the EEC (see discussion above and in section 5.5.2). PCT 1326 is 95% cleared, while PCT 838 is 85% cleared, comprising a 85-95% reduction in geographic extent of the TEC since 1750 (DPIE 2021b). BAM support have confirmed an overall >90% reduction in geographic extent of the TEC since 1750 or a >80% reduction in extent of the TEC since 1970. These PCTs occur on gently undulating terrain that has historically been cleared for agricultural purposes such as grazing, as well as residential development. There is ongoing risk of loss to the remaining occurrences of these PCTs, as the TEC was not noted as being conserved within the reserve network in the final determination for the TEC (NSW Scientific Committee 2011). It should however be noted that the local and regional occurrence of the TEC includes remnants in Conjola National Park, Narrawallee Nature Reserve (OEH 2013) and Yatte Yattah Nature Reserve (pers. obs.) (see Figure 8.5). Information provided by BAM Support and in BioNet (DPE 2021b) indicates that the TEC meets the criteria for reduction in geographic extent.
b). extent of reduction in ecological function for the TEC using evidence that describes the degree of environmental degradation or disruption to biotic processes (Principle 2, clause 6.7(2)(b) BC Regulation) indicated by: **i. change in community structure** **ii. change in species composition** **iii. disruption of ecological processes** **iv. invasion and establishment of exotic species** **v. degradation of habitat, and** **vi. fragmentation of habitat**	The NSW Scientific Committee (2011) final determination indicates that most remnants of this community are now small and fragmented, which threatens their long-term viability, with specific threats including further clearing, grazing, weed invasion, selective logging, rubbish dumping, residential and agriculture developments and damage from recreational activities. Some remnants are known to consist of regrowth after past clearing or other disturbance has occurred. Information provided by BAM Support indicates that this SAII entity meets the criteria for reduction in ecological function.
c). evidence of restricted geographic distribution (Principle 3, clause 6.7(2)(c) BC Regulation), based on the TEC's geographic range in NSW according to the: **i. extent of occurrence** **ii. area of occupancy, and** **iii. number of threat-defined locations**	Data provided by BAM Support indicates that the estimated area of occupancy for this TEC is 1,600 km^2 and that the estimated extent of occurrence is 2,241 km^2. The estimated total current extent in NSW is 2,284 ha. BAM Support indicates that the TEC will be reviewed in the future to test if it still meets requirements under Principle 3. No threat-defined locations are indicated in either the TBDC or in data provided by BAM Support.
d). evidence that the TEC is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation).	There is no evidence provided in either the TBDC or in data provided by BAM Support relating to this principle as specifically applied to Illawarra Lowlands Grassy Woodland. Eucalyptus dominated grassy woodland communities are, in general, capable of responding to management (*pers. obs*). Standard environmental management measures such as exclusion of damaging human activities, weed control, supplementary planting, maintenance of natural fire regimes and treatment of pest fauna are likely to result in positive responses in the composition and ecological function of the community.
(3). Where the TBDC indicates data is 'unknown' or 'data deficient' for a TEC for	Not applicable.

Criteria	Assessment
a criterion listed in Subsection 9.1.1(2.), the assessor must record this in the BDAR or BCAR.	
(4). In relation to the impacts from the proposal on the TEC at risk of an SAII, the assessor must include data and information on:	
a). the impact on the geographic extent of the TEC (Principles 1 and 3) by estimating the total area of the TEC to be impacted by the proposal: **i. in hectares, and** **ii. as a percentage of the current geographic extent of the TEC in NSW.** **Data and information should include direct impacts (i.e. from clearing) and indirect impacts where partial loss of the TEC is likely as a result of the proposal. The assessor should consider for example, changes to fire regime (frequency, severity), hydrology, pollutants, species interactions (increased competition, changes to pollinators or dispersal), fragmentation, increased edge effects and disease, pathogens and parasites, which are likely to contribute to the loss of flora and/or fauna species characteristic of the TEC**	The proposal would result in the removal of 1.38 ha of the TEC from within the development footprint. This represents an initial reduction in the geographic extent of 0.06 % of the total extent of the TEC in NSW, based on data provided by BAM Support, assuming the TEC only occurs in certain LGAs; or 0.03% of the total extent of associated PCTs in NSW, assuming the TEC can occur across the full range of these PCTs. There is potential for additional indirect impacts resulting from increased edge effects, disease and pathogens which may contribute to the loss of flora species characteristic of the TEC. Mitigation measures would be implemented under a CEMP for the proposal. The local occurrence at the study area outside of the development footprint would be maintained in the conservation lot under a VMP (and any future SMP attached to any BSA) . The conservation lot would be subject to a management and monitoring framework that will include specific measures to mitigate against any indirect impacts on the patch of the TEC retained at the study area in perpetuity. The VMP would provide for revegetation and regeneration of 1.93 hectares of degraded Illawarra Lowlands Grassy Woodland at the study area as part of a functional patch of the community. This would include weed control and regeneration of 0.5 hectares of PCT 1326 in poor condition that currently has very low tree cover and native species richness. A further 1.43 hectares of non-native vegetation forming gaps in the patch of the community would be subject to full structural revegetation with topsoil and habitat resources salvaged from the development footprint. In the medium term the proposal along with the implementation of the VMP would maintain a patch of Illawarra Lowlands Grassy Woodland with a greater extent and improved condition and security than the baseline condition. As such the proposal would not reduce the current geographic extent of the TEC in NSW.
b). the extent that the proposed impacts are likely to contribute to further environmental degradation or the disruption of biotic processes (Principle 2) of the TEC by:	
i. estimating the size of any remaining, but now isolated, areas of the TEC; including areas of the TEC within 500 m of the development footprint or equivalent area for other types of proposals	There are no additional areas of the TEC within 500 m of the development footprint (see Figure 8.5). Based on refined mapping of the study area completed as part of this assessment, about 11.53 ha of this TEC would be retained in the study area, all of which would be included in the conservation lot. A further 1.64 hectares of non-native vegetation forming gaps in the patch of the community would be subject to full structural revegetation with topsoil and habitat resources salvaged from the development footprint. The area of the TEC to be retained or restored is not isolated from other patches of vegetation, rather it forms part of a larger tract of vegetation that will be retained within the conservation lot and is connected to an extensive area of vegetation to the north and west of the study area including many thousands of hectares of habitat conserved in Conjola National Park.
ii. describing the impacts on connectivity and fragmentation of the remaining areas of TEC measured by: **• distance between isolated areas of the TEC, presented as the average distance if the remnant is retained AND the average distance if the remnant is removed as proposed, and**	There is a single 12.91 ha patch of the TEC at the study area. Around 11.53 ha of this TEC will be retained in the conservation lot as a single continuous patch in the north and west of the study area (see Figure 8.4). Based on the TEC mapping described above and shown on Figure 8.5, distances to other areas of the TEC include: - 4 km to a patch in Narrawallee Nature Reserve to the south. - 6.8 km to patches of the community in the upper reaches of Conjola Creek to the west

<table>
<tr><th>Criteria</th><th>Assessment</th></tr>
<tr><td>• estimated maximum dispersal distance for native flora species characteristic of the TEC, and
• other information relevant to describing the impact on connectivity and fragmentation, such as the area to perimeter ratio for remaining areas of the TEC as a result of the development</td><td>- 7.5 to 8.5 km to multiple patches in Yatte Yattah area and on agricultural land to the north of Milton to the south west
- 8.95 km to a patch at Swan Lake in Conjola National Park to the north.
Based on these calculations, the vegetation that is commensurate with the TEC that will be retained in the conservation lot would be separated from the closest other patches of the TEC by between 4 and 9 km. The proposal would result in two gaps in vegetation cover around 200 m across in a north-south direction and up to 700 m across in an east west direction. Connectivity would be maintained in the BSS around and through the two portions of the development footprint. The proposal would result in a minor increase in the current degree of fragmentation of vegetation in the locality and gaps between remnants of the TEC.
The area to external perimeter ratio for the remaining area of the TEC will increase slightly, as a result of the removal of vegetation within the development footprint.
A further 1.43 hectares of non-native vegetation forming gaps in the patch of the community would be subject to full structural revegetation with topsoil and habitat resources salvaged from the development footprint. This would remove small-scale gaps associated with former clearing of agricultural land and ongoing use of the study area by off road vehicles and improve the connectivity of retained native vegetation.</td></tr>
<tr><td>iii. describing the condition of the TEC according to the vegetation integrity score for the relevant vegetation zone(s) (Section 4.3). The assessor must also Biodiversity Assessment Method 43 include the relevant composition, structure and function condition scores for each vegetation zone.</td><td>The 1.38 ha of the TEC in the development footprint is in moderate condition, with a vegetation integrity score of 65.3.
The composition, structure and function condition scores for the vegetation zone that comprises the TEC is presented below.
<table>
<tr><th>Vegetation zone</th><th>Composition condition score</th><th>Structure condition score</th><th>Function condition score</th><th>Current vegetation integrity score</th></tr>
<tr><td>1326 moderate</td><td>71.6</td><td>86.2</td><td>45.2</td><td>65.3</td></tr>
</table></td></tr>
<tr><td>5. The assessor may also provide new information that demonstrates that the principle identifying that the TEC is at risk of an SAII is not accurate.</td><td>Not applicable.</td></tr>
</table>

8.6 Prescribed impacts

1.3.2 Identification of potential prescribed impacts

The *Biodiversity Conservation Regulation 2017* (BC Regulation) (clause 6.1) identifies additional biodiversity impacts to which the BOS applies. These 'prescribed impacts' are the impacts on biodiversity values which are not related to, or are in addition to, native vegetation clearing and habitat loss. These types of impacts are used by the decision-maker to inform the determination and conditions of consent for developments.

The following section summarises the prescribed impact features listed in the BC Regulation and BAM along with an assessment of their presence or otherwise at the study area, their characteristics and location, and the threatened entities that are associated with the feature. Justifications for features determined as not present are provided as appropriate. Potentially affected threatened species were identified based on the desktop assessment, site inspections and habitat assessments described above.

The following known or potential prescribed impacts are relevant to the proposal:

– Impacts on the habitat of threatened entities including:
  - non-native vegetation

– on areas connecting threatened species habitat, such as movement corridors
– that affect water quality, water bodies and hydrological processes that sustain threatened entities including:
  - floodplain habitats associated with intermittent drainage lines, small freshwater wetlands, surface water-dependent vegetation communities and potential GDEs in the study area
  - coastal habitats associated with the ICOLL in the lower reaches of Inyadda Creek and Inyadda Beach
– on threatened species or fauna that are part of a TEC from vehicle strikes.

The following known or potential prescribed impacts are not relevant to the proposal:

– Impacts on the habitat of threatened entities associated with:
  - karst, caves, crevices, cliffs, rocks and other geological features of significance, noting that there are no such geological features in the study area
  - human-made structures, noting that there are no structures with potential habitat value in the study area
– on threatened and protected animals from turbine strikes from a wind farm, noting that the proposal is not a wind farm development.

The BDAR must identify the relevant prescribed impacts and the suite of threatened species that use or rely on the habitat values or would be affected by the impact, as specified in BAM section 6. The likelihood, extent and magnitude of prescribed impacts must then be assessed using the approach specified in the BAM. Those of relevance to this project are described in detail in the sections below.

1.3.3 Habitat of threatened species

There are no areas of karst, caves, crevices or cliffs in the development site.

There are no human-made structures of relevance for threatened species present in the study area. There are no buildings, dwellings or features within the development footprint that could provide potential habitat for any threatened biota.

Potential prescribed impacts on habitats associated with non-native vegetation are described and assessed in Table 8.6.

Table 8.6 Habitats associated with non-native vegetation

BAM Criteria	Discussion
6.1.2 1. a. Provide a description of the type of non-native vegetation habitat	There is 1.64 ha of non-native vegetation and cleared land in the development footprint including exotic grassland, environmental weeds and infrastructure. The total area includes bare earth associated with former agricultural land uses and dwellings, more recently used tracks and other human disturbance. Some of this vegetation occurs along the southern border of the site, between the existing houses and vegetated portions of the study area. This area is mown/slashed, and apparently acts as an APZ for bushfire safety purposes and to provide access. It is apparently also used informally by neighbouring properties for storage of materials and recreation. This area is unfenced and immediately behind existing residential properties. There was evidence of regular dog activity in the area (via dog droppings), as well as visual sightings of domestic dogs within the existing properties. Other patches of exotic grassland occur around the disturbed areas in the centre of the site, where there has been substantial and ongoing disturbance such as vehicle and bike movements. There are patches of exotic perennial grasses in between car tracks.
6.1.2 1. b. Prepare a list of threatened species that use these features as habitat	The following species may utilise exotic grassland and cleared areas on occasion: Woodland birds: – Dusky Woodswallow Raptors and forest owls: – Little Eagle (foraging habitat) – Square-tailed Kite – Barking Owl (foraging habitat)

BAM Criteria	Discussion
	– Powerful Owl (foraging habitat) – Sooty Owl (foraging habitat) – Masked Owl (foraging habitat) Microbats: – Large-eared Pied Bat (foraging habitat) – Eastern False Pipistrelle – Large Bent-winged Bat (foraging habitat) – Eastern Coastal Free-tailed Bat (foraging habitat) – Greater Broad-nosed Bat Arboreal mammals: – Spotted-tailed Quoll
6.1.2 1. c. Describe how each threatened species could, or does, use the non-native vegetation as habitat (based on published literature and other reliable sources)	Threatened species that could use areas of cleared land and exotic grassland include raptors and large forest owls who may hunt in the area if suitable prey species are present, as well as threatened microbats and woodland birds who may forage over the area on occasion. Arboreal mammals may cross cleared areas while traversing the wider locality. As outlined in the first line of this table (section a), areas of non-native vegetation and cleared areas support limited shelter, roosting or breeding habitat for the species that could potentially occur. Given the lack of shelter and other resources of relevance for threatened fauna species, areas of non-native vegetation and cleared land would have minimal value for these species. None of these species would rely upon the areas of non-native vegetation within the development footprint. They are all wide-ranging mobile species capable of travelling throughout the landscape, and would not be limited to, or reliant on, the habitats present within the development footprint for any stage of their life cycle.
8.3.2 a. to c. Assessment of the impacts of the proposal on the habitat of threatened entities associated with non-native vegetation	**Nature** The proposal would remove or modify around 1.64 ha of non-native vegetation and cleared land in the development footprint including exotic grassland, environmental weeds, bare earth and tracks. These areas may be travelled over or through, or used occasionally as foraging habitat by threatened fauna species occupying adjoining habitat in native vegetation. After construction the development footprint would include a greater area of non-native vegetation than is currently present including in residential gardens, recreational open space and surface water management features. **Extent** The initial earthworks and construction of the proposal would remove or substantially modify up to 1.64 ha of non-native vegetation. There is a risk of direct harm to any native fauna occupying exotic vegetation during construction and a short term reduction in the extent of habitat resources. After construction the development footprint would include a considerably greater area of non-native vegetation than is currently present. **Duration** This impact would be in perpetuity, in that the baseline condition would never be restored. However after the initial construction period of around five years the established residential subdivision would include a considerably greater area of non-native vegetation and associated habitat resources than is currently present. **Consequences** Non-native vegetation in the development footprint may be travelled over or through or used occasionally as foraging habitat by native fauna, including a number of threatened species. Areas of non-native vegetation and cleared areas support limited shelter, roosting or breeding habitat for the species that could potentially occur and have minimal value for these species. These species or their prey may use habitat resources at the site on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the non-native vegetation in the development footprint for any stage of their life cycle.

BAM Criteria	Discussion
	Fauna management measures would be specified in a CEMP and would help mitigate the risk of harm to any resident fauna during clearing of exotic vegetation. Given the limited value of habitat resources in exotic vegetation at the development footprint, extensive areas of similar habitat in the surrounding residential landscape of Manyana and more valuable resources in native vegetation, the consequences of removal or modification of non-native vegetation would be minor.

8.6.1 Habitat connectivity

The extent and quality of habitat corridors and potential impacts on habitat connectivity are described and assessed in Table 8.7.

Table 8.7 Habitat connectivity

Criteria	Discussion
6.1.3 1. The assessor must use the map of native vegetation cover to identify areas of habitat connectivity between the subject land and the assessment area.	The assessment of landscape context according to the BAM is provided in 4.7. Existing connectivity is demonstrated on Figure 4.1 and Figure 4.3. Figure 4.2 shows the extent of the patch of vegetation that the study area falls within, with extensive areas of connected vegetation to the north-east, north and west of the site. The development footprint contributes to the overall patch of connected vegetation and habitats within the assessment area by providing an east-west linkage but comprises the southern limit of a north-south corridor. Figure 4.4 shows the resource flows within the study area, post fire, and showing the partial interruption of resource flows by the development footprint. Habitat connectivity is maintained in a broad north-south corridor to the east of the development footprint and in east-west corridors between the two portions of the subdivision and to the north. In this context the development footprint is unlikely to comprise a key link in a resource corridor, or to be critical to the ongoing connectivity in the local area.
6.1.3 2. Where corridors or other areas of connectivity link habitat for threatened entities, the assessor must: a. prepare a list of threatened entities that are likely to use or are a part of the connectivity or corridor	Three TECs form part of a vegetated corridor through the development site: – Swamp Oak Floodplain Forest – Illawarra Lowlands Grassy Woodland – Swamp Sclerophyll Forest. Threatened species that may occur or that are known to occur, and use the habitat corridor through the development footprint, include: – Woodland birds, parrots and cockatoos: • Dusky Woodswallow • Gang-gang Cockatoo (foraging habitat) • Glossy Black-cockatoo (foraging habitat) • Varied Sittella • Little Lorikeet • Swift Parrot • Eastern Ground Parrot • White-throated Needletail – Raptors and forest owls: • Little Eagle (foraging habitat) • Square-tailed Kite (foraging habitat) • Barking Owl (foraging habitat) • Powerful Owl (foraging habitat) • Eastern Osprey (foraging habitat) • Sooty Owl (foraging habitat) • Masked Owl (foraging habitat)

Criteria	Discussion
	– Arboreal and ground-dwelling mammals: • Eastern Pygmy-possum • Spotted-tailed Quoll • Brush-tailed Phascogale • Long-nosed Potoroo (SE mainland) – Microbats and flying foxes: • Eastern False Pipistrelle • Large Bent-winged Bat • Eastern Coastal Free-tailed Bat • Grey-headed Flying-fox • Greater Broad-nosed Bat. The development footprint is at least 400 m inland of coastal dunes and 500 m from the Inyadda Beach foreshore and does not form part of a coastal habitat corridor and is not likely to support any threatened species of marine or estuarine environments. Threatened or migratory birds of these environments may fly over the development footprint but are unlikely to occur in or pass directly through the habitat corridor that intersects the site.
b. describe the importance of the connectivity to threatened entities, particularly for maintaining movement that is crucial to the species' life cycle.	The 17.95 ha of native vegetation within the 19.68 ha development footprint is in moderate condition. The habitat corridor through the site includes dense groundcover vegetation and other habitat features that would support the movement of native fauna between areas of habitat. It also contains mature trees and species rich vegetation that would contribute to ecological processes such as pollination and seed fall. The threatened entities listed above may travel through the site on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the site to support their continued use of the local area. The development footprint comprises a small portion of a corridor that stretches from the southern boundary of the study area to Bendalong Road around 500 m to the north and includes the riparian corridors of the northern and southern tributaries of Inyadda Creek. The southern portion of the development footprint is at the far southern limit of this corridor. Connectivity to coastal habitat is maintained to the north of the development footprint and through the eastern portion of the conservation lot. The development footprint does not comprise a critical connecting links between any areas of habitat (i.e. connectivity would be maintained around the development footprint if it was cleared). Overall the development footprint forms part of a locally important connecting link but given the extent of native vegetation around and between the two portions of the subdivision it is unlikely to be critical to maintaining movement that is crucial to any native species' life cycles.
8.3.3. 1. a. to c. Assessment of the impacts of the proposal on habitat connectivity	**Nature and extent** The proposed subdivision would require the removal or modification of 17.95 ha of native vegetation within the 19.68 ha development footprint as summarised in Table 8.3. The extent of cut and fill, building envelopes and other infrastructure within the development footprint is shown on Figure 8.3. As described in section 8.1.3, cut and fill has been minimised as far as possible and building envelopes have been defined to support the conservation of hollow-bearing trees within the development footprint. The hollow-bearing trees mapped for retention would be conserved through a restriction on title. It is likely that some additional canopy trees, native groundcover vegetation and soil profiles would be maintained in the areas shown outside infrastructure envelopes and cut and fill areas on Figure 8.3 maintaining at least some connectivity of habitat. Conversely perimeter fences, residential lot boundary fences, roads and other infrastructure would function as barriers to movement of less mobile species. Overall the proposal would reduce habitat connectivity by removing or modifying 17.95 ha of native vegetation and creating two gaps in native vegetation cover around 1-200 m in width. This habitat fragmentation would increase the risk and energy cost of movement between patches of habitat for many native fauna species including the threatened entities listed above. Connectivity would be

Criteria	Discussion
	maintained around and through the study area including through an approximately 100 m wide riparian corridor between the northern and southern portions of the development footprint. This riparian corridor would be partially affected by the construction of a 6m wide elevated walkway but this would have a minor effect on its value as a connecting link for most fauna. The proposal may further affect habitat connectivity by deterring use of the native vegetation in adjoining areas through noise, light, traffic or the presence of humans and domestic animals. The CEMP for the proposal would include measure to help minimise these potential indirect impacts (see assessment of consequences below). **Duration** The impact would be permanent. Establishment of vegetation within residential lots would partially improve connectivity through the development footprint when compared to the immediate, post construction environment. However, the residential subdivision would comprise a permanent gap in habitat for the potentially affected threatened species and many other native fauna. **Consequences** The development footprint forms part of a locally important connecting link as described above. The proposal would remove mature trees, dense groundcover vegetation and other habitat features that support the movement of native fauna between areas of habitat and other ecological processes. The potentially affected threatened species listed above may travel through the site on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the site to support their continued use of the local area. East-west habitat connectivity would be maintained around the development footprint through the riparian corridors of the northern and southern tributaries of Inyadda Creek, the patch of Illawarra Lowlands Grassy Woodland that would be maintained in the conservation lot. Connectivity to coastal habitat would be maintained through the eastern portion of the conservation lot. The southern portion of the development footprint would reduce the overall extent of the north-south habitat corridor through the study area by around 100 m and approximately halve its width. The portion of the habitat corridor to be removed is at its far southern limit and so the proposal would not sever any connecting links or isolate any areas of habitat. The proposal does not include the erection of any large or hazardous structures that would significantly increase the risk or energy cost of movement of any threatened or migratory fauna. Removal of vegetation and construction of dwellings and associated infrastructure would increase in the degree of fragmentation between retained areas of habitat for these species, and would not result in the isolation of any habitat. The reduction in extent of habitat by 17.95 ha, as two discrete impact areas would be minor in the context of the many thousands of hectares of native vegetation in the locality. The proposal would create new gaps in habitat less than 200 m across, but connectivity would be maintained around the development footprint. In this context the impact to habitat connectivity is unlikely to have a significant impact on any ecological process such as migration or pollination. The following mitigation measures would be implemented during the operational phase of the proposed development (i.e. the use of the indicative development footprint as a residential area) and help to minimise impacts on habitat connectivity: – Appropriate management of APZs to prevent the spread of weeds and/or soil into adjacent areas of retained vegetation – Appropriate fencing to be erected at interface between residential lots and adjoining native vegetation to restrict domestic animals accessing these areas. – Street lighting to be designed to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats – Legal restrictions to be established preventing the owners or tenants of new residential areas from having cats, to limit the potential for cats to roam into retained bushland. In addition to the above mitigation measures, the conservation lot would be conserved and managed under a VMP (and any future SMP that is attached to

Criteria	Discussion
	any BSA). The VMP and potential future SMP attached to the BSA would include weed control and other biodiversity rehabilitation and conservation measures which will assist in improving and maintaining the biodiversity values within these areas. Around 2.36 ha of non-native vegetation would be restored to native PCTs improving habitat connectivity in the conservation lot and partially offsetting the fragmentation of habitat in the development footprint. Overall the consequences of the proposal's impact on habitat connectivity would be moderate and localised. Given the extent of native vegetation around and between the two portions of the subdivision, the impacts on habitat connectivity are unlikely to significantly disrupt any native species' life cycles.

8.6.2 Water quality, water bodies and hydrological processes

An Integrated Water Cycle Stormwater Management Report (Egis Consulting 2023b) has been prepared to accompany the DA and SEE (Egis Consulting 2023a). The purpose of this assessment is to determine the potential surface water quality and hydrology impacts that may be generated by construction and operation of the proposal and present a proposed approach to the management of these impacts. The stormwater management assessment presents the construction and operational water quality and flow management strategy that guided the design of the proposal (Egis Consulting 2023b).

The proposal does not include any direct changes to existing waterbodies. The development footprint is located entirely outside the floodplain defined by 150 mm water depth under the current 1% annual exceedance probability (AEP) and includes only minor changes to hydrological processes and construction of small waterbodies as part of the integrated stormwater management system (Egis Consulting 2023b). Lower lying areas in the eastern portions of the PCT 1231 and PCT 1236 in the development footprint are swamp forest and scrub communities that are maintained by hydrological processes. These TECs extend into downstream portions of the study area across the floodplain of Inyadda Creek.

Two small un-named ephemeral drainage lines merge to form Inyadda Creek in the eastern portion of the study area and drain east into the ICOLL at Inyadda Beach. Under above average rainfall conditions these drainage lines featured a chain of discontinuous pools and dense instream aquatic vegetation and fringing sedges. There are six farm dams through the study area, east of Inyadda Drive feature varying amounts of surface water, macrophyte beds and other habitat resources for wetland species.

Further detail about wetland habitats and associated resources and ecological communities is provided in section 5.8.3.

The extent, character and integrity of these habitats is maintained by hydrological processes at the study area and surrounding catchment in combination with coastal processes. Surface water flow extent, frequency, duration and depth would determine the presence and quality of aquatic habitat and the type and health of wetland vegetation. Shallow groundwater may also be important for maintaining these communities during periods when rainfall or overland flow is not available. Water quality, water bodies and hydrological processes that sustain threatened entities are described and assessed in Table 8.7 including consideration of:

- floodplain habitats associated with intermittent drainage lines, small freshwater wetlands, surface water-dependent vegetation communities and potential GDEs in the study area
- coastal habitats associated with the ICOLL in the lower reaches of Inyadda Creek and Inyadda Beach

Table 8.8 Assessment of water quality, water bodies and hydrological processes

Criteria	Discussion
6.1.4 1. Where water bodies or any hydrological processes that sustain threatened entities occur on the subject land, the assessor must: (a) prepare a list of threatened entities that may use or depend on water	There are two flood- dependent TECs in the development footprint and downstream portions of the study area: – Swamp Oak Floodplain Forest – Swamp Sclerophyll Forest The local occurrences of these TECs would be maintained by hydrological processes including flood waters from Inyadda Creek and its tributaries during

Criteria	Discussion
bodies or hydrological processes for all or part of their life cycle,	peak rainfall events as well local overland flow and potentially also shallow groundwater. Threatened species that may occur or that are known to occur in flood-dependent habitat at the study area and as such would at least partially depend upon hydrological processes, include: – Woodland birds, parrots and cockatoos: • Dusky Woodswallow • Gang-gang Cockatoo (foraging habitat) • Glossy Black-cockatoo (foraging habitat) • Varied Sittella • Little Lorikeet • Eastern Ground Parrot • White-throated Needletail – Raptors and forest owls: • Little Eagle (foraging habitat) • Square-tailed Kite • Barking Ow (foraging habitat) • Powerful Owl (foraging habitat) • Sooty Owl (foraging habitat) • Masked Owl (foraging habitat) – Arboreal and ground-dwelling mammals: • Eastern Pygmy-possum • Spotted-tailed Quoll – Microbats and flying-foxes: • Eastern False Pipistrelle • Large Bent-winged Bat (foraging habitat) • Eastern Coastal Free-tailed Bat • Grey-headed Flying-fox (foraging habitat) • Greater Broad-nosed Bat – Wetland birds: • Australasian Bittern • Black Bittern • Latham's Snipe In addition to the freshwater habitat described above the lower reaches of Inyadda Creek drain to an Intermittently Closed and Open Lake / Lagoon (ICOLL) which may support threatened species including: – The wetland birds listed above – Shorebirds, including known local populations of: • Hooded Plover • Sooty Oystercatcher • Pied Oystercatcher – Raptors of coastal and estuarine environments: • Eastern Osprey • White-bellied Sea-Eagle.
or (b) prepare a list of threatened entities that will be, or are likely to be impacted by changes to existing water bodies or hydrological processes or the construction of a new water body	See part (a) above. The proposal does not include any direct changes to existing waterbodies. The development footprint is located entirely outside the lower floodplain defined by 150 mm water depth under the current, undeveloped 1% annual exceedance probability (AEP) and includes only minor changes to hydrological processes and construction of small waterbodies as part of an integrated stormwater management system (Egis Consulting 2023b). Therefore, the proposal does not

Criteria	Discussion
	require consideration of the BAM section 6.1.4 1 part (b), noting that this criteria would apply to proposals that directly affect water bodies or hydrological processes such as construction of dams or changes to the operation of regulators.
(c) describe the habitat provided for each threatened entity by the water body or hydrological process	There are no waterbodies or associated frog breeding habitat or aquatic fauna habitat that is directly sustained by hydrological processes in the development footprint. Lower lying areas in the eastern portions of the PCT 1231 and PCT 1236 in the development footprint are swamp forest and scrub communities that are maintained by hydrological processes. These flood-dependent TECs extend into downstream portions of the study area across the floodplain of Inyadda Creek. These treed wetlands would provide shelter and foraging habitat for each of the threatened entities listed above. Two small un-named ephemeral drainage lines merge to form Inyadda Creek in the eastern portion of the study area and drain east into the ICOLL at Inyadda Beach. Under above average rainfall conditions these drainage lines featured a chain of discontinuous pools and dense instream aquatic vegetation and fringing sedges. Hydrological processes would help maintain wetland vegetation and a healthy population of frogs, macroinvertebrates including smooth crayfish, molluscs and insect larvae. These drainage lines would provide water sources, shelter and foraging habitat for each of the threatened entities listed above. They would have particular value as foraging habitat and as a movement corridor for the threatened wetland bird species. The six farm dams through the study area, east of Inyadda Drive feature varying amounts of surface water, macrophyte beds and other habitat resources for wetland species. As described above for the nearby reaches of natural drainage lines, each of these waterbodies would provide water sources, shelter and foraging habitat for each of the threatened entities listed above and would have particular value as foraging habitat for the threatened wetland bird species. The lower reaches of Inyadda Creek and ICOLL provide habitat for species of coastal and estuarine environments. The berm and sandy foreshore habitats adjoining the ICOLL also provide foraging habitat and potential nesting habitats for shorebirds including the threatened species listed above. Notably the berm may provide nesting habitat for local populations of the Eastern Hooded Dotterel and Pied Oystercatcher in certain years (pers. obs.; NPWS signage). Further detail about wetland habitats and associated resources and ecological communities is provided in section 5.8.3. The extent, character and integrity of these habitats is maintained by hydrological processes at the development site and surrounding catchment in combination with coastal processes. Surface water flow extent, frequency, duration and depth would determine the presence and quality of aquatic habitat and the type and health of wetland vegetation. Shallow groundwater may also be important for maintaining these communities during periods when rainfall or overland flow is not available. Water quality would be important for maintaining the health of wetland aquatic ecosystems which would in turn affect the productivity of foraging habitat for wetland birds and other threatened fauna.
8.3.4. 1. a) to c) Assessment of the impacts of the proposal on water quality, water bodies and hydrological processes that sustain threatened entities	**Nature** The proposal does not include any direct changes to existing waterbodies. The proposal would not directly affect the integrity of any water bodies or any associated hydrological processes. The various threatened entities and their habitats described above are sensitive receptors for potential indirect impacts on hydrological processes and water quality. The proposal may, in general, affect water quality, water bodies and hydrological processes that sustain threatened entities through the removal or modification of 17.95 ha of native vegetation on natural soil landscapes and alteration of surface water flows within the 19.68 ha development footprint. Exposed soil during construction and in the longer-term pavements and residential lots in the development footprint may generate polluted surface water. The extent of cut and fill, building envelopes and other infrastructure within the development footprint is shown on Figure 8.3. As described in section 8.1.3, cut and fill has been minimised as far as possible and building envelopes have been defined to support the conservation of natural soil surfaces and the principals of water Sensitive

Criteria	Discussion
	Urban Design (WSUD) within the development footprint (Egis Consulting 2023a, 2023b). A stormwater quality management system has been designed to contain flows and reduce discharge of major pollutants into downstream environments (Egis Consulting 2023b). The proposal does not include groundwater extraction or deep excavations that would directly intercept the water table or cause subsidence that would interfere with groundwater flows. The proposal may, in general, affect groundwater depth or flow rates through development of a portion of the catchment and associated changes to inflows. **Extent** The proposal would include clearing of 17.95 ha of native vegetation on natural soil landscapes and alteration of surface water flows within the 19.68 ha development footprint. These changes to the catchment would modify the hydrology of the development footprint and downstream environments include surface and groundwater flows. Construction activities would be located at least 50 m from the top of bank of drainage lines. Industry standard measures for managing soil and surface water are likely to mitigate against any tangible indirect impacts on drainage lines or any other waterbodies with particular habitat value. After construction the 19.68 ha development footprint comprises a potential source of pollutants that could be discharged to downstream environments. **Duration** The impact would be permanent. Once the proposed earthworks are complete and the residential subdivision and associated road and drain network and stormwater management features are constructed the catchment hydrology would be permanently changed. **Consequences** Each of the threatened species that could occur at the study area would rely on flood-dependent TECs and waterbodies within the study area as a water source and as foraging habitat, roosting and nesting habitat. The proposal design and implementation of the CEMP and are likely to ensure that there are no tangible impacts on waterbodies, water quality and hydrological processes outside the development footprint during construction. No industrial land uses or other activities are proposed that would be likely to generate heavy pollutant loads or particularly harmful polluting agents. The proposed 65 residential lots of greater than 2000 m^2 represents a relatively low intensity land use with much of the development footprint containing natural soil profiles and other pervious surfaces after construction. The proposed residential subdivision may, in general, generate pollutant loads such as sediment laden runoff, hydrocarbons from vehicle use, household and garden chemicals and nutrients from garden fertilizer and pet faeces. A stormwater quality management system has been designed to contain flows and reduce major pollutants in accordance with Council requirements including through construction of bioretention basins and roadside bio-swales. The performance of this strategy has been modelled and found to meet the pollutant removal targets set by Council. Gross pollutant traps will consist of trash racks prior to discharge into the bioretention basins unless otherwise approved by Council. Modelling of flow velocity in a 1% AEP flood event showed downstream velocities of <0.5m/s under both pre and post-development scenarios which is well below the threshold that would be expected to result in downstream erosion (Egis Consulting 2023b). This strategy is likely to ensure that the proposal would not result in any tangible negative impacts on water quality in downstream environments such that the threatened entities listed above would decline. Egis Consulting (2023b) completed flood modelling for existing and developed conditions, along with a discussion of the impacts on flooding that would result from the development of the residential subdivision and associated stormwater management system. Modelling of the 1% AEP flood event extents and depths showed that pre- and post-development scenarios were very similar with most flow contained in the tributaries of Inyadda Creek and with very similar flood behaviour across the Inyadda Creek floodplain. Analysis of the 1% AEP afflux (i.e. the rise in water level on the upstream side of a bridge or obstruction, frequently used as a measure of the change in flood levels between an existing scenario and a proposed scenario) confirmed that the proposal would not result in upstream

Criteria	Discussion
	flooding of Inyadda Drive as the main focus of the assessment (Egis Consulting 2023b). Analysis of the afflux mapping included as Figure 15 of Egis Consulting (2023b) suggests that water levels have not notably changed in the riparian corridors and downstream floodplain of Inyadda Creek as a result of the proposal. There would be less than 1cm change in depth over the majority of the Inyadda Creek floodplain (Hoogesteger D., Egis Consulting, pers. comm.). Additional analysis of pre and post development flood model simulations undertaken by Egis was performed across a wider range of flood events, namely four Exceedances per Year, 63% AEP, 18% AEP, 5% AEP, 1% AEP and the Probable Maximum Flood (PMF). This analysis found that pre and post development flowrates at the lower reach of Inyadda Creek were similar. For all the simulations from 18% AEP and rarer, the post-development peak flow was within 1.0% of the pre-development peak flow. For all the simulations from 5% AEP and rarer, the post-development event volume was within 2.2% of the pre-development event volume. For the more frequent events, there was tendency for the peak flow and event volume to be slightly lower post-development (about a 5% to 11% reduction in peak flow, and a 3% to 9% reduction in volume) (Horton Coastal Engineering 2023). This reduction in flow during frequent events may be a modelling artefact, or potentially due to an altered distribution of flow through the study area as the two proposed upgraded culverts entering the study area under Inyadda Drive would be designed to convey the 1% AEP flow (Horton Coastal Engineering 2023). It can be inferred from these results at the downstream end of Inyadda Creek that flood extent, depth and frequency would be substantially similar pre- and post-development across the Inyadda Creek floodplain. This modelling suggests that the proposal would have a minor effect on downstream flood events and other hydrological processes that maintain the health of flood-dependent TECs and populations of the threatened entities listed above. The potential impacts of the proposal on the opening and closing regime of the lower reaches of Inyadda Creek and ICOLL entrance downstream of the site on Inyadda Beach was assessed by Horton Coastal Engineering (2023). Aerial photography from 1970 to 2023 revealed that the ICOLL entrance is almost always closed with the entrance open only after rainfall events that generate sufficient runoff for the creek to overtop and flow over the beach berm. Once a breakout occurs, wave processes then act to close the entrance. The entrance is usually closed as only a small catchment drains to the entrance, which does not generate sufficient freshwater inflows to regularly open the entrance (Horton Coastal Engineering 2023). Various pre and post development flood model simulations were undertaken to cover a wide range of flow events and consideration of potential increases in the berm level due to sea level rise. As described above modelled pre and post development peak flowrates and event volumes are similar, other than a tendency for the peak flow and event volume to be slightly lower post-development in frequent events but not of a magnitude that would significantly alter the behaviour of the ICOLL entrance as a result of the proposal. The proposal is not expected to significantly affect freshwater inflows reaching the ICOLL entrance, and thus would not significantly affect how often breakouts occur and their duration. The opening and closing regime of the ICOLL would thus not be expected to change as a result of the proposal and Inyadda Creek would be expected to continue to have an entrance that is closed almost all of the time (Horton Coastal Engineering 2023). Therefore the proposal would not significantly affect wetland and aquatic habitat associated with the ICOLL nor shorebird nesting and foraging habitat associated with the downstream berm. The flood-dependent TECs listed above may also be groundwater dependent ecosystems (GDEs) (BOM 2023b, see section 5.7). None of these vegetation communities are likely to be obligate GDEs (i.e. they are not entirely dependent on groundwater). These GDEs are likely to be opportunistic facultative GDEs that depend on the presence of groundwater at certain locations and times, where an alternative source of water (i.e. local rainfall or overland flow) cannot be accessed to maintain ecological function. The proposal does not include groundwater extraction or deep excavations that would directly intercept the water table or cause subsidence that would interfere with groundwater flows. The proposal would affect inflow to aquifers through the clearing of 17.95 ha of native vegetation on natural soil landscapes and alteration of surface water flows within the 19.68 ha development footprint. Development of catchments may, in general, affect GDEs in the downstream environments by

Criteria	Discussion
	decreasing infiltration and inflows to the aquifer. The development footprint occupies just 17.95 ha of the approximately 186 ha catchment surrounding the Inyadda Creek floodplain (<10%, as shown on Figure 15 of Egis Consulting 2023b and excluding 13.57 ha in sub catchment C9 in developed land in Manyana that is less likely to charge the local aquifer). Around 50% of this development footprint would be pervious surfaces that would drain directly to the local aquifer. The majority of surface water falling on impervious surfaces would be diverted to bioretention basins and roadside bio-swales and would eventually reach the local aquifer, other than minor losses to evapotranspiration. Roof water may be diverted to rainwater tanks but much of this would also eventually reach the local aquifer via watering of gardens or overflow. There would be minor losses to evapotranspiration, but this would be partially offset by gains through irrigation with town water. Based on the above considerations the proposal is unlikely to result in substantial changes to the groundwater flows, depth or accessibility or otherwise affect the health of GDEs and populations of the threatened entities listed above. Overall, the consequences of the proposal's impact on waterbodies and hydrological processes would be minor.
8.3.4. 1. d. justify predictions of impacts with appropriate modelling (if available), relevant literature and other published sources of information	The above assessment of potential impacts is based on the: – Integrated Water Cycle Stormwater Management Report for the proposal (Egis Consulting 2023b) with regards floodplain habitats associated with intermittent drainage lines, small freshwater wetlands, surface water-dependent vegetation communities and potential GDEs in the study area – coastal engineering advice report for the proposal (Horton Coastal Engineering 2023) with regards coastal habitats associated with the ICOLL in the lower reaches of Inyadda Creek and Inyadda Beach and analysis of Egis modelling outputs of a wider range of flow events than were assessed in the stormwater report.

8.6.3 Vehicle strike

Table 8.9 Vehicle strike risk

Criteria	Discussion
6.1.6 1. a. identify potential impact locations on the Site Map, and	Inyadda Drive, along the western boundary of the study area, is a potential impact location as it passes through an extensive patch of native vegetation. The entire development footprint would comprise a potential impact location during construction from earthmoving equipment, trucks and light vehicles. All roads within the proposed subdivision as shown on Figure 1.2 would also pose a risk of vehicle collisions for threatened fauna after construction. There are currently unsealed, 4WD tracks throughout the study area including the development footprint and conservation lot. It is not known how frequently these informal tracks are used. The proposed subdivision would result in an increase in vehicle movements throughout and around the development footprint.
b. prepare a list of threatened fauna or animals that are part of a TEC at risk of vehicle strike.	Species at a particular risk of vehicle strike with the potential to occur within the site include the following arboreal and ground-dwelling mammals: – Eastern Pygmy-possum – Spotted-tailed Quoll The threatened woodland birds, parrots and cockatoos, raptors and forest owls, microbats and flying foxes listed in Table 8.7 may also be at risk of vehicle strike, though the likelihood of collisions would be considerably lower for these more mobile species. A diverse range of native terrestrial mammal, reptile, frog and invertebrate species that are part of the Illawarra Lowlands Grassy Woodland, Swamp Sclerophyll Forest and Swamp Oak Floodplain Forest TECs would also be at risk of vehicle collisions.

Criteria	Discussion
8.3.6. 1. a. to c. Assessment of the impacts of vehicle strikes on threatened fauna or fauna that are part of a TEC	**Likelihood** The proposal would create additional traffic on Inyadda Drive, Bendalong Road, the road network through the subdivision and nearby streets in the localities of Manyana, Bendalong and Cunjurong Point. This would include construction traffic during the construction stages and resident and visitor movements once the subdivision is established. Vehicles travelling to and from the subdivision would use Bendalong Road, Inyadda Drive and local roads along carriageway widths of approximately 10 m within a heavily vegetated landscape and so, in general, there is a risk of vehicle strikes to native fauna. The risk would be greatest at night when macropods and other native fauna are more active. Vehicle movements through the residential subdivision are likely to be low frequency at night, noting that it will contain just 65 residential dwellings and does not contain any through roads. Further, vehicle movements with the subdivision would be over distances of less than 1 km before right angle turns to Inyadda Drive and as such would be at low speeds with a minimal risk of collision. The addition of 65 dwellings and associated vehicles may slightly increase the risk of collisions associated with higher speed travel along Inyadda Drive and Bendalong Road. **Estimated rate of vehicle strike** The impacts of the proposal on the road network after construction of the subdivision were quantified by adding the traffic the use of the 65-lot subdivision to the expected future traffic volumes on the road network. The peak traffic generation rate for the proposed subdivision would occur after construction and is conservatively estimated to be a total of 46 vehicle trips per hour (10 in, 36 out) in the morning peak period and 51 vehicle trips per hour (41 in, 10 out) during the evening peak period (pdc consultants 2023). The construction and operation of the proposal would have a minor impact on road network operations such that only basic rural right and left turn intersections are required at the intersections with Inyadda Drive (pdc consultants 2023). The traffic assessment focused mainly on the capacity of the road network to accommodate additional traffic volumes and did not include any estimation of rates of vehicle strike on native fauna. The assessment indicates that the proposal is expected to have minimal impact on traffic volumes along the roads within the vicinity of the development footprint, given the very low anticipated peak hourly traffic volumes (pdc consultants 2023) and so it is likely that the proposal would result in a minor increase in the rate of vehicle strike. **Consequences** Vehicle movements to and from the subdivision would include travel along 80 km/h to 100 km/h stretches of Bendalong Road and Inyadda Drive which are unfenced, two-lane roads within a heavily vegetated landscape. These roads may be travelled over or through by native fauna including threatened species. Threatened species such as Eastern Pygmy-possum, Spotted-tailed Quoll, threatened microbats and forest owls are unlikely to experience a significant risk of vehicle strike as the majority of vehicle movements will occur during daylight hours when these species are inactive. Threatened raptors and woodland birds and other diurnal species may be at risk of vehicle strike during the day. Additional vehicle movements on the road network through the subdivision and nearby streets in the localities of Manyana, Bendalong and Cunjurong Point would be at low speed through developed areas with fragmented vegetation and would result in a negligible increase in the risk of collision with fauna. The proposal would result in a minor, but tangible increase in vehicle movements and associated risk of vehicle strike through the addition of vehicles associated with 65 residential dwellings to the local road network. The traffic assessment indicates that the proposal is expected to have minimal impact on traffic volumes (pdc consultants 2023) and so it is likely that the proposal would result in a minor increase in the rate of vehicle strike with minor consequences for local populations of native fauna.
d. justify predictions of impacts with relevant literature and other published sources of information	The consideration of increases in vehicle movements is based on the *Traffic Impact Assessment – Inyadda Drive Manyana* (pdc consultants 2023).

8.7 Consideration of MNES

The proposal would result in impacts to the following threatened biota and migratory species that are listed under the EPBC Act:

– The ecological communities:
  - Illawarra and south coast lowland forest and woodland ecological community EEC
  - Coastal Swamp Oak (*Casuarina glauca*) forest of NSW and South East Queensland CEEC
  - Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland EEC
– Habitat for the threatened fauna species:
  - Swift Parrot (*Lathamus discolor*) (a critically endangered species)
  - Regent Honeyeater (*Anthochaera phrygia*) (a critically endangered species)
  - Grey-headed Flying-fox (*Pteropus poliocephalus*) (a vulnerable species)
  - Spotted-tailed Quoll (*Dasyurus maculatus*) (a vulnerable species)
– Habitat for the migratory species:
  - Rufous Fantail (*Rhipidura rufifrons*)
  - Black-faced Monarch (*Monarcha melanopsis*)
  - Satin Flycatcher (*Myiagra cyanoleuca*)
  - White-throated Needletail (*Hirundapus caudacutus*).

A referral was submitted to the then Commonwealth DAWE (now DCCEEW, both referred to here as 'the Department') including assessment of significance of impacts on protected matters. The Department confirmed a decision to assess a previous iteration of the proposal as a controlled action in June 2021 (proposal NSW 2021/8948) due to the potential for significant impacts on the following matters protected under the EPBC Act:

– Coastal Swamp Oak (*Casuarina glauca*) Forest
– Illawarra and south coast forest and woodland ecological community
– the Grey-headed Flying-fox.

The Department provided a request for preliminary documentation in July 2021 and approved a Request for a Variation of the proposal under section 156A of the EPBC Act in November 2021. These decisions mean that the proposed subdivision must be approved by the Department under the Commonwealth EPBC Act, in addition to the requirement for approval by Council under NSW legislation. The proposal has been modified further through 2022 and 2023 and revisions to vegetation mapping have included recognition of an occurrence of the EEC 'Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland' in the development footprint. It is likely that the Department would approve a Request for a Variation of the proposal under section 156A of the EPBC Act and that consideration of likely significant impacts on the Coastal Swamp Sclerophyll Forest EEC may also be required. Preliminary documentation will be prepared separately to this BDAR, and will be submitted to DCCEEW for consideration.

The extent of habitat for these protected matters in the proposed subdivision development footprint and associated conservation lot that comprises the avoidance footprint for the proposal is summarised in Table 8.10 below.

The Commonwealth has formally endorsed the NSW BOS and BAM and so the preliminary documentation package will substantially rely on the information in the BDAR and any biodiversity offsets required under the EPBC Act would be secured through biodiversity credits according to the NSW system. The quantum of offset that would be secured for affected MNES is summarised in Table 8.10.

Table 8.10 Extent of impacts on habitat for protected matters

Habitat type	Proposed subdivision development footprint (ha)	Conservation lot / avoidance footprint (ha)
Coastal Swamp Oak (*Casuarina glauca*) Forest (EEC)	6.77	17.42

Habitat type	Proposed subdivision development footprint (ha)	Conservation lot / avoidance footprint (ha)
Illawarra and south coast forest and woodland ecological community (CEEC)	1.38	11.53
Coastal Swamp Sclerophyll Forest (EEC)	2.81	18.03
Grey-headed Flying-fox (vulnerable species)	17.95	54.89

9. Impact summary

9.1 Offset requirement for impacts under the BC Act

9.1.1 Impacts requiring offset

Impacts associated with the proposal that require offsetting comprise the removal of 17.95 hectares of native vegetation, comprising:

– 6.98 hectares of Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies (PCT 694)
– 2.81 hectares of Swamp Mahogany swamp sclerophyll forest on coastal lowlands (PCT 1231)
– 0.06 hectares of Swamp Oak Floodplain Forest (PCT 1232)
– 6.71 hectares of Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats (PCT 1236)
– 1.38 hectares of Woollybutt – White Stringybark – Forest Red gum grassy woodland on coastal lowlands, (PCT 1326)

The vegetation within the development footprint provides the following areas of habitat for species credit species:

– 17.88 hectares of known habitat for the threatened fauna species Eastern Pygmy Possum (*Cercartetus nanus*) (refer to Section 6.3).

Impacts within the development footprint requiring offsetting are shown on Figure 9.1.

The data from the fieldwork and mapping was entered into Version 1.4.0.00 of the BAM Calculator (BAM data last update 22/06/2023 - Version 61) as a 'Development' assessment to determine the number and type of biodiversity credits that would be required to offset impacts of the proposal. The BAM-C Case is '00029842/BAAS17023/22/00035932 Revision 3' incorporating legacy PCTs and version 1.2 benchmarks as stated in section 3.7. The biodiversity credit report is included in Appendix F.

Ecosystem credit requirements are summarised in in Table 9.1 and offset trading groups (OTGs) to ensure 'like for like' provision of biodiversity offsets are summarised in Table 9.2. Each of the ecosystem credit types can be traded with credits in the same OTG and located in the Jervis, Bateman, Ettrema, Illawarra and Jervis IBRA subregions or any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.

Species credit requirements are summarised in Table 9.3.

Table 9.1 Ecosystem credits required to offset residual impacts of the proposal

Zone ID	Plant community type	Area (ha)	Current vegetation integrity score	Future vegetation integrity score	BC Act status	EPBC Act status	Ecosystem credits required
1	PCT 694 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (Moderate)	4.62	58.6	0	Not listed		118
2	PCT 694 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (Poor)	2.36	45.8	0	Not listed		47
3	PCT1231: Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	2.81	78.3	0	EEC[1]	EEC[4]	110
4	PCT 1232 - Swamp Oak Floodplain Swamp Forest of the Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	0.06	74.3	0	EEC[2]	EEC[5]	2
5	PCT 1236 - Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	6.71	65.8	0	EEC[2]	EEC[5]	221
6	PCT 1326 – Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands of the southern Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	1.38	65.3	0	EEC[3]	CEEC[6]	45
	Total	**17.95**					

Notes:
1 Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community (EEC).
2 Swamp Oak Floodplain Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC.
3 Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion EEC, potential SAII entity.
4 Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland EEC.
5 Coastal Swamp Oak (Casuarina glauca) Forest of NSW and South East Queensland EEC.
6 Illawarra and south coast lowland forest and woodland CEEC.

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Table 9.2 'Like-for-like' ecosystem credits required to offset impacts of the proposal

Credit class	Any PCT in the below class	And in any of the below trading groups	Containing hollow-bearing trees
694	North Coast Wet Sclerophyll Forests This includes PCT's: 661, 686, 694, 827, 1217, 1237, 1244, 1285, 1504, 1841, 1843, 1915, 3067, 3073, 3078, 3088, 3102, 3136, 3145, 3147, 3171, 3177	North Coast Wet Sclerophyll Forests - ≥ 50% - < 70% cleared group (including Tier 3 or higher threat status).	Yes
1231	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 837, 839, 926, 971, 1064, 1092, 1227, 1230, 1231, 1232, 1235, 1649, 1715, 1716, 1717, 1718, 1719, 1721, 1722, 1723, 1724, 1725, 1730, 1795, 1798, 3272, 3906, 3983, 3985, 3986, 3988, 3989, 3990, 3995, 3997, 3998, 4000, 4001, 4004, 4006, 4009, 4013, 4019, 4020, 4021, 4044, 4047, 4057	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Yes
1232	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Yes
1236	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	No
1326	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion This includes PCT's: 838, 1326, 3269, 3327, 3330, 4052	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	Yes

Table 9.3 Species credits required to offset residual impacts of the proposal

Species impacted	Area of Habitat (hectares)	Species Credits Required
Eastern Pygmy-possum (*Cercartetus nanus*)	17.88	565

9.1.2 Impacts not requiring offset

The development footprint does not contain any areas of native vegetation that do not require offset. Each of the vegetation zones in the development footprint is in moderate or good condition with a vegetation integrity score that is above the minimum threshold for calculation of offsets according to the BAM (see Table 9.1).

9.1.3 Areas not requiring assessment

The development footprint includes 1.64 ha of cleared land and tracks that do not contain native vegetation (see Figure 9.1). Non-native vegetation does not require calculation of ecosystem credits according to the BAM. These areas were assessed for threatened species habitat according to the BAM and do not contain any habitat features or resources of value to any of the confirmed predicted threatened species or candidate threatened species at the development footprint. Notably these areas of cleared land and non-native vegetation do not contain any shelter or foraging resources for the Eastern Pygmy-possum and have been excluded from the species polygon for this species (see Figure 6.1).

9.2 Approach to delivering offsets

The biodiversity offset requirements described in Section 9.1 would be secured according to the offset rules established by the *Biodiversity Conservation Regulation 2017*. There are various means by which offset can be met. through a combination of the following:

– Purchase of biodiversity credits from other biodiversity stewardship sites (BSSs)
– Payment to the Biodiversity Conservation Fund (BCF) equivalent to the number and type of credits required.
– Potential future purchase of biodiversity credits generated by a future Biodiversity Stewardship Agreement (BSA) over the lot set aside for environmental conservation

Credits would be sourced from the 'open market' or via a payment into the BCF in accordance with the trading rules associated with the BOS and the requirements for offsetting impacts to MNES under the Amending Agreement to enable the development to commence.

Should a BSA be established over the conservation lot, further credits could be secured and retired to further assist in establishing a 'like for like conservation of the PCTs and threatened species affected by the proposal and directly benefit local populations of the species affected by development impacts.

The 57.25 hectare conservation lot that is part of the proposed subdivision would be a significant component of the offset strategy. Vegetation types at the conservation lot are similar to those at the development footprint and would provide habitat for a similar suite of threatened species and, if a BSA is established over the lot, contain the appropriate credits to at least partially meet offset obligations for the proposal, or provide offset credits to other proposals.

The conservation lot will be conserved and managed under the VMP to help ensure that construction impacts are mitigated and to support the restoration of Illawarra Lowlands Grassy Woodland and other biodiversity values. The conservation lot may then be the subject of a Biodiversity Stewardship Site Assessment Report (BSSAR) and BSA application in accordance with the BAM and associated regulations and policy documents. The BSSAR would draw upon survey results and data compiled for the BDAR and earlier biodiversity assessments but would require additional survey effort and assessment of the conservation lot. If necessary, the VMP would be modified and updated as required to become a site management plan (SMP) attached to any BSA. Once approved the BSA would generate biodiversity credits that would be used to offset the impacts of the proposal. However, importantly, the proponent's subdivision does not rely on this course in meeting offset obligations. The developer will

appropriately source credits from existing stewardship sites that provide biodiversity credits that comply with the trading rules of the BOS. These credits may be available on the existing open credit market for purchase. In the long-term, if appropriate, credits could be generated from land acquisition and subsequent BAM assessment and registration as a BSS. The intent and requirements of the VMP do not restrict the right of the landowner to enter into a BSA in the future or limit the quantum of biodiversity credits that could be generated under a BSA noting that both instruments are linked to the same development proposal and comprise the same commitment to conserve biodiversity values.

The 'like for like trading rules for the ecosystem credits required for the proposal are shown in Appendix F. An application to apply the 'variation to trading rules' is not preferred and would only be considered after all reasonable steps to seek like-for-like credits were undertaken (in accordance with the BAM and BOS) and suitable credits still could not be sourced. As explained in Section 9.3, offsetting by applying a variation to the credit trading rules is also not accepted by DCCEEW for offsetting significant impacts on MNES and so any use of the variation to trading rules would be applied to NSW listed threatened biota only.

The like for like rules for candidate species credits require matching credits for each individual species, although these credits could be generated anywhere in NSW. If such credits are unavailable, credits would be sourced in accordance with the 'variation report' generated by the BAM calculator and also included in Appendix F.

9.3 Offsets for impacts on MNES

Offsets would be required for any significant residual impacts on MNES, according to the requirements of the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012* (EPBC Act Offsets Policy) (DSEWPaC 2012). The proposal has been deemed a controlled action based on the potential for residual significant impacts on the following matters protected under the EPBC Act:

– Coastal Swamp Oak (*Casuarina glauca*) Forest (EEC)
– Illawarra and south coast forest and woodland ecological community (CEEC)
– the Grey-headed Flying-fox (a vulnerable species).

Offsets are also likely to be required for the EEC 'Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland' in the development footprint once the Department have considered a Request for a Variation of the proposal under section 156A of the EPBC Act.

The Commonwealth has formally endorsed the NSW BOS and BAM and the offset rules set out in the BC Act Regulation and so biodiversity offsets required under the EPBC Act would be secured through biodiversity credits according to the NSW system.

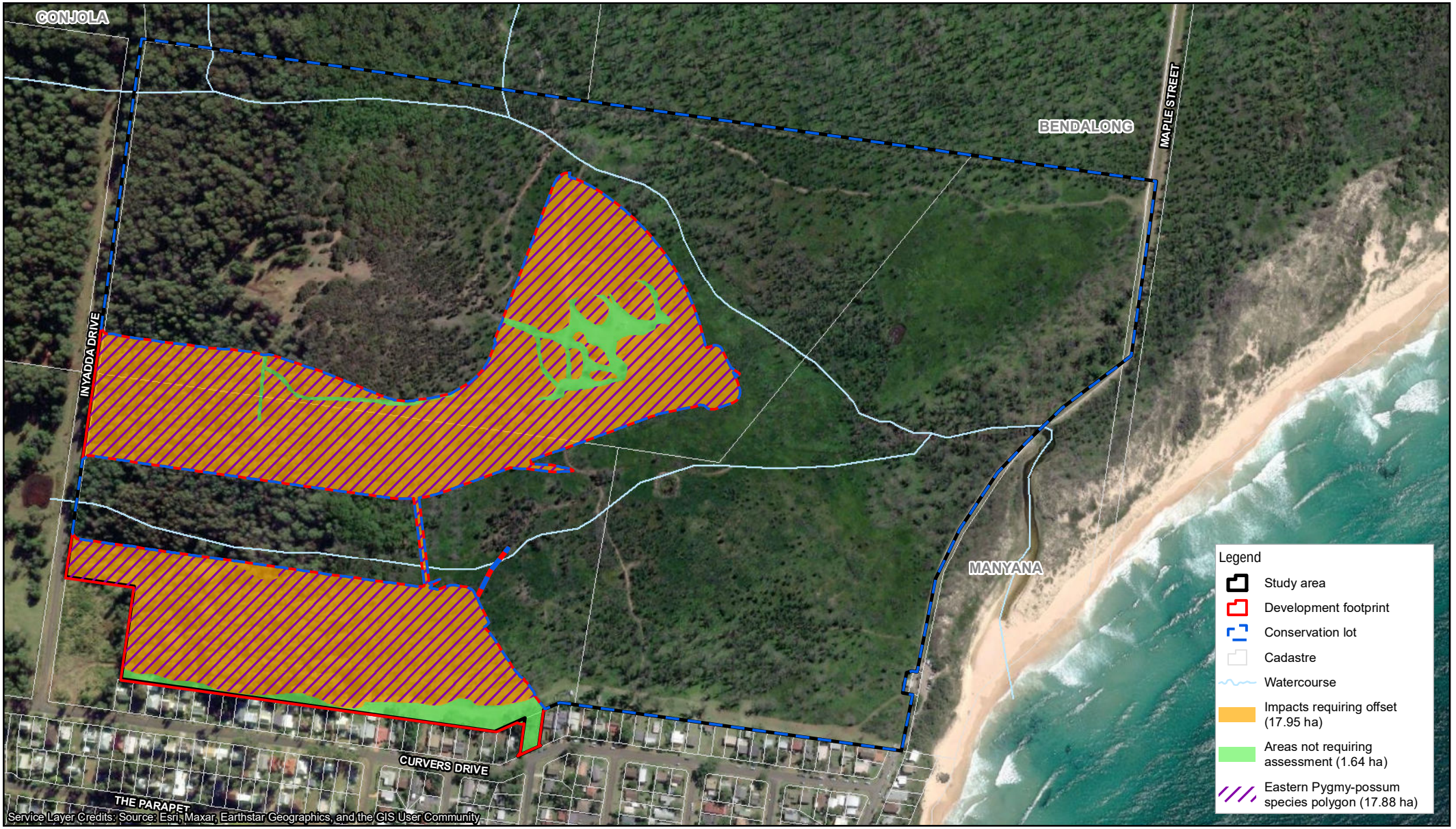
Ecosystem credits required to offset likely significant residual impacts to EPBC Act MNES are summarised in Table 9.4 along with the offset trading group for each credit type under the NSW BOS that would ensure provision of appropriate 'like for like' offsets for MNES. Under the NSW BOS each of the ecosystem credit types associated with TECs must be offset with credits associated with that TEC at a BSS. The quantum of offset for the Grey-headed Flying-fox would be secured through ecosystem credits associated with these TECs as well as ecosystem credits for foraging habitat in PCT 694.

As described above, biodiversity offsets for the proposed subdivision would be secured through retiring the appropriate credits from an established BSS or equivalent payment to the BCF. The proponent's offset strategy for the residual impacts of the proposed development is via a staged approach to credit retirement with offsets secured prior to the start of construction of each stage of the proposed subdivision. The 57.25 hectare conservation lot would be conserved under a VMP (and any SMP attached to a potential future BSA). Credits would be sourced from the 'open market' or via a payment into the BCF in accordance with the trading rules associated with the associated with the NSW Biodiversity Offset Scheme and the requirements for offsetting impacts to protected matters under the EPBC Act Condition-setting Policy (DAWE 2020). Should a BSA be established over the conservation lot, further credits could be secured and retired to further assist in establishing a 'like for like conservation of the PCTs and threatened species affected by the proposal and directly benefit local populations of the species affected by development impacts. The application to the BCT for a payment to the BCF would include notification that the proposal is a controlled action to help ensure that like-for-like offsets are secured for the protected matters listed above.

Table 9.4 Ecosystem credits required to offset significant impacts to EPBC Act MNES

Protected matter	Plant community type	Area (ha)	Ecosystem credits required	Offset trading group
Coastal Swamp Sclerophyll Forest (EEC)	PCT1231: Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	2.81	110	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, associated with vegetation containing hollow-bearing trees
Coastal Swamp Oak (*Casuarina glauca*) Forest (EEC)	PCT 1232 - Swamp Oak Floodplain Swamp Forest of the Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	0.06	2	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, associated with vegetation containing hollow-bearing trees
Coastal Swamp Oak (*Casuarina glauca*) Forest (EEC)	PCT 1236 - Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	6.71	221	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
Illawarra and south coast forest and woodland ecological community (CEEC)	PCT 1326 – Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands of the southern Sydney Basin Bioregion and South East Corner Bioregion (Moderate)	1.38	45	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion, associated with vegetation containing hollow-bearing trees
Grey-headed Flying-fox (vulnerable species)	Each TEC/PCT listed above and PCT 694 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (Moderate) PCT 694 – Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (Poor)	17.95	514[1]	As for each TEC/PCT listed above, and North Coast Wet Sclerophyll Forests - ≥ 50% - < 70% cleared group (including Tier 3 or higher threat status) for 165 PCT 694 ecosystem credits, associated with vegetation containing hollow-bearing trees and the

Notes: 1 – 543 ecosystem credits in total of which 165 are PCT 694 ecosystem credits and the remainder are ecosystem credits associated with the TECs listed above.



Paper Size ISO A4

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Heir Asquith Pty. Ltd.
North Manyana Subdivision
Biodiversity Development Assessment Report

Project No. 21-27200
Revision No. 1
Date 12 Oct 2023

Impact summary

Figure 9.1

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Print date: 12 Oct 2023 - 14:27

Data source: ERSI: Aerial Imagery, 2021; LPI: DTDB / DCDB, 2017. Created by: fmackay

10. Conclusion

Heir Asquith is proposing to develop a 65-lot residential subdivision at Lot 106 DP 755923, Lot 2 DP 1161638 and Lot 2 DP 1121854, at Manyana on the south coast of NSW. A large, community title conservation lot will be established incorporating land outside of the proposed residential subdivision lots and the adjacent Lot 2 DP 1121854. The conservation lot will be managed under a VMP until such time any BSA under the BC Act may be obtained over the land.

This BDAR has been prepared by an accredited assessor to identify the impacts of the proposal on biodiversity values within the development footprint. This assessment has been completed in accordance with the BAM and includes:

– Desktop assessment to describe the existing environment and landscape features of the development footprint and to identify the suite of threatened biota potentially affected by the proposal
– Field survey to describe the biodiversity values of the development footprint and surrounding study area and determine the likelihood of threatened biota and their habitats occurring in the study area or being affected by the proposal
– BAM credit calculations to quantify the biodiversity impacts of the proposal following implementation of measures to avoid and minimise impacts and to determine the biodiversity credits that would be required to be retired to offset the residual impacts of the proposal.

The proposal has aimed to avoid impacts to native vegetation and habitat values by amending the original subdivision layout for the development. Various iterations of the subdivision layout have been developed and then amended in response to detailed understanding of the site's biodiversity values and offset requirements as the BDAR and a previous biocertification proposal and development applications were prepared.

The discussion of measures to avoid impacts should be mainly based on the 'readily developable area', noting that if land use zoning or other environmental planning instruments restricts development in an area then there can be no genuine avoidance of an impact of a development that could not otherwise be carried out. The current subdivision proposal would remove 17.95 ha of native vegetation for a 19.58 ha subdivision containing 65 residential lots within the total readily developable area of 36.54 hectares. The proposed subdivision includes a conservation lot around 57.25 ha in area over the remainder of the study area, including 17.98 ha of the readily developable area. To further minimise potential impacts of the proposal on biodiversity, a series of mitigation measures have been identified, which would be implemented as part of the construction environmental management plan for the site.

The proposal would result in the following residual impacts:

– 6.98 hectares of Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694)
– 2.81 hectares of Swamp Mahogany swamp sclerophyll forest on coastal lowlands (PCT 1231) which comprises part of an endangered ecological community listed under the BC Act and EPBC Act
– 0.06 hectares of Swamp Oak Floodplain Swamp Forest of the Sydney Basin Bioregion and South East Corner Bioregion (PCT 1232) which comprises part of an endangered ecological community (EEC) listed under the BC Act and EPBC Act
– 6.71 hectares of Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats (PCT 1236) which comprises part of an endangered ecological community (EEC) listed under the BC Act and EPBC Act
– 1.38 hectares of Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands of the southern Sydney Basin Bioregion and South East Corner Bioregion (PCT 1326), which comprises part of an EEC listed under the BC Act and a critically endangered ecological community (CEEC) listed under the EPBC Act. This EEC is also identified as a serious and irreversible impact (SAII) entity as defined under the BC Act
– Removal of 17.88 hectares of habitat for the threatened fauna species credit matter, the Eastern Pygmy Possum (*Cercartetus nanus*)
– Removal of up to 17.95 hectares of habitat for threatened or migratory fauna associated with the PCTs listed above

– Removal of a further 1.64 ha of non-native vegetation and cleared land in the development footprint that may comprise habitat for threatened species.

The proposal would not impact any threatened biota listed under the FM Act.

There are 12.91 hectares of vegetation commensurate with Illawarra Lowlands Grassy Woodland across the study area, that comprises an entity at risk of SAII. This is the only remaining patch of the community in the local area though there is around 130.01 hectares of the community in a 10 km radius. The proposal has included purposeful design of the subdivision within the readily developable land at the study area to substantially avoid and minimise impacts to the community, resulting in residual impacts to just 1.38 hectares of the community and regeneration of 1.94 hectares as part of a functional patch of the community with a greater extent and improved condition and security than the baseline condition. As such the proposal is likely to avoid the risk of a SAII to Illawarra Lowlands Grassy Woodland.

A BAM assessment and credit calculations have been performed in accordance with the methodology (DPIE 2020a) and using credit calculator version 1.4.0.00 incorporating legacy PCTs and version 1.2 benchmarks. The following biodiversity credits are required to be secured and retired to offset the impacts of the proposal:

– 110 ecosystem credits for impacts on Swamp Mahogany (Bangalay) swamp sclerophyll forest on coastal lowlands (PCT 1231)
– 2 ecosystem credits for impacts on Swamp Oak Floodplain Swamp Forest of the Sydney Basin Bioregion and South East Corner Bioregion (PCT 1232)
– 45 ecosystem credits for impacts on Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands of the southern Sydney Basin Bioregion and South East Corner Bioregion (PCT 1326)
– 165 ecosystem credits for impacts on Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694).
– 221 ecosystem credits for impacts on Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats (PCT 1236).
– 565 species credits for Eastern Pygmy Possum (*Cercartetus nanus*)

Removal of habitat for additional threatened species that were recorded at the study area and/or identified as potentially impacted would be offset through the retirement of the above listed ecosystem credits for PCT 1232, PCT 1236, PCT 1326, PCT 694 and PCT 1231 in any BSA over the conservation lot. Should this not occur, Credits would be sourced from the ‘open market’ or via a payment into the BCF in accordance with the trading rules associated with the NSW Biodiversity Offset Scheme and the requirements for offsetting impacts to protected matters under the EPBC Act Condition-setting Policy (DAWE 2020).

The proposal would result in impacts to threatened biota and migratory species that are listed under the EPBC Act.

A referral was submitted to the then Commonwealth DAWE including assessment of significance of impacts on protected matters. The Department confirmed a decision to assess a previous iteration of the proposal as a controlled action in June 2021 due to the potential for significant impacts on the following matters protected under the EPBC Act:

– Coastal Swamp Oak (*Casuarina glauca*) Forest
– Illawarra and south coast forest and woodland ecological community
– the Grey-headed Flying-fox.

The proposed subdivision must be approved by DCCEEW under the Commonwealth EPBC Act, in addition to the requirement for approval by Council under NSW legislation. Preliminary documentation will be prepared separately to this BDAR, and will be submitted to DCCEEW for consideration. The Commonwealth has formally endorsed the NSW BOS and BAM and so the preliminary documentation package will substantially rely on the information in the BDAR and any biodiversity offsets required under the EPBC Act would be secured through biodiversity credits according to the NSW system.

The residual impacts would be appropriately offset by sourcing credits from other BSSs on the ‘open market’ or via a payment into the BCF in accordance with the trading rules associated with the NSW Biodiversity Offset Scheme and the requirements for offsetting impacts to protected matters under the EPBC Act Condition-setting Policy (DAWE 2020). A payment to the Biodiversity Conservation Fund would only be considered if a suitable number and type of biodiversity credits cannot be secured.

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Appendix A

Consistency with Guidelines for applying the BAM at severely burnt sites

The *Guideline for applying Biodiversity Assessment Method at severely burnt sites* (EES 2020) ('the Guideline') was reviewed and the methods outlined in the document were applied where appropriate to this assessment. The requirements for applying the BAM to severely burnt sites have been addressed in this report as outlined below.

The requirements for applying the BAM to severely burnt sites

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
BAM Chapter 3: Establishing the site context				
3.1	**Bushfire description** Where the GEEBAM Burnt Area Classes Canopy fully affected, Canopy partially affected and Canopy unburnt are present on the subject land, a description of the recent bushfire(s) should be provided for the subject land and surrounding landscape, including the 1500 m buffer (or 500 m buffer for linear developments). This may require description of several bushfires where the subject land was only partially burnt by each. Describe the following (where information is available): – estimated time since the most recent bushfire(s) (months) – total area of the most recent bushfire event(s) (km^2) – sites of resource flows and sinks, e.g. where moisture and nutrients are likely to accumulate and support more rapid regeneration of vegetation and a higher carrying capacity (include justification). All supporting material must be clearly referenced and dated. A justification should be provided for any missing information, including efforts undertaken to obtain it.	Section 1.2 Section 4.9 Table 4.3	Prepare two versions of the Site Map and Location Map using: – the most recent pre-fire aerial imagery, and – the most recent post-fire aerial imagery (where available). All maps must include the extent of the most recent bushfire(s) across the assessment area. All maps must include the likely sites of resource flows and sinks.	Figure 1.1 Figure 4.3 Figure 4.1
3.2	**Vegetation cover** Estimate the native vegetation cover on the subject land and within a 1500 m buffer (or 500 m buffer for linear developments) prior to the most recent bushfire(s), using the most-recent pre-fire aerial imagery.	Section 4.7 Section 5.1	N/A	Figure 4.1
BAM Chapter 4: Assessing native vegetation, threatened ecological communities and vegetation integrity				
4.1	**Vegetation extent** Map the native vegetation extent on the subject land prior to the most recent bushfire(s), using the most recent pre-fire aerial imagery.	Section 4.7 Section 5.1		Figure 4.1

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
4.2	**PCT and TEC determination** The identification of PCTs and TECs must be determined by the most likely PCT/TEC that was present prior to the severe bushfire. The assessor should not determine a different PCT/TEC on the basis of any changes in species composition predicted as resulting from the severe bushfire. Identification of PCTs/TECs will require judgement, supported by clear reasoning and use of the decision support tools provided in the Guideline. Determine the most likely PCTs/TECs on the subject land using a combination of the following (in addition to the criteria in BAM, 5.2.1.5): – flora species present, particularly dominant species, determined by an extensive search for residual fertile material or regeneration – geology and soils – landscape position – elevation, aspect and slope – mean annual rainfall – observation of unburnt PCTs on the subject land, adjacent to it or in the surrounding area – existing site specific or nearby plot data from BioNet Systematic Flora Survey data collection (Vegetation Information System (VIS) data) in the BioNet Atlas application. – local or regional vegetation maps – aerial imagery (most recent pre-fire) – other documented flora records from the local area. Provide justification for the basis on which the PCT/TEC was assigned, including reference to specific characteristics used and consideration for how bushfire(s) occurrence has affected the determination. Evidence of any discussions and/or agreements with the Department regarding the selection of PCTs and TECs and all source material should be provided in the BDAR/BCAR. Where the PCT cannot be identified with reasonable certainty or accuracy, it is recommended the vegetation assessment be delayed until sufficient regeneration occurs to support a more certain identification.	Section 4.9 Section 5.5 Table 4.1		Figure 5.1 Figure 5.3

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
	Where a TEC cannot be identified with reasonable certainty or accuracy, it is recommended the vegetation assessment be delayed until sufficient regeneration occurs to support identification, or presence of the TEC may be assumed. The assessor should document in the BDAR/BCAR that they have the technical and botanical expertise to support their determination of a PCT and TEC, based on fire remnants and early regeneration of vegetation. This may include documenting advice supporting the assessment that was provided by third parties who have: – previously worked in or are familiar with the ecological values of the subject or local area – knowledge of the vegetation on the subject land area prior to recent severe bushfire(s) – demonstrable experience in botanical identification and/or aerial imagery interpretation.			
4.3	**Vegetation zones** Determine the most likely vegetation zone(s) and patch size area(s) on the subject land prior to the severe bushfire(s), using the most recent pre-fire aerial imagery. As the vegetation zones are determined by pre-fire condition state, they may support burnt and unburnt areas. Where the vegetation zone cannot be determined by condition prior to the severe bushfire event(s), delineate the vegetation zones by PCT only and assess the vegetation as being in a single condition state. If the assessment has been partially completed prior to the severe bushfire event, information from that work should be used to determine vegetation zones. Document the basis on which the vegetation zone(s) and patch size area(s) have been assigned, including why pre-fire condition state was unable to be determined (if applicable). All source material should be provided in the BDAR/BCAR, including references and dates. Vegetation zones should be evaluated as severely burnt or not severely burnt as per section 4.2.2. The criteria in Table 1 should be used as a guide, comparing the features to those expected for the PCT present. The assessor must use their judgement to determine if the combination of the features	Section 5.2 .		Figure 5.2 Table 5.2

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
	described in Table 1 is evidence that the vegetation zone is severely burnt. A vegetation zone is considered severely burnt where all or part of the native vegetation within that zone is determined as severely burnt. A determination for all or part of the vegetation zone being severely burnt or not severely burnt must be documented in the BDAR/BCAR. This should be supported by a clear description of the criteria in Table 1 and justification for the decision based upon the features observed (for the PCT present). If the vegetation zone is determined not severely burnt the justification should include details for why the BAM will provide a measure of vegetation integrity for that vegetation zone that is representative of the biodiversity values that were present on the subject land prior to severe bushfire. Determine the extent of bushfire impact within the vegetation zone as area fully burnt and area partially burnt. Map vegetation zone(s) and patch size area(s) using the most recent pre- and post-fire aerial imagery (where available). Provide photographs (with dates, GPS coordinates and bearings) of each vegetation zone clearly identifying the burn severity and regeneration of vegetation (where present). Provide justification in the BDAR/BCAR where any information was not provided.			
4.3	**Vegetation Integrity** The Guideline sets out several options that can be used to assess the most likely vegetation integrity value for a vegetation zone prior to fire. Consultation with the consent authority or the Department on the most appropriate approach for determining vegetation integrity prior to beginning the assessment is recommended. Identify one of the following options (Figure 2) for determining vegetation integrity in a severely burnt vegetation zone. For vegetation zones not severely burnt, apply the BAM. Clearly identify the option selected for each vegetation zone and provide justification for the choice of method in the BDAR/BCAR, including reasoning for why other options were unsuitable. Include reference to or evidence of any	Section 1.2 Section 4.9 Section 5.3 Table 4.3 presents an assessment of fire impact severity at the time of collection of plot data in the post September 2021 survey rounds and confirms that these areas did not comprise severely burnt vegetation at the time of sampling. Noting that 2018-2019 plot data may have limitations associated with the drought conditions during that period, BAM vegetation integrity plots sampled in unburnt portions of the site and/or when substantial post		Table 3.3 Table 4.3 Table 5.3

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
	discussions and/or agreements with the Department and details of all source material, including references and dates. The options for collecting vegetation integrity data are presented below. Assessors should note that a mix of options may be used for an assessment, depending on the specific circumstances of each vegetation zone and the context of the site. Recommendations on when to apply each option are provided. **Option 1. Use an unburnt section(s) of the vegetation zone and replicate plot data in the BAM-C** This approach is applicable where either: – the vegetation integrity assessment was partially completed prior to the severe bushfire, or – parts of the vegetation zone contain unburnt vegetation and assessment outcomes from that area can be extrapolated to determine native vegetation integrity for the vegetation zone, including the severely burnt areas. The selection of a suitably unburnt area should be justified with respect to the regenerative characteristics of the PCT and include reference to the composition, structure, function and habitat features as expected for the PCT prior to the severe bushfire(s). The area of the vegetation zone containing unburnt vegetation must be large enough for a BAM plot and transect. Requirements for random location of BAM plots (BAM, 5.3.4.5 and 5.3.4.6) may be varied to meet the minimum plot numbers. Where BAM 5.3.4.5 and BAM 5.3.4.6 requirements are varied to achieve the minimum plot numbers, justification and details should be included in the BDAR/BCAR. When the configuration and size of the unburnt part(s) of the vegetation zone does not allow for the minimum plots required by the BAM, the highest number possible must be surveyed (plots may be placed side by side in this case, with explanation provided in the BDAR/BCAR). Where the minimum number of plots cannot be achieved, plot data can be replicated in the BAM-C to allow the assessment to proceed. If replicating plot data in the BAM-C, all plots must be replicated equally (this may exceed the minimum plot requirements for the vegetation zone). For example, if plot data is available for two plots and five are required by the	fire regeneration had occurred have been preferred for BAM-C calculations in this BDAR (i.e. plot data from unburnt vegetation and mature post-fire regeneration sampled in September 2021, November 2021, January 2023 or October 2023).		

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
	BAM, then both plots must be replicated three times. This would result in a total of six plots being entered in the BAM-C. When replicating plots in the BAM-C, the assessor must enter actual plot data, rather than an average of the plot data. Clearly identify where this occurs and justify the need for replicating plot data. Identify the use of this option by including 'rep' in the vegetation zone(s) name within the BAM-C.			
	Option 2. Locate surrogate plots for vegetation zone It is recommended that this approach be applied where: – there is no unburnt vegetation on the subject land (for the relevant vegetation zone), and – the likely vegetation condition state for the vegetation zone was moderate to poor prior to the severe bushfire(s). Select a surrogate vegetation zone (as described in Box 1) located on land as close as possible and within 10 km of the subject land boundary. Plot data from a surrogate site must not be replicated to meet the minimum number of plots required by the BAM. Plots data from a surrogate site should be identified by including '_sur' in the vegetation zone(s) name within the BAM-C.	N/A	Justification for the selection of a surrogate vegetation zone must be provided in the BDAR/BCAR using the criteria listed in Box 1. A map of the surrogate vegetation zone location in relation to the subject land must be included.	
	Option 3. Use of existing VIS data It is recommended that this approach be applied where: – there is no unburnt vegetation on the subject land (for the relevant vegetation zone), and – the VIS data is representative of the broad condition state of the vegetation zone prior to the recent severe bushfire(s). Existing VIS data can be accessed from the BioNet Systematic Flora Survey in the BioNet Atlas application. Where VIS data is available for the subject land or nearby site (generally within 10 km of the subject land boundary) for the same PCT (as described in Box 1), it may be used to inform the vegetation integrity assessment. VIS data should be evaluated for being representative of the broad condition	N/A	Justification for the selection of VIS data must be provided in the BDAR/BCAR using the criteria listed in Box 1. Include a map of the VIS survey site location in relation to the subject land.	

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
	state of the vegetation zone prior to the recent severe bushfire(s). As VIS data does not include function scores, the assessor should collect information on the number of large trees and presence of stem size classes from the subject land. The likelihood of regeneration being present may be based on consideration of previous land use and other information used in section 5.2. Alternatively, the assessor may use benchmark condition. The VIS survey name and site number (as documented in the database) should be provided in the BDAR/BCAR including justification for the allocation of PCT from VIS data (where PCT has not been identified in the database). Plot data from VIS should be identified by including '_vis' in the vegetation zone(s) name within the BAM-C. Where the VIS data does not meet the minimum number of plots required by the BAM, advice may be sought from the consent authority or the Department as to the most appropriate approach for determining vegetation integrity.			
	Option 4. Assume benchmark condition It is recommended that this approach be applied where: – there are no patches on the subject land with unburnt vegetation (for the relevant vegetation zone), and/or – the PCT condition state was likely to have been high or very high prior to the recent severe bushfire(s). Benchmark condition scores (located in the BioNet Vegetation Classification module for each PCT) may be used to represent the vegetation integrity for the severely burnt vegetation zone. Use of this approach should be identified by including '_bm' in the vegetation zone(s) name within the BAM-C.	N/A		
	Hollow bearing trees The number of trees with hollows must be assessed (as per BAM, 5.3.4.29) on the subject land. Plots should be randomly allocated (as per BAM, 5.3.4), including placement within the vegetation zone(s) or parts of vegetation zone(s) burnt by bushfire(s).	Table 3.3 Table 5.3 Appendix D	Clearly identify these plots on the Site Maps, providing GPS coordinates and bearings.	Figure 3.1 Figure 5.2

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
	Where hollow bearing trees are present then this feature is recorded in the BAM-C irrespective of the option selected to estimate vegetation integrity scores.			
BAM Chapter 5: Assessing the habitat suitability for threatened species				
5.1 5.2 5.3	**Assessing habitat constraints for ecosystem and species credit species** Threatened species habitat suitability must be assessed on the subject land, including within all severely burnt and not severely burnt vegetation zones, applying the BAM with the use of the Guideline. Generally, habitat constraints that are components of vegetation should not be determined as being absent (including from the impact of bushfire) unless evidence is provided that the constraint was not present prior to the bushfire(s) (e.g. it is not present on unburnt areas of the subject land). **Assumed presence and expert reports** Threatened species should be assumed present or assessed with an expert report for all vegetation zones on the subject land (except with agreement from the consent authority for the assessor to undertake a threatened species survey for specific threatened plants, such as particular fire respondent species). If using an expert report, threatened species presence must be assessed on the subject land, including within the severely burnt vegetation zones. A threatened species may be excluded from further assessment if the expert determines that the species would not or is unlikely to have been present on the subject land prior to the severe bushfire. An expert report must not be used for a species for which assessment is required by referring to an important mapped area. **Threatened species survey** Survey for threatened plant species can only be undertaken where evidence indicates the species, if present, will be identifiable above ground as part of the early regeneration following severe bushfire. Evidence includes peer-reviewed literature describing the species presence on sites within six	Section 3.4 Chapter 6 Section 9.1		Figure 3.1 Figure 3.2 Figure 3.3 Figure 3.4 Figure 3.5 Figure 6.1 Figure 6.2

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
	months following a severe bushfire or reference populations in similar post-severe bushfire sites under similar conditions (e.g. rainfall, season) are detectable. All source material should be provided in the BDAR/BCAR, including references and dates. An assessor should seek written agreement from the consent authority prior to conducting a threatened species survey and provide documentation of this agreement in the BDAR/BCAR. Surveys cannot be undertaken to assess presence or absence of threatened fauna after the fire event **Species polygons and counts** The area of habitat or estimated number of individuals should, in general, be based on the pre-fire occurrence. The habitat condition, used to calculate credits for species assessed by area, of the species polygon is determined by the vegetation integrity score for each vegetation zone (as determined by the selected approach in 5.3).			
BAM Chapter 10: Thresholds for assessing and offsetting the impacts of development				
9.1	Entities at risk of a SAII must be assumed present or assessed by expert report.	1.3.1		Figure 8.4
9.1.1	All criteria in paragraph 9.1.1 must be addressed and include consideration of the impacts of the recent bushfire(s) on threatened ecological communities.	8.5.1		Figure 8.4 Figure 8.5 Figure 8.6
9.1.2	All criteria in paragraph 9.1.2 must be addressed and include consideration for the interaction of impacts from the recent bushfire(s) with those from development on the threatened species populations.	N/A		
BAM Appendix B	**Streamlined assessment module – clearing paddock trees** Determine if the vegetation meets the definition of paddock trees using most recent pre-fire aerial imagery. Where a paddock tree has been damaged by bushfire, the diameter at breast height (DBH) must be estimated to represent the DBH prior to the severe bushfire(s).	N/A		

BAM reference[1]	Information	Where addressed in this BDAR	Maps and data	Where addressed in this BDAR
	Photos of all paddock trees in the assessment must be included (with dates, with GPS coordinates and bearings). If the occurrence of hollows cannot be reliably determined, then presence of hollows must be assumed. If hollows are determined absent, justification should be included in the BAM.			
BAM Appendix C	**Streamlined assessment module – small area development that requires consent** Identify the most likely dominant PCT on the subject land prior to the severe bushfire(s) using most recent pre-fire aerial imagery. Determine vegetation integrity using the preferences outlined in section 5.3 (of Table 2, Vegetation integrity), employing a qualitative (observation) or quantitative approach (as detailed in the BAM, Appendix 2). Threatened species habitat suitability must be assessed on the subject land for species at risk of a SAII, including within the severely burnt vegetation zones. Generally, habitat constraints that are components of vegetation should not be determined as being absent (including from the impact of bushfire) unless evidence is provided that the constraint was not present before the bushfire(s) (e.g. it is not present on unburnt areas of the subject land).	N/A		

Notes: 1 - The *Guideline for applying Biodiversity Assessment Method at severely burnt sites* (EES 2020) BAM reference is to the chapters and sections of the BAM 2017 and has been updated here to refer to the equivalent BAM 2020 sections.

Appendix B

Threatened species for assessment

Threatened biota habitat table

Databases searched

– NSW BioNet (DPE 2023a) Threatened Biodiversity Data Collection list of candidate species credit-type species and predicted species accessed via the BAM calculator version 1.4.00 as per the date on the finalised credit report
– NSW Department of Planning, Industry and Environment (DPIE) BioNet Atlas for records of threatened biota previously recorded in a 10 kilometre radius around the proposal site (DPIE b and Threatened Biodiversity Data Collection (TBDC) profiles of threatened species listed under the BC Act (DPIE 2021)
– DPE (2023c). BAM - Important Areas viewer to identify mapped areas of important habitat that comprise species credit matters
– DPE Threatened biodiversity profile search online database for threatened ecological communities and species listed under the BC Act (DPIE 2023d)
– DAWE (2021b) EPBC Act Protected Matters Search Tool – for a 10 kilometre radius around the proposal site (searched July 2021)
– Note: Marine species which are restricted to marine environments only (such as whales, dolphins, sharks and seabirds) are excluded from the Likelihood of Occurrence Table as there is no marine habitat adjoining the development footprint or with the potential to be subject to indirect impacts.

Habitat suitability

Matters considered in determining the habitat suitability:

– Known natural distributions including prior records (database searches) and site survey results
– Geological/ soil preferences
– Specific habitat requirements (e.g. aquatic environs, seasonal nectar resources, tree hollows etc.)
– Climatic considerations (e.g. wet summers)
– Home range size and habitat dependence
– Topographical preferences (e.g. coastal headlands, ridgetops, midslopes, wetlands)

The likelihood of occurrence scale is defined in the following table:

Likelihood of occurrence scale

Scale	Description
Known	Species known to occur within the site (e.g. breeding and foraging habitat; foraging habitat; movement corridors). Detected on or immediately adjacent to the site.
High	Presence of high value suitable habitat (e.g. breeding and foraging habitat; important movement corridors). Not detected.
Moderate	Presence of medium value suitable habitat (e.g. disturbed breeding conditions; constrained foraging habitat; movement corridors). Not detected.
Low/Unlikely	Presence of low value suitable habitat (e.g. disturbed conditions; isolated small habitat area; fragmented movement corridors). Not detected.
None	No suitable habitat or corridors linking suitable habitat present. Not detected.

Assessment of habitat suitability for threatened flora

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association (DPE 2023b)	Source	Habitat suitability
Flora						
Caladenia tessellata	Thicked-lipped Spider-orchid	E	V	Known to exist within the Sydney and Central Coast area of NSW. It is found in grassy sclerophyll woodland. Found on clay loam or sandy soils. Flowers from September to November (this is reduced from late September to early October for southern populations).	Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	MODERATE – suitable habitat within PCT 659 and potential habitat in PCT 1231. Targeted surveys conducted in September 2018 and October 2023. Not detected.
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	The Leafless Tongue Orchid has been recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites). Also recorded at Munmorah State Conservation Area, Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park and Ben Boyd National Park. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi),* Red Bloodwood and Black Sheoak (*Allocasuarina littoralis*); appears to prefer open areas in the understorey of this community.	14 records within 10 km (BioNet Atlas) Predicted within 10 km (PMST)	MODERATE – known populations in the wider locality. Directly observed at a reference site around 1 km from the study area. Broadly suitable habitat at the study area but more likely to occur on sandy, free draining soil landscapes than those present at the study area. Targeted surveys conducted during January 2018, December 2022 and January 2023. Not detected.
Cynanchum elegans	White Flowered Wax Plant	V	V	Occurs from Gerroa (Illawarra) to Brunswick Heads and west to Merriwa in the upper Hunter. Most common near Kempsey. Usually occurs on the edge of dry rainforest	Predicted within 10 km (PMST)	UNLIKELY – broadly suitable in PCTs 659, 1231 and 694 at the study area. Not a confirmed candidate species. Development footprint is south of the species' known range. Not detected in vegetation surveys or targeted surveys for other species.

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association (DPE 2023b)	Source	Habitat suitability
				or littoral rainforest, but also occurs in Coastal Banksia Scrub, open forest and woodland, and Melaleuca scrub. Soil and geology types are not limiting.		
Galium australe	Tangled Bedstraw	E		Most flowering collections have been made in late spring to early autumn. In NSW (and ACT Territory in Jervis Bay), Tangled Bedstraw has been recorded in Turpentine forest and coastal Acacia shrubland. In other States the species is found in a range of near-coastal habitats, including sand dunes, sand spits, shrubland and woodland.	Predicted to occur (BAM calculator)	MODERATE – broadly suitable in some PCTs at the study area. Not a confirmed candidate species. Not detected despite general consideration in vegetation surveys or targeted surveys for other species.
Genoplesium baueri	Yellow Gnat-orchid	E	E	Grows in dry sclerophyll forest and moss gardens over sandstone. Flowers February to March	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present within the development footprint
Genoplesium vernale	East Lynne Midge-orchid	V	V	The East Lynne Midge Orchid grows in dry sclerophyll woodland and forest extending from close to the coast to the adjoining coastal ranges. Confined to areas with well-drained shallow soils of low fertility, often occurring near the crests of ridges and on low rises where the ground cover is more open and sedge dominated rather than being shrubby. Each plant produces a single leaf-like stem that emerges from an underground tuber. The orchid stems can appear from late October and take only a few weeks to produce flowers. Many stems that emerge do not produce flowers. The species generally flowers between early November and mid December. The fruit then take several weeks to ripen.	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present within the development footprint

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association (DPE 2023b)	Source	Habitat suitability
Haloragis exalata subsp *exalata*	Square Raspwort	V	V	Square Raspwort occurs in 4 widely scattered localities in eastern NSW. It is disjunctly distributed in the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW. Square Raspwort appears to require protected and shaded damp situations in riparian habitats. Flowering specimens in NSW are recorded from November to January.	Predicted to occur (BAM calculator)	UNLIKELY - suitable habitat along riparian zones in broader study area. Not a confirmed candidate species as habitat constraints are not present in the development footprint. Not detected despite general consideration in vegetation surveys or targeted surveys for other species.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Generally grows in damp places, often near streams or low-lying areas on alluvial soils or low slopes of sheltered aspects (OEH 2018).	Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	Moderate –habitat present within PCTs 694, 1232, 1236. Targeted surveys undertaken in September 2018, March 2019, December 2022 and January 2023. Not detected.
Prostanthera densa	Villous Mintbush	V	V	This species has been recorded from the Currarong area in Jervis Bay, Royal National Park, Cronulla, Garie Beach and Port Stephens (Gan Gan Hill, Nelson Bay). *Prostanthera densa* generally grows in sclerophyll forest and shrubland on coastal headlands and near coastal ranges, chiefly on sandstone, and rocky slopes near the sea. Plants regenerate from rootstock after fire and flower within the first year or two.	Predicted to occur (BAM calculator)	UNLIKELY - suitable habitat in PCT 659 broader study area. Not a confirmed candidate species as habitat constraints are not present in the development footprint. Not detected despite general consideration in vegetation surveys or targeted surveys for other species.
Pterostylis gibbosa	Illawarra Greenhood	E	E	All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum *Eucalyptus tereticornis*, Woollybutt *E. longifolia* and White Feather Honey-myrtle *Melaleuca decora*. Near Nowra, the species grows in an open forest of	Predicted within 10 km (PMST)	MODERATE – suitable habitat within PCT 1326. Targeted surveys undertaken in September 2018 and October 2023. Not detected.

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association (DPE 2023b)	Source	Habitat suitability
				Spotted Gum *Corymbia maculata*, Forest Red Gum and Grey Ironbark *E. paniculata*. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark *E. crebra*, Forest Red Gum and Black Cypress Pine *Callitris endlicheri.*		
Pterostylis ventricosa		CE		Predominantly in more open areas of tall coastal eucalypt forest often dominated by one or more of the following tree species:- Turpentine, Spotted Gum, Grey Ironbark, Blackbutt, White Stringybark, Scribbly Gum and Sydney Peppermint. Often favours more open areas such as along powerline easements and on road verges where the tree overstorey has been removed or thinned. Grows in a range of groundcover types, including moderately dense low heath, open sedges and grasses, leaf litter, and mosses on outcropping rock. Small moss gardens are a commonly associated micro-habitat feature in most habitats.	2 records within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	MODERATE – potentially suitable habitat within PCT 694. Targeted surveys undertaken in March 2019 and April 2023. Not detected.
Rhodamnia rubescens	Scrub Turpentine	CE		Scrub turpentine is known to occur in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	3 records within 10 km (two immediately adjacent to the site)	MODERATE - species has been recorded immediately adjacent to site and potential habitat present in PCT 694. Targeted surveys undertaken in September 2018, March 2019, December 2022 and January 2023. Not detected.
Senecio spathulatus	Coast Groundsel	E		Coast Groundsel occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park (with a possible occurrence at Cudmirrah). In Victoria there are scattered populations from Wilsons Promontory to the NSW border.	Predicted to occur (BAM calculator)	UNLIKELY – no suitable habitat present within the development footprint

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association (DPE 2023b)	Source	Habitat suitability
				Coast Groundsel grows on frontal dunes.		
Syzygium paniculatum	Magenta Lilly Pilly	E	V	On the NSW central coast species occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (OEH 2018).	Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	MODERATE - habitat present in PCTs 1231 and 694. Targeted surveys undertaken in September 2018, March 2019, December 2022 and January 2023. Not detected.
Thesium austral	Austral Toadflax	V	V	Found in small, scattered populations along the east coast, northern and southern tablelands. Occurs in grassland or grassy woodland. Found in association with Kangaroo Grass *Themeda australis*. Flowers in spring and summer.	Predicted within 10 km (PMST)	UNLIKELY – broadly suitable in PCT 1326 at the study area. Not a confirmed candidate species. Not detected in vegetation surveys or targeted surveys for other species.
Wilsonia backhousei	Narrow-leafed Wilsonia	V		In NSW Narrow-leaf Wilsonia is found on the coast between Mimosa Rocks National Park and Wamberal north of Sydney (Nelson's Lake, Potato Point, Sussex Inlet, Wowly Gully, Parramatta River at Ermington, Clovelly, Voyager Point, Wollongong and Royal National Park). It grows in all southern states. This is a species of the margins of salt marshes and lakes. Flowering occurs in spring and summer.	1 record within 10 km (BioNet Atlas);	UNLIKELY – no suitable habitat present within the development footprint

Note: All information in this table is taken from NSW OEH and Commonwealth DAWE Threatened Species profiles (OEH, 2018c)(DoEE, 2018c) unless otherwise stated. The codes used in this table are: CE – critically endangered; E – endangered; V – vulnerable; EP – endangered population; CEEC – critically endangered ecological community; EEC – endangered ecological community.

Threatened fauna known or predicted from the locality, habitat association and likelihood of occurring at the site.

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
Frogs						
Heleioporus australiacus	Giant Burrowing Frog	V	V	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollemi National Park. Appears to exist as 2 populations with a 100 km gap in records between Jervis Bay and Eden. Northern population occurs on sandy soils supporting heath, woodland or open forest. Breeds in ephemeral to intermittent streams with persistent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	UNLIKELY – no suitable stream-breeding habitat present within the development footprint. Very marginal habitat in intermittent streams in the broader study area. Targeted surveys undertaken in December 2018 supplementary surveys under above average rainfall conditions in December 2022 and January 2023. Not detected
Litoria aurea	Green and Golden Bell Frog	E	V	Inhabits marshes, dams and stream-sides, particularly those containing bulrushes (Typha spp.) or spikerushes (Eleocharis spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available (OEH 2018).	9 records within 10 km (BioNet Atlas) Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	MODERATE – no suitable breeding habitat present within the development footprint due to a lack of permanent water. Potential breeding habitat in the broader study area. Targeted surveys undertaken in December 2018 and supplementary targeted surveys under above-average rainfall conditions in December 2022 and January 2023. Not detected
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	Occurs on plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground.	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present within the development footprint or broader study area.
Birds						

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
Anthochaera phrygia	Regent Honeyeater	CE	CE	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	4 records within 10 km (BioNet Atlas); Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	LOW - potential foraging habitat present but not preferred habitat and not mapped as an area of important habitat (OEH 2021). Targeted surveys undertaken in September and December 2018. Not detected.
Artarmus cyanopterus	Dusky Woodswallow	V		The Dusky Woodswallow is widespread from the coast to inland, including the western slopes of the Great Dividing Range and farther west. It is often recorded in woodlands and dry open sclerophyll forests, and has also been recorded in shrublands, heathlands regenerating forests and very occasionally in moist forests or rainforests. The understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, often with coarse woody debris. It is also recorded in farmland, usually at the edges of forest or woodland or in roadside remnants or wind breaks with dead timber.	1 records within 10 km (BioNet Atlas)	KNOWN - suitable habitat present across the site. Recorded in the study area.
Burhinus grallarius	Bush Stone-curlew	E		Scattered distribution across NSW. Inhabits lowland grassy woodland and open forest and, in coastal areas, *Casuarina* and *Melaleuca* woodlands, saltmarsh and mangroves. Requires a low, sparse groundcover, some fallen timber and leaf litter, and a general lack of a shrubby understory (OEH 2018).	Predicted to occur (BAM calculator)	MODERATE - suitable habitat present across the site. Targeted surveys undertaken in December 2018 and supplementary spotlighting surveys undertaken in December 2022 and January 2023. Not detected.
Calidris acuminata	Sharp- tailed Sandpiper		M	Prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewage farms, flooded fields, mudflats, mangroves, rocky shores and beaches. Its breeding habitat in Siberia is the peat-hummock and lichen tundra of the high Arctic.	Predicted within 10 km (PMST)	UNLIKELY- no suitable habitat present within the development footprint
Calidris canutus	Red Knot		E	The Red-necked Stint is mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. They also occur in saltworks and sewage	Predicted within 10 km(PMST)	UNLIKELY- no suitable habitat present within the development footprint

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
				farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats. They sometimes use flooded paddocks or damp grasslands. They have occasionally been recorded on dry gibber plains, with little or no perennial vegetation (DoEE 2018).		
Calidris ferruginea	Curlew Sandpiper	E	CE, M	Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters (OEH 2018).	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present within the development footprint
Callocephalon fimbriatum	Gang-gang Cockatoo	V		The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. In summer, this species is generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, it may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. The species may also occur in sub-alpine Snow Gum *Eucalyptus pauciflora* woodland and occasionally in temperate rainforests. Favours old growth attributes for nesting and roosting (OEH 2018).	60 record within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	KNOWN- suitable habitat present across the site. Species detected in 2015 by EMM and in the current study. Nest trees not detected despite targeted survey in 2018 and 2019 and supplementary nest tree census in December 2022 and January 2023.
Calyptorhynchus lathami	Glossy Black-cockatoo	V		Distributed from the east coast to the southern tablelands and central western plains. Occurs in woodland and open forests, rarely away from *Allocasuarina*. Feeds almost exclusively on the seeds of *Allocasuarina* species. Requires sufficient extent of forage within home range to support breeding. Roosts in leafy canopy trees, preferably eucalypts, usually <1 km from feeding site. Nests in large (approximately 20 cm) eucalypt hollows (Higgins, 1999).	61 records within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	KNOWN - suitable habitat present across the site. Species detected in 2015 by EMM and in 2018 by OMVI Ecological. Nest trees not detected despite targeted survey in 2018 and 2019 and supplementary nest tree

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
						census in December 2022 and January 2023.
Charadrius mongolus	Lesser Sand Plover	V	E	Almost entirely coastal in NSW, favouring the beaches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats; occasionally occurs on sandy beaches, coral reefs and rock platforms (OEH 2018).	1 records within 10 km (BioNet Atlas)	UNLIKELY – no suitable habitat present within the development footprint
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies	V		Occurs from Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell to the east coast, in areas such as the Snowy River Valley, Cumberland Plain, Hunter Valley and parts of the Richmond and Clarence Valleys. Most common on the inland slopes and plains. Inhabits eucalypt woodlands and dry open forest, usually dominated by stringybarks or rough-barked species with open grassy understorey. Fallen timber is important foraging habitat. Nests in hollows in standing trees or stumps.	3 records within 10 km (BioNet Atlas)	LOW – habitat across the site generally unsuitable, and a low density of fallen logs
Dasyornis brachypterus	Eastern Bristlebird	E	E	Three main populations, in south-eastern Queensland, Central NSW and southern NSW. The species prefers open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone; all of these vegetation types are fire prone. Feeds on a variety of insects, particularly ants. Nests are elliptical domes constructed on or near the ground amongst dense vegetation and eggs are laid between August to February.	1 record within 10 km (BioNet Atlas) Predicted within 10 km (PMST)	MODERATE – potential habitat within PCT 1326, particularly in areas with dense, low cover.
Daphoenositta chrysoptera	Varied Sittella	V		Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	13 records within 10 km (BioNet Atlas)	KNOWN– suitable habitat present within PCT 1326, particularly where mature trees present. Recorded in the study area.
Hirundapus caudacutus	White-throated Needletail		M	Forage aerially within Australia over a very wide range of habitats. Do not land within Australia and breed within Asia.	Predicted within 10 km (PMST)	KNOWN– though likely to only forage aerially above the site. Recorded on eastern study area boundary

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
Glossopsitta pusilla	Little Lorikeet	V		Occurs from coast to western slopes of the Great Dividing Range. Inhabits dry, open eucalypt forests and woodlands. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Feed primarily on profusely-flowering eucalypts and a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands *Eucalyptus albens* and *E. melliodora* are particularly important food sources for pollen and nectar respectively. Mostly nests in small (opening approx. 3 cm) hollows in living, smooth-barked eucalypts, especially *Eucalyptus viminalis*, *E. blakelyi* and *E. dealbata*. Most breeding records are from the western slopes.	15 records within 10 km (BioNet Atlas)	KNOWN - suitable habitat present across the site. Species detected in 2015 by EMM and in 2018 by OMVI Ecological
Haematopus fuliginosus	Sooty Oystercatcher	V		Evenly distributed along NSW coast, including offshore islands. Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. Forages on exposed rock or coral at low tide. Breeds almost exclusively on offshore islands, and occasionally on isolated promontories.	19 records within 10 km (BAM calculator)	UNLIKELY – no suitable habitat present within the development footprint. Recorded in 2014 by EMM in the eastern dunes outside of the study area.
Haematopus longirostris	Pied Oystercatcher	E		Favours intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish. Nests mostly on coastal or estuarine beaches although occasionally they use saltmarsh or grassy areas (OEH 2018).	42 records within 10 km (BioNet Atlas)	UNLIKELY – no suitable habitat present within the development footprint. Recorded in 2014 by EMM in the eastern dunes outside of the study area.
Haliaeetus leucogaster	White-bellied Sea Eagle	V	Marine	Preferred foraging habitat includes marine and estuarine wetlands and marine habitats. Nests in tall trees in open forest (OEH 2018).	49 records within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	MODERATE –Targeted surveys undertaken in September 2018 and December 2018 and supplementary nest tree census in December 2022 and January 2023. Not detected.
Hieraaetus morphnoides	Little Eagle	V		Distribution throughout New South Wales is in the densely forested part of the Dividing Range. Occupies open eucalypt forest, woodland or open woodland. Acacia, Sheoak and riparian woodlands are favourable. Feeds on birds, reptiles and mammals. Nests in tall trees in remnant patches in winter and lays eggs in spring.	8 records within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	KNOWN species recorded at the site. No breeding individuals recorded. Targeted surveys undertaken in September 2018 and August 2019. Nest trees not detected

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
						despite targeted survey in 2018 and 2019 and supplementary nest tree census in December 2022 and January 2023. Not detected.
Ixobrychus flavicollis	Black Bittern	V		Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. Feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night. During the day, roosts in trees or on the ground amongst dense reeds. When disturbed, freezes in a characteristic bittern posture (stretched tall, bill pointing up, so that shape and streaked pattern blend with upright stems of reeds), or will fly up to a branch or flush for cover where it will freeze again. Generally solitary, but occurs in pairs during the breeding season, from December to March.	1 record within 10 km (BioNet Atlas)	MODERATE – no suitable wetland habitat present within the development footprint. Potential habitat is present in the drainage lines through the conservation lot and small dams, with likely habitat present in the ICOLL at the eastern edge of the study area. The species may occasionally occur in swamp forest and paperbark scrub in the development footprint.
Lathamus discolor	Swift Parrot	E	CE	Migrates to the Australian southeast mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*) (OEH 2018).	1 record within 10 km (BioNet Atlas) Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	MODERATE - suitable foraging habitat present on the site. Not mapped as an area of important habitat by OEH (2021). Not breeding habitat. Targeted surveys were undertaken in September 2018, March and August 2019. Not detected.
Limosa lapponica	Bar-tailed Godwit		V, M	This species is usually found in sheltered bays, estuaries and lagoons (OEH 2018).	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present within the development footprint
Lophoictinia isura	Square-tailed Kite	V		Occurs across NSW, resident in North, northeast and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands and open forests, with preference for timbered watercourses. Favours productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes,	10 records within 10 km (BioNet Atlas)	KNOWN – detected in January 2018 by OMVI Ecological. Foraging habitat present only.

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
				and Coolibah/River Red Gum on the inland plains. In Sydney area nests in mature living trees within 100 m of ephemeral/permanent watercourse. Large home range > 100 km^2.	Predicted to occur (BAM calculator)	Nest trees not detected despite targeted survey in 2018 and 2019 and supplementary nest tree census in December 2022 and January 2023.
Monarcha melanopsis	Black- faced Monarch		M	Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	Predicted within 10 km (PMST)	KNOWN – detected in January 2018 by OMVI Ecological.
Monarcha trivirgatus	Spectacled Monarch		M	The Spectacled Monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. Prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	Predicted within 10 km (PMST)	NIL– outside species usual range and no habitat present.
Myiagra cyanoleuca	Satin Flycatcher		M	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Predicted within 10 km (PMST)	KNOWN. Recorded in the development footprint
Neophema chrysogaster	Orange-bellied Parrot	CE	CE	On the mainland, the Orange-bellied Parrot spends winter mostly within 3 km of the coast in sheltered coastal habitats including bays, lagoons, estuaries, coastal dunes and saltmarshes. The species also inhabits small islands and peninsulas and occasionally saltworks and golf courses. Birds forage in low samphire herbland or taller coastal shrubland. Diet mainly comprises seeds and fruits of sedges and salt-tolerant coastal and saltmarsh plants. Occasionally, flowers and stems are eaten. Orange-bellied Parrots are known to forage among flocks of Blue-winged Parrots. Recent records from unexpected places, including Shellharbour and Maroubra suggest that the species may be expanding their selection of habitats and foraging plant species. Birds seen in NSW in 2003 were foraging on weed species several hundred metres from the coast.	Predicted to occur (BAM calculator)	LOW – habitat unlikely to be suitable though birds may opportunistically forage in the area. Surveys undertaken in September and December 2018, March and August 2019. Not detected.
Ninox connivens	Barking Owl	V		Inhabits eucalypt woodlands, open forest, swamp woodlands, and, especially in inland areas, timber along watercourses. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as *Acacia* and *Casuarina* species, or in dense clumps of canopy leaves in large eucalypts. The Barking owl feeds on	1 record within 10 km (BioNet Atlas)	MODERATE – suitable foraging habitat across the site. No suitable hollows and therefore no breeding habitat present. Targeted surveys undertaken in

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
				a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits important during breeding. This species lives alone or in a pair with territories ranging from 30 to 200 hectares. Nests are built in hollows of large, old eucalypts (OEH 2018).	Predicted to occur (BAM calculator)	August 2019. Nest trees not detected despite targeted survey in 2018 and 2019 and supplementary nest tree census in December 2022 and January 2023. Not detected.
Ninox strenua	Powerful Owl	V		Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The species requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. It roosts by day in dense vegetation and requires hollows for nesting. The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider (OEH 2018).	54 records within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	MODERATE – suitable foraging habitat across the site. No suitable hollows and therefore no breeding habitat present. Targeted surveys undertaken in August 2019. Nest trees not detected despite targeted survey in 2018 and 2019 and supplementary nest tree census in December 2022 and January 2023. Not detected.
Numenius madascariensis	Eastern Curlew		CE, M	Preferred foraging and roosting habitat are intertidal mudflats, particularly where mangroves are present, and saltmarsh. Intertidal coastal mudflats, coastal lagoons, sandy spits (OEH 2018).	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present within the development footprint
Pandion cristatus	Eastern Osprey	V	M	The species occurs in littoral and coastal habitats and terrestrial wetlands in tropical and temperate Australia, and offshore islands mostly found in coastal regions on cliffs, but also occur along rivers. Feeding requires expansive areas of open fresh, brackish or saline water. Occur sympatrically with the White-bellied Sea-eagle.	7 records within 10 km (BioNet Atlas) Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	KNOWN– Recorded in the study area in 2014 by EMM. Nest trees not detected despite targeted survey in 2018 and 2019 and supplementary nest tree census in December 2022 and January 2023.
Petroica boodang	Scarlet Robin	V		In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs	1 record within 10 km (BioNet Atlas)	LOW – general lack of logs and woody debris. May forage in the site occasionally, though no breeding habitat present

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
				and coarse woody debris are important habitat components.		
Petroica rodinogaster	Pink Robin	V		The Pink Robin is found in Tasmania and the uplands of eastern Victoria and far south-eastern NSW, almost as far north as Bombala. On the mainland, the species disperses north and west and into more open habitats in winter, regularly as far north as the ACT area, and sometimes being found as far north as the central coast of NSW. Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies. Catches prey by the perch-and-pounce method, foraging more on the ground than the more flycatcher-like Rose Robin. Insects and spiders are the main dietary items. Breeds between October and January and can produce two clutches in a season.	4 records within 10 km (BioNet Atlas)	UNLIKELY – no suitable habitat within the site. Diurnal bird surveys were undertaken in September and December 2018, March and August 2019. Not detected.
Pezoporus wallicus wallicus	Eastern Ground Parrot	V		The Ground Parrot occurs in high rainfall coastal and near coastal low heathlands and sedgelands, generally below one metre in height and very dense (up to 90% projected foliage cover). These habitats provide a high abundance and diversity of food, adequate cover and suitable roosting and nesting opportunities for the Ground Parrot, which spends most of its time on or near the ground. When flushed, birds fly strongly and rapidly for up to several hundred metres, at a metre or less above the ground. The coastal and subcoastal heathland and sedgeland habitats of the Ground Parrot are particularly fire-prone. Ground Parrots can re-colonise burnt habitat after 1-2 years and reach maximum densities after 15-20 years without fire.	1 record within 10 km (BioNet Atlas)	MODERATE - suitable habitat present within PCT 1326
Ptilinopus superbus	Superb Fruit-dove	V		Occurs mainly north from NE NSW, much less common further south and largely confined to pockets of habitat south to Moruya. Vagrants occur south to VIC and TAS. Inhabits rainforest and closed forests, may also forage in eucalypt or acacia woodland with fruit-bearing trees. Nests 5-30 m above ground in rainforest/rainforest edge tree and shrub species. Part of the population migratory/nomadic.	1 record within 10 km (BioNet Atlas)	UNLIKELY – no suitable habitat present within the development footprint
Rhipidura ruffifrons	Rufous Fantail		M	The Rufous Fantail is found in northern and eastern coastal Australia, being more common in the north. Found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas.	Predicted within 10 km (PMST)	KNOWN – detected in January 2018 by OMVI Ecological.

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
Rostratula australis	Australian Painted Snipe	V	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. Forages nocturnally on mud-flats and in shallow water (OEH 2018).	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present within the development footprint
Sternula albifrons	Little Tern	E	M	In NSW, it arrives from September to November, occurring mainly north of Sydney, with smaller numbers found south to Victoria. Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers (with occasional offshore islands or coral cay records). Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands.	52 records within 10 km (BioNet Atlas)	UNLIKELY – no suitable habitat present within the development footprint
Thinornis rubricollis rubricollis	Hooded Plover	CE	V	In south-eastern Australia Hooded Plovers prefer sandy ocean beaches, especially those that are broad and flat, with a wide wave-wash zone for feeding, much beachcast seaweed, and backed by sparsely vegetated sand-dunes for shelter and nesting. Occasionally Hooded Plovers are found on tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, and small beaches in lines of cliffs. They regularly use near-coastal saline and freshwater lakes and lagoons, often with saltmarsh. Hooded Plovers forage in sand at all levels of the zone of wave-wash during low and mid-tide or among seaweed at high-tide, and occasionally in dune blowouts after rain. At night they favour the upper zones of beaches for roosting. When on rocks they forage in crevices in the wave-wash or spray zone, avoiding elevated rocky areas and boulder fields. In coastal lagoons they forage in damp or dry substrates and in shallow water, depending on the season and water levels.	24 records within 10 km (BioNet Atlas)Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present within the development footprint. EMM (2015) did detect the species in the dunes adjacent to the site, though species is highly unlikely to enter the site, preferring beaches and dunes.
Tyto tenebricosa	Sooty Owl	V		Occurs in the coastal, escarpment and tablelands regions of NSW. More common in the north and absent from the western tablelands and further west. Inhabits tall, moist eucalypt forests and rainforests, and are strongly associated with sheltered gullies, particularly those with tall rainforest understorey. Roosts in tree hollows, amongst dense foliage in gullies or in caves, recesses or ledges of cliffs or banks. Nest in large (>40 cm wide, 100 cm deep)	22 records within 10 km (BioNet Atlas)	KNOWN – detected by EMM in 2015. Foraging habitat present only within the site. No suitable hollows and therefore no breeding habitat present. Nest trees not detected despite targeted survey in 2018 and 2019 and supplementary nest tree

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
				tree hollows in unlogged/unburnt gullies within 100 m of streams or in caves.		census in December 2022 and January 2023.
Tyto novaehollandiae	Masked Owl	V		This species occurs in dry eucalypt woodlands at altitudes from sea level to 1100 m and roosts and breeds in hollows and sometime caves in moist eucalypt forested gullies. It hunts along the edges of forests and roadsides and has a home range covering between 500 ha and 1000 ha. Prey for this species are principally terrestrial mammals but arboreal species may also be taken (OEH 2018).	13 records within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	MODERATE - suitable habitat present across the site. Foraging habitat present only within the site. No suitable hollows and therefore no breeding habitat present. Targeted diurnal field surveys and spotlighting in August 2019. Nest trees not detected despite targeted survey in 2018 and 2019 and supplementary nest tree census in December 2022 and January 2023. Not detected.
Mammals						
Cercartetus nanus	Eastern Pygmy Possum	V		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. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (Pseudocheirus peregrinus) dreys or thickets of vegetation, (e.g. grass-tree skirts); tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.	Predicted to occur (BAM calculator)	KNOWN- one individual recorded during survey
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern	Predicted within 10 km (PMST)	LOW – no roosting habitat available, though may forage across the site if roosts present elsewhere in the vicinity. Anabat detectors were deployed

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
				Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.		in December 2018. Not detected.
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	2 records within 10 km (BioNet Atlas) Predicted within 10 km (PMST)	MODERATE - suitable foraging habitat present within PCT 1326. No breeding habitat present. Higher quality habitat is present to the west.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy (OEH 2018).	6 records within 10 km (BioNet Atlas)	KNOWN – detected by EMM in 2015.
Isoodon obesulus obesulus	Southern Brown Bandicoot	E	E	The Southern Brown Bandicoot has a patchy distribution. It is found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River, southern coastal Victoria and the Grampian Ranges, south-eastern South Australia, south-west Western Australia and the northern tip of Queensland. Southern Brown Bandicoots are largely crepuscular (active mainly after dusk and/or before dawn). They are generally only found in heath or open forest with a heathy understorey on sandy or friable soils. They feed on a variety of ground-dwelling invertebrates and the fruit-bodies of hypogeous (underground-fruiting) fungi. Their searches for food often create distinctive conical holes in the soil.	Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	UNLIKELY – potential suitable habitat across the site, particularly in areas with a thick understorey, not recorded during targeted surveys in the study area undertaken in December 2018 and no records in the locality.
Kerivoula papuensis	Golden-tipped Bat	V		The Golden-tipped Bat is distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to Bega in southern NSW. It is found in rainforest and adjacent sclerophyll forest. Roost in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests located in rainforest gullies on small first- and second-order streams.	2 records within 10 km ((BioNet Atlas)	UNLIKELY – no suitable foraging or roosting habitat.
Miniopterus australis	Little Bent-winged Bat	V		East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Occurs in 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. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes	Added to the BAM calculator as a predicted threatened species for foraging habitat.	KNOWN – recorded in site

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
				buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. Only five nursery sites /maternity colonies are known in Australia.	No breeding habitat present.	
Miniopterus orianae oceanensis	Large Bent-winged Bat	V		Generally occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only 4 known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill 2008).	8 records within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	KNOWN – detected by EMM in 2015.
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	V		Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Forages in natural and artificial openings in vegetation, typically within a few kilometres of its roost. Roosts primarily in tree hollows but also recorded from man-made structures or under bark (Churchill 2008).	6 records within 10 km (BioNet Atlas)	KNOWN – detected by EMM in 2015 and in current survey
Myotis macropus	Southern Myotis	V		Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in flat/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage, typically in close proximity to water (Campbell 2011). Breeds November or December (Churchill 2008).	9 records within 10 km (BioNet Atlas) Predicted to occur (BAM calculator)	UNLIKELY – no suitable foraging habitat (lack of water bodies) and therefore unlikely to roost within the site (as it is far from resources). Anabat detectors deployed in December 2018 and March 2019. Not detected
Petaurus australis	Yellow-bellied Glider	V		Occurs along the east coast to the western slopes of the Great Dividing Range. Inhabits a variety of forest types but prefers tall mature eucalypt forest with high rainfall and rich soils. Relies on large hollow-bearing trees for shelter and nesting, with family groups of 2-6 typically denning together. In southern NSW its preferred habitat at low altitudes is moist gullies and creek flats in mature coastal forests. Mostly feeds on sap, nectar and honeydew.	19 records within 10 km (BioNet Atlas)	LOW – suitable foraging habitat within remnant forest only, though there is a general lack of hollows and therefore unsuitable sheltering and breeding habitat. Arboreal trapping completed in December 2018. Not detected.
Petaurus norfolcensis	Squirrel Glider	V		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	2 records within 10 km (BioNet Atlas)	LOW – suitable foraging habitat within remnant forest only, though there is a general lack of hollows

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
				with a shrub or Acacia midstorey. Requires abundant tree hollows for refuge and nest sites. Occupies a home range of 3 to 5 hectares (OEH 2018).	Predicted to occur (BAM calculator)	and therefore unsuitable sheltering and breeding habitat. Arboreal trapping completed in December 2018. Not detected.
Petauroides volans	Greater Glider		V	The greater glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevational range from sea level to 1200 m above sea level. It prefers taller montane, moist eucalypt forest with relatively old trees and abundant hollows.	Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	LOW – suitable foraging habitat within remnant forest only, though there is a general lack of hollows and therefore unsuitable sheltering and breeding habitat. Arboreal trapping completed in December 2018. Not detected.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Species prefers rocky escarpments, cliffs and rock ledges	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present
Phascogale tapoatafa	Brush- tailed Phascogale	V		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. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide. Mating occurs May – July.	Predicted to occur (BAM calculator)	MODERATE – suitable foraging and breeding habitat within PCT 1326, though more likely to occur in remnant stands of these vegetation types. Arboreal trapping completed in December 2018. Not detected.
Phascolarctos cinereus	Koala	V	V	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred hectares.	2 records within 10 km (BioNet Atlas) Predicted within 10 km (PMST)	UNLIKELY – low density of suitable feed trees are present within PCT 1326. Not detected on site and no evidence from SAT surveys undertaken in December 2018. Very few nearby records in BioNet. The subject site is not within an Area of Regional Koala Significance. The Koala Likelihood Map v2.0 (Aug 2019) predicts the likelihood of finding a Koala within the study area to be around nil, with

Scientific name	Common Name	BC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the site
						a confidence rating of 'High'.
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	V	V	Restricted to east of the Great Dividing Range, with annual rainfall >760 mm. Inhabits coastal heath and dry and wet sclerophyll forests. Requires relatively thick ground cover and appears restricted to areas of light and sandy soil (Johnston 2008). Feeds on fungi, roots, tubers, insects and their larvae, and other soft-bodied animals in the soil.	17 records within 10 km (BioNet Atlas) Predicted within 10 km (PMST)	MODERATE – suitable habitat across the site, particularly in areas with a thick understorey. Six baited infra-red motion cameras were set up in December 2018. Not detected.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Roosts in camps within 20 km of a regular food source, typically in gullies, close to water and in vegetation with a dense canopy. Forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and street trees, particularly in eucalypts, melaleucas and banksias. Highly mobile with movements largely determined by food availability (Eby and Law 2008). Will also forage in urban gardens and cultivated fruit crops.	20 records within 10 km (BioNet Atlas) Predicted within 10 km (PMST) Predicted to occur (BAM calculator)	HIGH –Suitable foraging habitat present across the site. No camp detected on site.
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species (OEH 2018).	4 records within 10 km (BioNet Atlas)	KNOWN – detected by EMM in 2015.
Reptiles						
Hoplocephalus bungaroides	Broad-headed Snake	E	V	The Broad-headed Snake is restricted to the sandstone ranges in the Sydney Basin and within a radius of approximately 200 km of Sydney. It is often found in rocky outcrops and adjacent sclerophyll forest and woodland. The most suitable sites occur in sandstone ridgetops. Common canopy species include *Corymbia eximia, C. gummifera, Eucalyptus sieberi, E. punctata* and *E. piperita*.	Predicted within 10 km (PMST)	UNLIKELY – no suitable habitat present

Note: Marine and littoral threatened species (particularly shorebirds) which are restricted to coastal or estuarine environments were excluded from the threatened biota table.

Wildlife Atlas records: only records from 1980 or later were considered. All information in this table is taken from NSW OEH and Commonwealth DAWE Threatened Species profiles (DoEE, 2018c; OEH, 2018c) unless otherwise stated. The codes used in this table are: CE – Critically Endangered; E – Endangered; V – Vulnerable; EP – Endangered Population; CEEC – Critically Endangered Ecological Community; EEC – Endangered Ecological Community.

Appendix C

Species recorded within the study area

Table C.1 Flora species recorded in plots

The table below shows the flora species recorded in each plot, along with percentage cover within the plot

Family	Exotic	Scientific Name	Common Name	P1_2021	P2_2021	P3_2021	P4_2021	P5_2021	P6_2021	Q1	Q10	Q11	Q12	Q13	Q2	Q3	Q3_2020	Q4	Q4_2020	Q5	Q6	Q6_2020	Q7	Q7_2020	Q8	Q8_2020	Q9
Adiantaceae		*Pellaea falcata*	Sickle Fern							0.2																	
Alliaceae	*	*Nothoscordum borbonicum*	Onion Weed						0.1																		
Apiaceae		*Centella asiatica*	Indian Pennywort	0.1	1			0.5		0.1		0.2	0.1	0.1	0.1		0.1		2	0.1			0.1	0.1	0.1	0.1	
		Hydrocotyle laxiflora	Stinking Pennywort	0.1																							
		Hydrocotyle tripartita	Pennywort		0.2			2																			
	*	*Hydrocotyle spp.*	0							0.1		0.1	0.1		0.1		0.1		0.1							0.1	
Apocynaceae		*Marsdenia rostrata*	Milk Vine	0.1						0.2						0.1										0.1	
		Parsonsia straminea	Common Silkpod		0.1						0.1	0.1				0.1			0.1					0.1	0.1	0.1	
Araceae	*	*Zantedeschia aethiopica*	Arum Lily							0.1					0.1												
Asparagaceae	*	*Asparagus aethiopicus*	Asparagus Fern																0.1							0.1	
		Asparagus asparagoides	Bridal Creeper							0.1			0.1								0.1						
Asteraceae		*Lagenophora stipitata*	Common Lagenophora									0.1		0.1										0.1		0.1	0.1
		Senecio linearifolius	Fireweed Groundsel	0.1																							
		Sigesbeckia orientalis subsp. orientalis	Indian Weed	0.1																							
		Solenogyne bellioides	Solengyne									0.1															
	*	*Bidens pilosa*	Cobbler's Pegs		0.1											0.1	0.1										
		Cirsium vulgare	Spear Thistle	0.1			0.5										0.1										
		Conyza bonariensis	Flaxleaf Fleabane			0.1																					
		Gamochaeta purpurea	Purple Cudweed				0.2																				
		Gamochaeta spp.	0			0.2			0.1																		
		Hypochaeris glabra	Smooth Catsear			0.1																					
		Hypochaeris radicata	Catsear		0.1		0.5		0.1				0.1										0.1				
		Senecio spp.	Groundsel, Fireweed					0.1																			
		Sonchus oleraceus	Common Sowthistle			0.1	0.1	0.1																			
		Taraxacum officinale	Dandelion				0.5																				
Campanulaceae		*Wahlenbergia gracilis*	Sprawling Bluebell					0.1																			
Casuarinaceae		*Allocasuarina littoralis*	Black She-Oak		25						0.5											0.2					
		Casuarina glauca	Swamp Oak					10						1	20	30		0.1	15	0.1	30		10		10		
Clusiaceae		*Hypericum gramineum*	Small St John's Wort									0.1		0.1													
Commelinaceae		*Commelina cyanea*	Native Wandering Jew	0.1																							
Convolvulaceae		*Convolvulus erubescens*	Pink Bindweed					0.2																			
		Dichondra repens	Kidney Weed	0.1	0.5					0.1		0.1	0.1	0.1	0.1		0.1		10	0.1		0.1	0.1	0.1		0.1	0.1
		Polymeria calycina	0									0.1	0.1	0.1	0.1		0.1		0.1	0.1		0.1	0.1		0.1	1	
Cyperaceae		*Carex appressa*	Tall Sedge					0.2																			
		Carex inversa	Knob Sedge																							0.1	
		Carex longebrachiata	0	0.5	0.5			30		25						15	10		0.1	0.1			0.1	0.5			
		Carex spp.	0									0.1															
		Cyathochaeta diandra	0								0.1				0.1			0.1			0.1						
		Fimbristylis dichotoma	Common Fringe-sedge																							0.1	
		Gahnia aspera	Rough Saw-sedge	0.5	2					75	2		50	0.1	3			0.1	0.1				0.1	0.1	0.2	0.2	20
		Gahnia clarkei	Tall Saw-sedge					5																			
		Gahnia melanocarpa	Black Fruit Saw-sedge								0.5					40	20			25	0.5				0.5		
		Lepidosperma filiforme	0							0.2		0.1						0.1		0.1		0.1				0.1	0.1
		Lepidosperma laterale	Variable Sword-sedge								0.3									0.1		0.2		0.1		1	
		Schoenus brevifolius	0					0.5																			
Dennstaedtiaceae		*Pteridium esculentum*	Bracken	20									0.1			0.1	0.1					0.2					
Dilleniaceae		*Hibbertia aspera*	Rough Guinea Flower								10							0.1					0.1			0.5	0.1
		Hibbertia scandens	Climbing Guinea Flower	40	1					0.1	0.1		0.1		1	0.2	0.5		0.1	0.1							
Ericaceae		*Leucopogon juniperinus*	Prickly Beard-heath								1										0.5					1	0.1

Family	Exotic	Scientific Name	Common Name	P1_2021	P2_2021	P3_2021	P4_2021	P5_2021	P6_2021	Q1	Q10	Q11	Q12	Q13	Q2	Q3	Q3_2020	Q4	Q4_2020	Q5	Q6	Q6_2020	Q7	Q7_2020	Q8	Q8_2020	Q9
		Monotoca scoparia	0									0.1	0.1														
Fabaceae (Caesalpinioideae)	*	*Senna pendula var. glabrata*	0	20	5					0.2					0.2	0.2	0.1		1	0.1	0.1						
Fabaceae (Faboideae)		*Daviesia ulicifolia*	Gorse Bitter Pea																								0.1
		Desmodium gunnii	Slender Tick-trefoil							0.1		0.1		0.1			0.1	0.1	0.1							0.1	
		Glycine clandestina	Twining glycine	0.1																							
		Glycine microphylla	Small-leaf Glycine		0.1						0.1	0.1					0.1		0.1		0.1					0.1	
		Glycine tabacina	Variable Glycine					0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1		0.1			0.1	0.1	0.1	0.1	
		Hardenbergia violacea	False Sarsaparilla														0.1	0.1						0.1		0.1	
		Kennedia rubicunda	Dusky Coral Pea																0.1								
		Pultenaea retusa	0										0.1	0.1													
		Viminaria juncea	Native Broom					0.5																			
	*	*Trifolium repens*	White Clover				0.5	0.2																			
Fabaceae (Mimosoideae)		*Acacia irrorata*	Green Wattle								0.5					5			15	10							
		Acacia longifolia	0								0.1		0.1	0.2			0.1		0.1				0.1		0.5		
		Acacia maidenii	Maiden's Wattle		0.1			5																			
		Acacia mearnsii	Black Wattle	20	5			5																			
		Acacia suaveolens	Sweet Wattle																							0.1	
Gentianaceae	*	*Centaurium erythraea*	Common Centaury			0.2	0.2	0.5	0.1																		
Geraniaceae		*Geranium solanderi*	Native Geranium							0.1				0.1													
Haloragaceae		*Gonocarpus teucrioides*	Germander Raspwort					5				0.1	0.1	0.1	0.1			0.1		0.1	0.1		0.1		0.1		
Iridaceae	*	*Crocosmia spp.*	0			0.2																					
Juncaceae		*Juncus kraussii subsp. australiensis*	Sea Rush					0.1																			
		Juncus usitatus	0							0.1																	0.1
Lamiaceae		*Clerodendrum tomentosum*	Hairy Clerodendrum	0.1												0.1										0.1	
Lauraceae		*Cassytha glabella*	0		0.2						0.1	0.1	0.1	0.1							0.1						
		Cassytha pubescens	Downy Dodder-laurel																0.1								
Lindsaeaceae		*Lindsaea linearis*	Screw Fern											0.1													
Lobeliaceae		*Lobelia anceps*	0					0.1																			
		Lobelia purpurascens	Whiteroot	0.1	0.1			0.5		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1
Lomandraceae		*Lomandra filiformis*	Wattle Matt-rush																			0.1					
		Lomandra longifolia	Spiny-headed Mat-rush	2	75					0.1	1	1	0.2	0.1	5	0.1	0.5	2	0.1	1	3	0.1	0.1	0.1	0.1	5	0.1
		Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush															0.1			0.1			0.1			0.1
Luzuriagaceae		*Eustrephus latifolius*	Wombat Berry										0.1							0.1				0.1			
		Geitonoplesium cymosum	Scrambling Lily	0.1	0.1					0.1							0.1					0.1					
Malvaceae	*	*Sida rhombifolia*	Paddy's Lucerne	0.1																							
Meliaceae		*Synoum glandulosum subsp. glandulosum*	Scentless Rosewood	10	0.5					5			0.2	0.1	0.1	0.1				0.1	0.1				0.1		
Menispermaceae		*Stephania japonica*	Snake vine																	0.1							
Myrsinaceae	*	*Lysimachia arvensis*	Scarlet Pimpernel			0.1	0.2	0.1																			
Myrtaceae		*Acmena smithii*	Lilly Pilly							0.2																	
		Angophora floribunda	Rough-barked Apple								5									10		1					
		Corymbia gummifera	Red Bloodwood																							0.5	
		Eucalyptus botryoides	Bangalay		10					0.5			25		40		30		5			10					1
		Eucalyptus globoidea	White Stringybark							10												0.2		5		20	
		Eucalyptus longifolia	Woollybutt							2								20		30	3	5	0.1	10		5	35
		Eucalyptus paniculata	Grey Ironbark							50	25						15					5		30		10	
		Eucalyptus spp.	0					0.1																			
		Kunzea ambigua	Tick Bush					5			1										30		70		20		
		Leptospermum continentale	Prickly Teatree					0.5																			
		Leptospermum polyanthum	0									0.1															
		Leptospermum polygalifolium	Tantoon											0.2	0.1			0.1	1		15	0.1			30		
		Melaleuca ericifolia	Swamp Paperbark					5				90		95					5								
		Melaleuca hypericifolia	Hillock bush					10													1						
		Melaleuca linariifolia	Flax-leaved Paperbark									0.1	0.1		0.3				0.1			0.1					
		Melaleuca sieberi	0										0.1											0.1	0.2		

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		Syncarpia glomulifera	Turpentine							10																	
Ochnaceae	*	*Ochna serrulata*	Mickey Mouse Plant												0.1												
Oleaceae		*Notelaea longifolia*	Large Mock-olive		0.1					0.1	0.1		0.1								0.1				0.1	0.1	
	*	*Olea europaea subsp. cuspidata*	African Olive																0.1								
Orchidaceae		*Microtis parviflora*	Slender Onion Orchid		0.1																						
		Pterostylis spp.	Greenhood													0.1											
Oxalidaceae		*Oxalis exilis*	0														0.1		0.1							0.1	
		Oxalis perennans	0								0.1	0.1		0.1	0.1					0.1					0.1		
Phormiaceae		*Dianella caerulea*	Blue Flax-lily	0.2	0.2																					0.1	
		Dianella caerulea var. producta	0								0.1	0.5		0.1													
		Dianella revoluta	Blueberry Lily										0.1										0.1				0.1
Phyllanthaceae		*Breynia oblongifolia*	Coffee Bush		0.2					0.1			0.1									0.1					
		Glochidion ferdinandi	Cheese Tree																0.5					0.1		0.1	
Phytolaccaceae	*	*Phytolacca octandra*	Inkweed					0.1																			
Pittosporaceae		*Billardiera scandens*	Hairy Apple Berry		0.1						0.1				0.1		0.1	0.1	0.1	0.1	0.1					0.1	0.1
		Pittosporum revolutum	Rough Fruit Pittosporum							0.1	0.5													0.1			
		Pittosporum undulatum	Sweet Pittosporum		0.1								0.1					0.1		0.1			0.1				0.1
Plantaginaceae		*Veronica plebeia*	Trailing Speedwell							0.1		0.1					0.1		0.1								
	*	*Plantago lanceolata*	Lamb's Tongues			0.1	0.2		0.2																		
Poaceae		*Anisopogon avenaceus*	Oat Speargrass								5			0.1				40		0.1	0.5			1	10	15	15
		Aristida vagans	Threeawn Speargrass															0.1									
		Cymbopogon refractus	Barbed Wire Grass									0.2															
		Cynodon dactylon	Common Couch				0.1																		10		
		Echinopogon caespitosus	Bushy Hedgehog-grass	0.1																							
		Echinopogon ovatus	Forest Hedgehog Grass		0.5																						
		Entolasia marginata	Bordered Panic					0.5				1	0.1	0.1	0.1	0.1	0.1		20		5	0.1	0.1	0.1	0.2		
		Entolasia stricta	Wiry Panic	20	5						10	40	0.1	0.1		0.1	0.1	0.1	5	1	10		0.2	0.1	15	5	0.1
		Eragrostis brownii	Brown's Lovegrass									0.1		0.1				0.1									
		Imperata cylindrica	Blady Grass	2	0.5						0.1	10	50	40	0.1		0.2	0.2	10		0.3	0.2	0.1	1	0.1		
		Microlaena stipoides	Weeping Grass	40	5			20																			
		Microlaena stipoides var. stipoides	Weeping Grass							0.1	0.3	5		0.1	40		0.1		20	40			0.2	0.1	10	1	0.1
		Oplismenus aemulus	0							0.1		0.1	0.1		0.5	25	0.1			10						0.1	
		Oplismenus imbecillis	0	5	2																						
		Panicum simile	Two-colour Panic											0.1									0.1	0.1			0.2
		Sporobolus creber	Slender Rat's Tail Grass				0.2																				
		Themeda australis	0									5						0.1			5						
	*	*Andropogon virginicus*	Whisky Grass				0.2																		0.1		
		Anthoxanthum odoratum	Sweet Vernal Grass			0.2		0.5																			
		Briza minor	Shivery Grass			0.2																					
		Briza subaristata	0				0.5																				
		Bromus diandrus	Great Brome				0.2																				
		Lolium perenne	Perennial Ryegrass			0.1																					
		Nassella neesiana	Chilean Needle Grass					0.2																			
		Paspalum dilatatum	Paspalum			0.5			0.2																		
		Pennisetum clandestinum	Kikuyu Grass			80	50		80																		
		Setaria pumila	Pale Pigeon Grass												0.1												
		Stenotaphrum secundatum	Buffalo Grass				10		20																		
Proteaceae		*Banksia integrifolia*	Coast Banksia		0.5														0.5								
		Banksia serrata	Old-man Banksia									0.1	0.1	0.1													
		Hakea dactyloides	Finger Hakea		0.5			0.1					5	0.5							0.2		0.2				
		Hakea salicifolia subsp. salicifolia	0																0.5								
		Hakea teretifolia	Needlebush																						0.1		
Ranunculaceae		*Clematis aristata*	Old Man's Beard														0.1										
		Ranunculus spp.	0									0.1															

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	*	*Ranunculus repens*	Creeping Buttercup		0.1			0.5									0.1										
Rosaceae		*Rubus parvifolius*	Native Raspberry																								
	*	*Rubus fruticosus sp. agg.*	Blackberry complex				0.5																				
Rubiaceae		*Morinda jasminoides*	Sweet Morinda													0.1				0.1			0.1				
		Opercularia diphylla	Stinkweed											0.1				0.1									0.1
	*	*Galium spp.*	0												0.1	0.1											
Sapindaceae		*Dodonaea triquetra*	Large-leaf Hop-bush															0.1			0.1						0.1
Solanaceae		*Solanum prinophyllum*	Forest Nightshade	0.1											0.1	0.1	0.1										
	*	*Solanum mauritianum*	Wild Tobacco Bush					0.1																			
		Solanum nigrum	Black-berry Nightshade												0.1				0.1								
Ulmaceae		*Trema tomentosa var. aspera*	Native Peach												0.1												
Verbenaceae	*	*Lantana camara*	Lantana	20	0.5								0.1			0.1			0.1								
		Verbena bonariensis	Purpletop			2	0.1																				
Violaceae		*Viola hederacea*	Ivy-leaved Violet	0.1	5							0.1				0.1	0.1		3								
Vitaceae		*Cissus hypoglauca*	Giant Water Vine	0.2																							
		Sisyrinchium rosulatum				0.1	0.2		0.1																		

Fauna species recorded within the study area

Class	Family	Scientific Name	Common Name	BC Act Status	EPBC Act Status	EMM 2014	Current study (GHD and OMVI Ecological)
Amphibia	Hylidae	*Litoria nudidigita*	Leaf Green River Tree Frog				O
Amphibia	Hylidae	*Litoria peronii*	Peron's Tree Frog				O
Amphibia	Hylidae	*Litoria verreauxii*	Verreaux's Frog				O
Amphibia	Myobatrachidae	*Limnodynastes peronii*	Brown-striped Frog				O
Amphibia	Myobatrachidae	*Paracrinia haswelli*	Haswell's Froglet				O
Aves	Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill				O
Aves	Acanthizidae	*Acanthiza lineata*	Striated Thornbill				O
Aves	Acanthizidae	*Acanthiza nana*	Yellow Thornbill				O
Aves	Acanthizidae	*Acanthiza pusilla*	Brown Thornbill				W
Aves	Acanthizidae	*Gerygone mouki*	Brown Gerygone				W
Aves	Acanthizidae	*Gerygone olivacea*	White-throated Gerygone				O
Aves	Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren				O
Aves	Accipitridae	*Accipiter fasciatus*	Brown Goshawk				O
Aves	Accipitridae	*Accipiter novaehollandiae*	Grey Goshawk				O
Aves	Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V		Present	O
Aves	Accipitridae	*Pandion cristatus*	Eastern Osprey	V	M	Present	
Aves	Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra				O,W
Aves	Alcedinidae	*Todiramphus sanctus*	Sacred Kingfisher				W
Aves	Anatidae	*Anas castanea*	Chestnut Teal				O
Aves	Anatidae	*Anas superciliosa*	Pacific Black Duck				O
Aves	Apodidae	*Hirundapus caudacutus*	White-throated Needletail		C,J,K		Observed, eastern boundary
Aves	Ardeidae	*Nycticorax caledonicus*	Nankeen Night Heron				O
Aves	Artamidae	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	V			Observed, eastern boundary

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Aves	Artamidae	*Cracticus quoyi*	Black Butcherbird				O
Aves	Artamidae	*Cracticus tibicen*	Australian Magpie				O,W
Aves	Artamidae	*Cracticus torquatus*	Grey Butcherbird				W
Aves	Artamidae	*Strepera graculina*	Pied Currawong				O
Aves	Cacatuidae	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V		Present	O
Aves	Cacatuidae	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo				O,W
Aves	Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V		Present	O
Aves	Cacatuidae	*Eolophus roseicapillus*	Galah				W
Aves	Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike				O
Aves	Campephagidae	*Coracina tenuirostris*	Cicadabird				O,W
Aves	Charadriidae	*Thinornis rubricollis*	Hooded Plover	E4A	V	Recorded, dunes to east	
Aves	Climacteridae	*Climacteris erythrops*	Red-browed Treecreeper				O
Aves	Climacteridae	*Cormobates leucophaea*	White-throated Treecreeper				O,W
Aves	Columbidae	*Leucosarcia melanoleuca*	Wonga Pigeon				O
Aves	Columbidae	*Macropygia amboinensis*	Brown Cuckoo-Dove				O
Aves	Columbidae	*Ocyphaps lophotes*	Crested Pigeon				W
Aves	Columbidae	*Phaps chalcoptera*	Common Bronzewing				O,W
Aves	Coraciidae	*Eurystomus orientalis*	Dollarbird				O
Aves	Corvidae	*Corvus coronoides*	Australian Raven				O
Aves	Cuculidae	*Chalcites basalis*	Horsfield's Bronze-Cuckoo				O,W
Aves	Cuculidae	*Eudynamys orientalis*	Eastern Koel				O
Aves	Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo				O
Aves	Estrildidae	*Neochmia temporalis*	Red-browed Finch				O,W
Aves	Haematopodidae	*Haematopus fuliginosus*	Sooty Oystercatcher	V		Recorded, dunes to east	

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Aves	Haematopodidae	*Haematopus longirostris*	Pied Oystercatcher	E1		Recorded, dunes to east	
Aves	Hirundinidae	*Hirundo neoxena*	Welcome Swallow				O
Aves	Maluridae	*Malurus cyaneus*	Superb Fairy-wren				O,W
Aves	Megaluridae	*Cincloramphus mathewsi*	Rufous Songlark				O,W
Aves	Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill				O,W
Aves	Meliphagidae	*Anthochaera carunculata*	Red Wattlebird				O,W
Aves	Meliphagidae	*Anthochaera chrysoptera*	Little Wattlebird				O,W
Aves	Meliphagidae	*Caligavis chrysops*	Yellow-faced Honeyeater				W
Aves	Meliphagidae	*Lichmera indistincta*	Brown Honeyeater				O
Aves	Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater				O
Aves	Meliphagidae	*Melithreptus brevirostris*	Brown-headed honeyeater				O
Aves	Meliphagidae	*Melithreptus lunatus*	White-naped Honeyeater				O
Aves	Meliphagidae	*Philemon corniculatus*	Noisy Friarbird				O,W
Aves	Meliphagidae	*Phylidonyris niger*	White-Cheeked Honeyeater				O
Aves	Meliphagidae	*Phylidonyris novaehollandiae*	New Holland Honeyeater				O,W
Aves	Monarchidae	*Grallina cyanoleuca*	Magpie-lark				W
Aves	Monarchidae	*Myiagra cyanoleuca*	Satin Flycatcher		Bonn		O
Aves	Monarchidae	*Myiagra rubecula*	Leaden Flycatcher				W
Aves	Monarchidae	*Monarcha melanopsis*	Black-faced Monarch		Bonn		O
Aves	Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird				W
Aves	Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V			O
Aves	Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-Thrush				O,W
Aves	Pachycephalidae	*Falcunculus frontatus frontatus*	Eastern Shrike-tit				O
Aves	Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler				O,W
Aves	Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler				O,W

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Aves	Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote				W
Aves	Pardalotidae	*Pardalotus striatus*	Striated Pardalote				O
Aves	Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin				O
Aves	Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant				O
Aves	Phasianidae	*Coturnix ypsilophora*	Brown Quail				O
Aves	Psittacidae	*Alisterus scapularis*	Australian King-Parrot				O,W
Aves	Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V		Present	W
Aves	Psittacidae	*Platycercus elegans*	Crimson Rosella				O,W
Aves	Psittacidae	*Platycercus eximius*	Eastern Rosella				O,W
Aves	Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet				O,W
Aves	Psophodidae	*Psophodes olivaceus*	Eastern Whipbird				O,W
Aves	Ptilonorhynchidae	*Ptilonorhynchus violaceus*	Satin Bowerbird				O
Aves	Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail				O
Aves	Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail		Bonn		O
Aves	Strigidae	*Ninox novaeseelandiae*	Southern Boobook				O
Aves	Timaliidae	*Zosterops lateralis*	Silvereye				O,W
Aves	Turdidae	*Zoothera lunulata*	Bassian Thrush				O,W
Aves	Tytonidae	*Tyto javanica*	Eastern Barn Owl				O
Aves	Tytonidae	*Tyto tenebricosa*	Sooty Owl	V		Heard, northern boundary	
Mammalia	Burramyidae	*Cercartetus nanus*	Eastern Pygmy-possum	V			Tr
Mammalia	Dasyuridae	*Antechinus agilis*	Agile Antechinus				O
Mammalia	Dasyuridae	*Antechinus stuartii*	Brown Antechinus				O
Mammalia	Dasyuridae	*Antechinus swainsonii*	Dusky Antechinus				O
Mammalia	Leporidae	*Oryctolagus cuniculus*	Rabbit				O
Mammalia	Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo				O

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Mammalia	Macropodidae	*Macropus rufogriseus*	Red-necked Wallaby				O
Mammalia	Macropodidae	*Wallabia bicolor*	Swamp Wallaby				O,W
Mammalia	Molossidae	*Austronomus australis*	White-striped Freetail-bat				D
Mammalia	Molossidae	*Micronomus norfolkensis*	Eastern Coastal Free-tailed Bat	V		ERM 2004 record	D
Mammalia	Molossidae	*Mormopterus ridei*	Eastern Free-tailed Bat				D
Mammalia	Muridae	*Rattus fuscipes*	Bush Rat				O
Mammalia	Muridae	*Rattus rattus*	Black Rat				O
Mammalia	Peramelidae	*Perameles nasuta*	Long-nosed Bandicoot				Tr
Mammalia	Petauridae	*Petaurus breviceps*	Sugar Glider				O
Mammalia	Phalangeridae	*Trichosurus* sp.	Brushtail possum				Tr
Mammalia	Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum				O
Mammalia	Rhinolophidae	*Rhinolophus megaphyllus*	Eastern Horseshoe-bat				D
Mammalia	Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna				O
Mammalia	Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat				D
Mammalia	Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat				Pr
Mammalia	Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V		Present	
Mammalia	Vespertilionidae	*Miniopterus australis*	Little Bent-winged Bat	V		Present	D
Mammalia	Vespertilionidae	*Miniopterus orianae oceanensis*	Large Bent-winged Bat	V		Present	Pr
Mammalia	Vespertilionidae	*Myotis macropus/ Nyctophilus* sp.	Southern Myotis / a long-eared bat	V			SG
Mammalia	Vespertilionidae	*Nyctophilus geoffroyi/ gouldi*	Lesser Long-eared Bat/ Gould's Long-eared Bat				SG
Mammalia	Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V		Present	
Mammalia	Vespertilionidae	*Scoteanax rueppellii/ Scotorepens orion/ Falsistrellus tasmaniensis*	Greater Broad-nosed Bat/ Eastern Broad-nosed Bat/ Eastern False Pipistrelle	V			SG
Mammalia	Vespertilionidae	*Vespadelus darlingtoni*	Large Forest Bat				D
Mammalia	Vespertilionidae	*Vespadelus pumilus*	Eastern Forest Bat				D

Class	Family	Scientific Name	Common Name	BC Act Status	EPBC Act Status	EMM 2014	Current study (GHD and OMVI Ecological)
Mammalia	Vespertilionidae	Vespadelus regulus	Southern Forest Bat				Pr
Mammalia	Vespertilionidae	*Vespadelus vulturnus/pumilus /Chalinolobus morio*	Little Forest Bat/ Eastern Forest Bat/ Chocolate Wattled Bat				SG
Reptilia	Agamidae	*Amphibolurus muricatus*	Jacky lizard				O
Reptilia	Elapidae	*Cryptophis nigrescens*	Eastern Small-eyed Snake				O
Reptilia	Elapidae	*Pseudechis porphyriacus*	Red-bellied Black Snake				O
Reptilia	Varanidae	*Varanus varius*	Lace Monitor				O

Status key: Migratory - Bonn, C, J, K, Vulnerabe – V, Endangered - E1, E, Critically endangered - E4A, CE

Observation key: O – Observed, W – Heard, Tr – Trapped, D - Definite (anabat), Pr - Probable (anabat), SG - Species Group (Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species)

Status: BC Act = Biodiversity Conservation Act 2016; EPBC Act = Environment Protection and Biodiversity Conservation Act 1999

Appendix D

Vegetation integrity plot data

Table D.2 Vegetation integrity plot data for plots sampled within the development footprint

				Composition						Structure						Function														
Veg zone	PCT	Condition	Plot	TG	SG	GG	FG	EG	OG	TG	SG	GG	FG	EG	OG	Large trees	Hollow trees	Litter cover (%)	Fallen logs (m)	Tree regen	Tree DBH 5-10 (cm)	Tree DBH 10-20 (cm)	Tree DBH 20-30 (cm)	Tree DBH 30-50 (cm)	Tree DBH 50-80 (cm)	HTE cover (total)	Zone	Easting	Northing	Bearing
			Benchmark	**9**	**15**	**6**	**8**	**5**	**12**	**69**	**50**	**7**	**4**	**15**	**21**	**3**		**72.0**	**15.0**											
2	694	Good	P2_2021	5	5	8	7	0	6	35.7	6.3	90.5	7.1	0.0	1.6	2	1	8.0	56.0	0	0	1	1	1	1	5.8	56	274036	6096171	97
			Q3 (2020)	2	2	8	9	1	8	45.0	0.2	31.1	0.9	0.1	1.2	3	0	62.0	49.8	1	1	1	1	1	1	0.2	56	274200	6095910	90
			Benchmark	**9**	**15**	**6**	**8**	**5**	**12**	**69**	**50**	**7**	**4**	**15**	**21**	**3**		**72.0**	**15.0**											
3	694	Poor	P1_2021	1	2	8	10	1	5	0.1	30.0	70.1	1.1	20.0	40.5	0	1	10.0	54.0	0	0	1	1	0	0	40.2	56	273964	6096004	66
			P9_2023	3	6	14	8	1	6	40.7	16.2	7.5	1.4	0.2	0.9	0	0	53.0	14.0	1	1	1	1	1	0	90.4	56	274268.4	6096148.894	274
			Benchmark	**4**	**9**	**8**	**6**	**2**	**5**	**26**	**19**	**52**	**3**	**2**	**3**	**5**		**44.0**	**44.0**											
4	1231	Moderate	Q4_2020	4	6	7	8	0	7	21.0	21.7	55.3	15.5	0.0	0.7	1	0	67.0	142.0	1	1	1	1	1	1	1.3	56	274327	6095896	279
			P8_2023	2	8	13	5	0	4	30.0	62.6	30.1	0.8	0.0	0.8	0	0	34.0	5.0	1	1	1	1	1	0	0.0	56	274369.9	6095853.304	105
			Benchmark	**4**	**9**	**8**	**6**	**2**	**5**	**26**	**19**	**52**	**3**	**2**	**3**	**5**		**44.0**	**44.0**											
5	1232	Moderate	Q3_2021	2	6	6	6	1	6	26	11.6	70.4	4.6	5	2	0	1	47.0	17.0	1	1	1	1	1	0	2.0	56	274099	6096078	183
			Benchmark	**4**	**8**	**8**	**8**	**2**	**4**	**21**	**21**	**69**	**3**	**1**	**1**	**1**		**40.0**	**12**											
6	1236	Moderate	Q6_2021	3	11	8	2	0	5	6.2	52.6	29.5	0.2	0	3.4	0	0	19.0	0.0	1	0	0	0	0	0	0.0	56	274421	6096182	275
			Q7_2021	3	6	6	4	0	3	2.1	39	5	0.5	0	0.6	0	0	19.0	0.0	0	0	0	1	1	0	0.0	56	274453	6096273	100
			Q8_2021	3	6	8	2	0	2	13	20.1	45.7	0.3	0	2.2	0	0	19.0	0.0	0	0	1	1	1	0	0.0	56	274497	6096357	17
			P5_2021	3	7	6	6	0	2	15.1	26.1	55.8	3.3	0.0	0.3	0	0	9.2	34.0	1	1	1	0	0	0	2.3	56	274525	6096180	153
			Benchmark	**5**	**8**	**12**	**14**	**2**	**4**	**52**	**15**	**59**	**9**	**1**	**4**	**3**		**40.0**	**4**											
7	1326	Moderate	Q5_2021	3	7	9	6	0	7	41	10.2	58.6	0.8	0	3.2	0	0	59.0	3.0	1	1	1	1	1	0	0.2	56	274182	6096206	115
			Benchmark	n/a																										
		Non-native	P6_2021	0	0	2	0	0	0	0.0	0.0	0.3	0.0	0.0	0.0	0	0	3.8	0.0	1	0	0	0	0	0	64.6	56	274557	6096268	64
			P4_2021	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	2.6	0.0	0	0	0	0	0	0	100.9	56	274408	6095833	262

*TG=Tree; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other; HTE=High Threat Exotic

Vegetation integrity plot data for plots sampled in the conservation lot

				Composition						Structure						Function													
Veg zone	PCT	Condition	Plot	TG	SG	GG	FG	EG	OG	TG	SG	GG	FG	EG	OG	Large trees	Hollow trees	Litter cover (%)	Fallen logs (m)	Tree regen	Tree DBH 5-10 (cm)	Tree DBH 10-20 (cm)	Tree DBH 20-30 (cm)	Tree DBH 30-50 (cm)	Tree DBH 50-80 (cm)	HTE cover (total)	Zone	Easting	Northing	Bearing
			Benchmark	**7**	**11**	**6**	**8**	**2**	**9**	**51**	**26**	**30**	**5**	**19**	**10**	**3**		**65.0**	**45.0**											
1	659	Good	P10_2023	2	3	12	11	1	6	20.2	5.7	67.2	3.7	0.1	5.5	3	1	52.0	24.0	1	0	0	0	1	1	0.3	56	275068	6096232	40
			Benchmark	**9**	**15**	**6**	**8**	**5**	**12**	**69**	**50**	**7**	**4**	**15**	**21**	**3**		**72.0**	**15.0**											
2	694	Moderate	Q6 (2020)	6	3	6	2	1	2	21.4	0.3	0.9	0.2	0.2	0.2	5	0	36.0	14.0	1	1	1	1	1	1	0	56	274200	6096486	235
			Benchmark	**5**	**8**	**12**	**14**	**2**	**4**	**52**	**15**	**59**	**9**	**1**	**4**	**3**		**40.0**	**4.0**											
7	1326	Moderate	Q7 (2021b)	5	5	9	4	0	4	52	7.4	16.1	0.4	0	2.3	0	0	83.0	0	1	1	1	1	1	0	0	56	274311	6096428	180
			Q8 (2021b)	6	4	6	7	0	2	33.2	0.9	7.4	0.9	0	0.3	0	0	76.0	42	1	1	1	1	1	0	0	56	274053	6096467	192
			Q9_2021	2	5	8	5	0	1	32	15.3	27.1	0.6	0	0.2	0	0	36.0	0	1	1	1	1	0	0	0	56	274352	6096354	267
			Q4_2021	3	6	6	5	0	3	18	8.2	7.5	0.9	0	2.4	0	0	64.0	11.0	1	1	1	1	0	0	0	56	274319	6096259	104
			Q10_2021	4	9	7	3	0	3	31.2	9.1	14.6	0.8	0	0.4	0	0	85.0	0	1	1	1	1	1	0	0	56	274163	6096438	196
			Benchmark	**5**	**8**	**12**	**14**	**2**	**4**	**52**	**15**	**59**	**9**	**1**	**4**	**3**		**40.0**	**4**											
8	1326	Poor	P7_2023	3	8	12	9	0	1	37.0	9.1	15.5	1.1	0.0	0.1	0	0	39.0	5.5	1	1	1	1	1	0	30.2	56	274124.7	6096342.017	79
			Benchmark	n/a																										
		Non-native	P3_2021	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	1.4	0.0	0	0	0	0	0	0	84.2	56	274186	6096336	71

*TG=Tree; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other; HTE=High Threat Exotic

Appendix E

Threatened orchid habitat assessment report – preliminary species expert advice

ecoplanning
ecology | planning | offsets

Ben Harrington
Technical Director Biodiversity
GHD
Level 15 / 133 Castlereagh St.
Sydney NSW 2000
Supplied by email

5 October 2023

Re: Habitat assessment report – preliminary species expert advice, Inyadda Dr (Lot 106 // DP 755923 and Lot 2 // DP 1161638), Manyana, NSW

Dear Ben,

This letter has been prepared to document the results of a literature review and site inspection of the property at Lot 106 // DP 755923 and Lot 2 // DP 1161638, Inyadda Dr, Manyana, NSW (**Figure 2**; the 'study area'). The purpose of the literature review and site inspection was to determine the extent and quality of potential habitat for two orchid species, *Caladenia tessellata* and *Pterostylis ventricosa*. The findings of the literature review and site inspection are attached to this letter (**Attachment A**) and are intended to support inputs to a Biodiversity Development Assessment Report (BDAR) being prepared for a proposed residential subdivision within the study area.

If you have any queries regarding the attached information, please do not hesitate to contact me.

Yours sincerely,

B. J. Towle

Brian Towle

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ATTACHMENT A

Introduction

This habitat assessment report has been prepared for GHD Pty Ltd, on behalf of Heir Asquith Pty Ltd, to inform a Biodiversity Development Assessment Report (BDAR) being prepared for a proposed residential subdivision at Lot 106 // DP 755923 and Lot 2 // DP 1161638, Inyadda Dr, Manyana, NSW (**Figure 2**; the 'study area'). For the purposes of this report, 'study area' refers to the entirety of Lot 106 // DP 755923 and Lot 2 // DP 1161638, while 'subject land' refers to the development footprint for the proposed residential subdivision (**Figure 2**). Specifically, this report aims to identify the extent and quality of potential habitat for two orchid species, *Caladenia tessellata* and *Pterostylis ventricosa* within the study area. The information presented within this report is to inform future targeted surveys, or preparation of an expert report, in accordance with the NSW Biodiversity Assessment Method (BAM; DPIE 2020a).

Under Section 5.3 of the BAM an expert report can be used instead of a targeted survey to determine whether a species is present or not present on the subject land. An expert report can only be prepared by a person who, in the opinion of the Secretary of the Department or anyone authorised by the Secretary, has specialised knowledge, which may be based on training, study or experience, to provide an expert opinion regarding the threatened species to which the report relates. This preliminary advice has been prepared by Brian Towle, an accredited species expert in accordance with the BAM for both *Caladenia tessellata* and *Pterostylis ventricosa* (full curriculum vitae provided in **Attachment 2**). While this preliminary advice does not represent an 'expert report' in accordance with the minimum requirements of Section 5.3 of the BAM, this advice aims to justify the likelihood of occurrence of the species within the subject land and estimate the area of potential habitat on the subject land.

Methods

This report has been prepared based upon available information pertaining to the two subject species and their habitats, including the following:

- Published literature which is cited throughout this document.
- Vegetation mapping for the subject land prepared by GHD.
- A review of habitat data and associated vegetation communities held within the BioNet database including the BioNet Threatened Biodiversity Data Collection (TBDC; DPE 2023a), 'as-held' records from the BioNet Atlas provided by DPE on the 23 February 2023 (DPE 2023b), and information on Plant Community Types (PCT) held within the BioNet Vegetation Classification database (DPE 2023c).
- Vegetation mapping across the range of the two subject species, specifically the NSW State Type Vegetation Map ('STVM', DPE 2022).
- My experience and knowledge in undertaking targeted surveys and habitat assessments for the two subject species.

Inspections of the study area were completed on 17 and 18 April 2023 and on 3 and 4 October 2023. The purpose of these inspections was to enable a comparison of habitat within the study

area and known habitat for the subject species. During these inspections the vegetation mapping and PCT allocation of GHD was broadly assessed which involved comparing the dominant flora species, vegetation structure, landscape position and soil types across the subject land with that described for relevant PCTs.

Concurrent with the habitat assessment, the author participated in targeted surveys for *P. ventricosa* (April 2023) and *Caladenia tessellata* (October 2023) across areas of potential habitat (associated PCTs) for the species within the subject land, as well as adjoining areas of non-associated PCTs. These targeted surveys were undertaken in accordance with the relevant survey guidelines (DPIE 2020b) including undertaking the surveys during the flowering period of the species as confirmed by visiting reference populations at Falls Creek (*P. ventricosa*) and Sassafras (*C. tessellata*). The targeted surveys involved parallel traverses across the area of potential habitat, with transects generally separated by approximately 5 m. In accordance with the guidelines, transects spacing was increased up to 10 m in areas of open habitat and targeted surveys were not completed in areas of unsuitable habitat, including areas with surface water, dumped fill and dense weed infestations.

Results - habitat assessments

Results of the habitat assessments and literature reviews are presented separately for the two subject species.

Caladenia tessellata

Caladenia tessellata is a terrestrial orchid with a restricted distribution in New South Wales and Victoria. It is listed as endangered under Part 2 of Schedule 1 of the NSW *Biodiversity Conservation Act 2016* (BC Act) and vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The historic range of this species extends south from the Central Coast of NSW to southern Victoria (Backhouse 2018), noting that there is some uncertainty about the species limit within parts of Victoria due to incomplete speciation or hybridization with *C. cardiochila* (VicFlora 2020). Across its range the species is identified as usually occurring at low altitudes near the coast but extending well inland in southern NSW (Backhouse 2018). There are historic records of the species from Queanbeyan (1942) and Orange (1928), however, these plants have not been seen for many decades with no recent records of the species in proximity to these locations. Similarly, several old records of *C. tessellata* (including the type location) are from areas of Sydney (e.g., Hunters Hill, Sutherland, Como) which have been heavily modified by urban development such that suitable habitat is no longer present at these locations.

The BioNet TBDC (DPE 2023a), the database which informs the BAM and the BAM credit calculator, identifies 13 PCTs with which the species is associated (**Table 1**). While most of the PCTs listed under the TBDC as being associated with habitat for *C. tessellata* correlate well with known habitat, some are unlikely to represent habitat for the species as they occur outside the known distribution and altitudinal range of the species. For example, the grassland 'Plains grass; Purple wiregrass; Wallaby Grass grassland on basalt soils of the Merriwa plateau' (PCT 1698) would appear to be distributed entirely out of the known range of *C. tessellata*.

There are two recent documents that detail known occurrences of *C. tessellata* and its habitat associations: a review by the NSW Scientific Committee (2008); and the national recovery plan prepared by Duncan (2010). From these documents and 'as-held' BioNet Atlas data provided by DPE on the 23 February 2023 (DPE 2023b) a total of ten extant or recently observed (post 1990) populations of the species from NSW are identified (**Table 2**). Habitat for *C. tessellata*, as determined from recently (post-1990) observed populations or extant occurrences of the species, is variable across its range. Records of the species in the southern portions of its range (Victoria) are from coastal areas including heathlands, heathy woodlands, and open forests (Backhouse and Jeanes 1995; Duncan 2010; Backhouse 2018). In NSW known habitat ranges from coastal heathlands to tableland dry sclerophyll forests. A summary of habitats at each of the extant or recently observed populations is included within **Table 2**.

Table 1: Vegetation associations of *Caladenia tessellata* from the TBDC (2023a)*

Vegetation formation	Vegetation class	Approved PCTs including revised eastern NSW PCTs (DPE 2023a)	Legacy PCTs including decommissioned eastern NSW PCTs (DPE 2023a)
Grassy Woodlands	Southern Tablelands Grassy Woodlands	731: Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion	731: Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion
		1330: Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion	1330: Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion
Grasslands	Maritime Grasslands	3407: Central Headland Grassland	897: Kangaroo Grass sod tussock grassland of coastal areas of the Sydney Basin Bioregion 898: Coastal headland grassland 1653: Coast Tea Tree - Coast Banksia - Ficinia nodosa low open shrubland on coastal foredunes 1697: Kangaroo Grass - Coastal Rosemary grassland on coastal headlands 1817: Coastal headland clay heath
	Western Slopes Grasslands	1698: Plains grass; Purple wiregrass; Wallaby Grass grassland on basalt soils of the Merriwa plateau	1698: Plains grass; Purple wiregrass; Wallaby Grass grassland on basalt soils of the Merriwa plateau
Heathlands	Coastal Headland Heaths	3789: Coastal Headland Clay Heath	1652: Camfield's Stringybark - Narrow-leaved Stringybark heathy woodland on lowlands of the Central Coast 1697: Kangaroo Grass - Coastal Rosemary grassland on coastal headlands

Vegetation formation	Vegetation class	Approved PCTs including revised eastern NSW PCTs (DPE 2023a)	Legacy PCTs including decommissioned eastern NSW PCTs (DPE 2023a)
			1701: Prickly-leaved Paperbark - Fern-leaved Banksia heath on coastal headlands of Central Coast
		3793: Hunter Coast Headland Clay Heath	1700: Dwarf Casuarina - Prickly-leaved Paperbark - Hairpin Banksia Coastal Heath of the Central Coast and lower North Coast 1701: Prickly-leaved Paperbark - Fern-leaved Banksia heath on coastal headlands of Central Coast
	Sydney Montane Heaths	3861: Morton Plateau Rocky Heath-Woodland	662: Banksia - Red Bloodwood - Hard-leaved Scribbly Gum heathy open woodland on sandstone plateaux, southern Sydney Basin Bioregion 844: Fringe Myrtle - Blue Mountains Mallee Ash heath on skeletal sandstone plateaux of Morton NP, southern Sydney Basin Bioregion 1152: Silvertop Ash - Hard-leaved Scribbly Gum - Blue-leaved Stringybark heathy woodland on sandstone plateaux, southern Sydney Basin Bioregion
DSF (Shrubby sub-formation)	Coastal Dune Dry Sclerophyll Forests	3545: Coastal Sands Bloodwood Low Forest	1644: Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast 1775: Coastal sand Apple-Bloodwood forest
	Southern Tableland DSF	1093: Red Stringybark - Brittle Gum - Inland Scribbly Gum dry open forest of the tablelands, South Eastern Highlands Bioregion	1093: Red Stringybark - Brittle Gum - Inland Scribbly Gum dry open forest of the tablelands, South Eastern Highlands Bioregion

Vegetation formation	Vegetation class	Approved PCTs including revised eastern NSW PCTs (DPE 2023a)	Legacy PCTs including decommissioned eastern NSW PCTs (DPE 2023a)
	South Coast Sands DSF	3638: South Coast Sands Bangalay Forest	659: Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion 1793: Coastal Sand Bangalay Forest
Grassy Woodlands	Coastal Valley Grassy Woodlands	1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter
		1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter
	Subalpine Woodlands	1191: Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion	1191: Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion

* Data accessed 10 July 2023; DSF = Dry Sclerophyll Forest

Table 2: Extant or recent (post 1990) recorded populations of *C. tessellata* in NSW and habitat (STVM, DPE 2022)

Population	Population size and current status	Mapped PCT (SVTM, DPE 2022)
Morton National Park	An extant population monitored as part of the ongoing SOS program.	3861: Morton Plateau Rocky Heath-Woodland 3949: Southern Highlands Sand Swamp Sedgeland 3809: Shoalhaven Rockplate Heath
Braidwood (private property)	An extant population monitored as part of the ongoing SOS program.	3744: Palerang Hills Peppermint Dry Shrub Forest
Nadgee National Park	An extant population first discovered in spring 2020.	3816: Far Southeast Coastal Lowland Heath
Ulladulla	A small extant population (four individuals) found at Ulladulla (approximately 1 km from the South Pacific Heathland Reserve) in September 2021.	3588: Shoalhaven Foothills Bloodwood Heathy Forest
Munmorah State Recreation Area	Two sub-populations have been recorded including approximately 30 plants from Frazers Park last seen in 1997 and approximately 20 plants reported from 'Above Little Bumpy Headland' and 'Above Big Bumpy Headland'. Plants within these sub-populations have not been seen since the 1990's despite regular searches.	4006: Northern Paperbark-Swamp Mahogany Saw-sedge Forest 3793: Hunter Coast Headland Clay Heath 3794: Lower North Coast Headland Clay Heath
South Pacific Heathland Reserve, Ulladulla	A small population was found at South Pacific Heathland Reserve in 1998 (NSW Scientific Committee), although recent searches failed to find any sign of the species (K. Coutts-McClelland pers. comm. 2020).	3638: South Coast Sands Bangalay Forest[1] 3789: Coastal Headland Clay Heath

[1] PCT 3638: South Coast Sands Bangalay Forest is present at the study area and is equivalent to the legacy PCT 659: Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion

Population	Population size and current status	Mapped PCT (SVTM, DPE 2022)
Wyrrabalong National Park	BioNet records for this location identify that plants were last reported in 1996, although Duncan (2010) reports this population of less than 10 plants was not seen since 1997.	3789: Coastal Headland Clay Heath 3546: Coastal Sands Littoral Scrub-Forest
Porter Creek Wetland Reserve	The only formally documented record of the species from this area is from 1953, has poor accuracy and appears to be based only on a record of the generalised locality (i.e. 'Wyong'). It is unclear whether subsequent references to plants in this location (Gunninah 2003) refer to additional observations of the species or are based only on the original 1953 record. However, Duncan (2010) identifies that the species was last seen at this location in 1999 and that the population consisted of less than 10 plants.	Unknown – no accurate site location available
Budderoo National Park	Population identified by NSW Scientific Committee (2008) as being last observed in 2000, although the record of the species on BioNet has been 'Rejected as certainly incorrect'. No count data.	3896: Budderoo-Morton Damp Swamp Heath
Arcadia Vale	Record of a single plant observed spring 2019 and uploaded to the BioNet Atlas in 2020. However, no further data regarding this record is available and the validity of this record is questionable.	4020: Coastal Creekflat Layered Grass-Sedge Swamp Forest

Pterostylis ventricosa

Pterostylis ventricosa is a terrestrial, perennial orchid which persists as an underground tuber for much of the year. Generally, detection and identification of the species is only possible during the flowering period from March to May. The species is listed as critically endangered under the NSW *Biodiversity Conservation Act 2016*.

Current understanding of the habitat requirements for *P. ventricosa* are biased towards the Shoalhaven region as the species was thought to be endemic to this region until records were made from the Southern Highlands in 2017. Habitat for *P. ventricosa* was broadly described by Jones (2008; 2021) as open areas within tall eucalypt forest with a dense heathy understorey in sand or moisture-retentive grey silty loam. Stephenson (2011) also describes habitat as broadly similar and consisting of *"…open forest and heathland in well drained sandy or grey silty loam*." It is noted that both these habitat descriptions accompany descriptions of the species as being highly localised and, therefore, do not incorporate the recent records of the species from the Southern Highlands. The endangered species profile for *P. ventricosa* (DPIE 2021) also notes the occurrence of the species from skeletal soils and moss beds on sandstone rock shelves. Records of *P. ventricosa* from the Jervis IBRA subregion, which surrounds the study area, are associated with Permian aged sedimentary rocks including sandstones, siltstones, and conglomerates (Troedson and Hashimoto 2013). The TBDC ('TBDC'; DPE 2023a), the database which informs the BAM and the BAM credit calculator, identifies 12 PCTs types with which the species is associated (**Table 3**).

Table 3: Vegetation associations of *Pterostylis ventricosa* from the TBDC (2023a*)

Vegetation formation	Vegetation class	Approved PCTs including revised eastern NSW PCTs (DPE 2023a)	Legacy PCTs including decommissioned eastern NSW PCTs (DPE 2023a)
Dry Sclerophyll Forests (Shrubby sub-formation)	South Coast Sands Dry Sclerophyll Forests	3638: South Coast Sands Bangalay Forest	659: Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion 1793: Coastal Sand Bangalay Forest
	South East Dry Sclerophyll Forests	3643: Bungonia Tableland Silvertop Ash-Stringybark Forest	1150: Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion
		3654: Shoalhaven Lowland Bloodwood Shrub Forest	1079: Red Bloodwood - Blackbutt - Spotted Gum shrubby open forest on coastal foothills, southern Sydney Basin Bioregion 1080: Red Bloodwood - Grey Gum shrubby open forest on shale-sandstone interface of the lower Shoalhaven valleys, southern Sydney Basin Bioregion
		3662: South Coast Lowland Blackbutt Forest	1079: Red Bloodwood - Blackbutt - Spotted Gum shrubby open forest on coastal foothills, southern Sydney Basin Bioregion 1084: Red Bloodwood - Silvertop Ash - White Stringybark heathy open forest on coastal foothills, southern South East Corner Bioregion
		3668: Southern Highlands Scribbly Gum Forest	1152: Silvertop Ash - Hard-leaved Scribbly Gum - Blue-leaved Stringybark heathy woodland on

Vegetation formation	Vegetation class	Approved PCTs including revised eastern NSW PCTs (DPE 2023a)	Legacy PCTs including decommissioned eastern NSW PCTs (DPE 2023a)
			sandstone plateaux, southern Sydney Basin Bioregion
	Southern Tablelands Dry Sclerophyll Forests	3737: Bungonia Tableland Scribbly Gum Shrub Forest	728: Broad-leaved Peppermint - Brittle Gum shrubby open forest on the eastern tablelands, South Eastern Highlands Bioregion 888: Inland Scribbly Gum - Brittle Gum low woodland of the eastern tablelands, South Eastern Highlands Bioregion
	Sydney Coastal Dry Sclerophyll Forests	3588: Shoalhaven Foothills Bloodwood Heathy Forest	662: Banksia - Red Bloodwood - Hard-leaved Scribbly Gum heathy open woodland on sandstone plateaux, southern Sydney Basin Bioregion 1082: Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion
	Sydney Hinterland Dry Sclerophyll Forests	3614: Southern Highlands Sandstone Peppermint Forest	1086: Red Bloodwood - Sydney Peppermint - Blue-leaved Stringybark heathy forest of the southern Blue Mountains, Sydney Basin Bioregion 1246: Sydney Peppermint - Grey Gum shrubby open forest of the western Blue Mountains, Sydney Basin Bioregion

Vegetation formation	Vegetation class	Approved PCTs including revised eastern NSW PCTs (DPE 2023a)	Legacy PCTs including decommissioned eastern NSW PCTs (DPE 2023a)
Forested Wetland	Coastal Floodplain Wetland	4019: Coastal Alluvial Bangalay Forest	1794: Coastal alluvial Bangalay forest
Wet Sclerophyll Forests (Grassy sub-formation)	Southern Lowland Wet Sclerophyll Forests	3267: Shoalhaven Foothills Turpentine Forest	1080: Red Bloodwood - Grey Gum shrubby open forest on shale-sandstone interface of the lower Shoalhaven valleys, southern Sydney Basin Bioregion 1283: Turpentine - Red Bloodwood - Sydney Peppermint shrubby open forest on the foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion
		3268: Shoalhaven Foothills Turpentine-Ironbark Moist Forest	1206: Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion
		3273: South Coast Lowland Shrub-Grass Forest	1212: Spotted Gum - Grey Ironbark - Woollybutt grassy open forest on coastal flats, southern Sydney Basin Bioregion and South East Corner Bioregion

* Database accessed 10 July 2023

A total of 461 records of *P. ventricosa* from the Jervis IBRA subregion were identified from 'as-held' data BioNet Atlas provided by DPE on the 23 February 2023 (DPE 2023b). The reported accuracy of the records is generally high (< 100 m) or the location description provided with the record provides a high level of confidence that the record location is accurate. These records are considered an accurate representation of the locations of the species' presence and its general habitat associations within the Jervis IBRA subregion. There is greater uncertainty regarding records of the species and its habitat associations near its western extent in the Burragorang and Moss Vale IBRA subregions. In the Moss Vale and Burragorang IBRA subregions, the records of the species on BioNet are unlikely to represent the full range of habitat types in which the species occurs in these IBRA subregions, although that is not relevant to this report.

Within the Jervis IBRA subregion, records of *P. ventricosa* occur within nine PCTs as mapped by the State Type Vegetation Map (STVM, DPE 2022;**Table 4**). The species is most frequently recorded within areas mapped as 'South Coast Lowland Shrub-Grass Forest' (PCT 3273) and 'Shoalhaven Lowland Bloodwood Shrub Forest' (PCT 3654), accounting for 77.4% (357/461) and 14.5% (67/461) of the recorded locations, respectively (**Figure 1**). For those plants recorded within areas where no PCT was mapped by DPE (2022), generally associated with areas where vegetation slashing has occurred, records were assigned to the nearest mapped vegetation polygon. It is noted that these calculations are based upon the number of recorded locations, not the number of individuals plants recorded. This is due to there being many BioNet records for the species without data on the number of individuals present. Consequently, this analysis may misrepresent the association of the species with some PCTs where a large number of records are made for an individual population. However, this analysis is consistent with the descriptions of the habitat by Jones (2008; 2021) and Stephenson (2011) and is considered informative for considering habitat associations.

It is noted that six records of *P. ventricosa* on the BioNet Atlas are within a single patch of vegetation mapped at the regional scale as PCT 4028 (SVTM, DPE 2022). However, field inspections of the general habitat for this record, conducted as part of the preparation of previous expert reports by the author of this report, identified that the habitat for these records is more characteristic of PCT 3273: South Coast Lowland Shrub-Grass Forest.

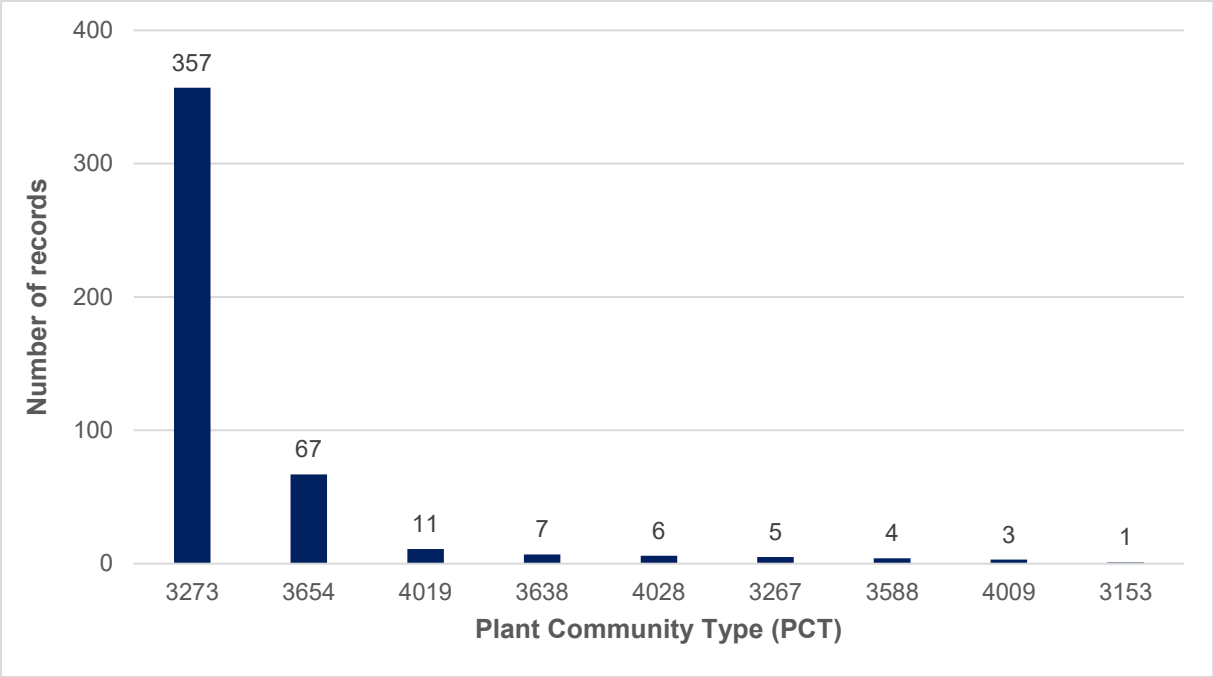

Figure 1: BioNet records of *P. ventricosa* (DPE 2023b) by PCT (STVM, DPE 2022)

Table 4: PCTs in which *P. ventricosa* has been recorded (BioNet, DPE 2023b; SVTM, DPE 2022)

Location of records (BioNet. DPE 2023b)	Mapped PCT (SVTM, DPE 2022)	Vegetation formation	Vegetation Class
Falls Creek	3153: Illawarra Escarpment Bangalay x Blue Gum Wet Forest	Wet Sclerophyll Forests (Shrubby sub-formation)	North Coast Wet Sclerophyll Forests
Twelve Mile Rd	3267: Shoalhaven Foothills Turpentine Forest	Wet Sclerophyll Forests (Grassy sub-formation)	Southern Lowland Wet Sclerophyll Forests
Tomerong, St Georges Basin, Basin View, Mondayong, Sussex Inlet	3273: South Coast Lowland Shrub-Grass Forest		
Yerriyong	3588: Shoalhaven Foothills Bloodwood Heathy Forest	Dry Sclerophyll Forests (Shrubby sub-formation)	Sydney Coastal Dry Sclerophyll Forests
Sanctuary Point, St Georges Basin, Sussex Inlet	3638: South Coast Sands Bangalay Forest[2]		South Coast Sands Dry Sclerophyll Forests
Tomerong, Yerriyong, Worrowing Heights	3654: Shoalhaven Lowland Bloodwood Shrub Forest		South East Dry Sclerophyll Forests
Tomerong	4009: Shoalhaven Lowland Flats Wet Swamp Forest	Forested Wetland	Coastal Swamp Forests
Falls Creek, Sussex Inlet	4019: Coastal Alluvial Bangalay Forest		Coastal Floodplain Wetlands
Basin View	4028: Estuarine Swamp Oak Twig-rush Forest		

[2] PCT 3638: South Coast Sands Bangalay Forest is present at the study area and is equivalent to the legacy PCT 659: Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion

Vegetation within the study area

The PCTs within the study area have been mapped and described by GHD (**Figure 3**). Field inspections undertaken as part of the preparation of this advice confirmed that the mapping of GHD was generally representative of the floristics pattern across the study area. For each of the PCTs mapped within the study area, an assessment of the likelihood of habitat being present for the two subject species is provided below.

'South Coast Sands Bangalay Forest' (PCT 3638; equivalent to the legacy PCT 659: Bangalay - Old-man Banksia open forest on coastal sands) is mapped by GHD along the eastern extent of the study area in association with an area of aeolian sands dominated by *Eucalyptus botryoides* (**Figure 3**). There are records of both subject species from areas mapped as supporting this PCT (DPE 2023b) and the TBDC (DPE 2023a) identifies this PCT as habitat for both species. Based upon these associations, PCT 3638 is considered potential habitat for the two subject species. However, it is noted that the occurrence of this PCT on "…*low-lying marine sand deposits and occasionally on wind-formed headland dunes…*" (DPE 2023c), which matches the landscape position of this PCT within the study area, is distinct from the loamy soils which *P. ventricosa* is most commonly associated (Jones 2008; Stephenson 2011).

'Estuarine Swamp Oak Twig-rush Forest' (PCT 4028; equivalent to legacy PCT1232 Swamp Oak floodplain swamp forest) and 'Southern Estuarine Swamp Paperbark Creekflat Scrub' (PCT 4056; equivalent to legacy PCT1236: Swamp Paperbark -Swamp Oak tall shrubland on estuarine flats) have been mapped by GHD in association with low-lying areas in the east and west of the study area (**Figure 3**). These PCTs were characterised by a canopy dominated by *Casuarina glauca* and an understorey including species associated with periodical inundation or poorly drained soils. Neither of these two PCTs, 4028 and 4056, are identified as habitat for either of the two subject species within the TBDC (DPE 2023a). Similarly, these species have not been recorded within these habitats based upon BioNet records (DPE 2023b) and regional vegetation mapping (DPE 2022). It is noted that six records of *P. ventricosa* on the BioNet Atlas are within a single patch of vegetation mapped at the regional scale as PCT 4028 (SVTM, DPE 2022). However, field inspections of the general habitat for this record, conducted as part of the preparation of previous expert reports by the author of this report, identified that the habitat for these records is more characteristic of 'South Coast Lowland Shrub-Grass Forest' (PCT 3273). It is concluded that areas supporting PCTs 4028 or 4056 are very unlikely to support either of the two subject species due to these PCTs occurring in "…*near-permanently waterlogged margins of estuaries and coastal lagoons*…" (PCT 4056, DPE 2023c) or as supporting species "…*tolerant of inundation*…" (PCT 4028, DPE 2023c). The landscape position of these two PCTs within the study area is consistent with the descriptions of the PCTs, being associated with waterlogged or inundated habitats. Both subject species are associated with free draining sandy soils or silty loams and there is no evidence of either species occurring within periodically inundated habitats with some saline influence.

'Shoalhaven Lowland Flats Wet Swamp Forest' (PCT 4009; equivalent to legacy PCT1231: Swamp Mahogany swamp sclerophyll forest on coastal lowlands) is also mapped by GHD as occurring in low-lying eastern portions of the study area with a canopy including *Eucalyptus botryoides* (Swamp Mahogany; **Figure 3**). Observations of this PCT within the study area indicated that it occupied transitional areas between the *Casuarina glauca* dominated lowest

lying areas in the east and the drier woodlands present on the highest elevation areas in the west of the study area. Neither of the two subject species are identified within the TBDC (DPE 2023a) as occurring in association with PCT 4009. Similarly, *C. tessellata* has not been recorded within areas mapped as supporting this PCT based upon BioNet records (DPE 2023b) and regional vegetation mapping (DPE 2022). There are three records of *P. ventricosa* from a single polygon mapped as PCT 4009 (STVM, DPE 2022) within the area known as 'Nebraska Estate'. These records originate from surveys completed by BES in 2007 and an additional record with poor accuracy (also noted as being for a 'broad area'). Detailed surveys of the area from which these records originate was completed by BES in 2007 and 2008 and identified 467 individuals of the species within 'Nebraska Estate', all of which were identified as occurring in 'Currambene Lowlands Forest' (BES 2009). Currambene Lowlands Forest, as described by Tozer 2010, has been identified as being equivalent to the decommissioned PCT 1079, which in turn would now form part of either 'Shoalhaven Lowland Bloodwood Shrub Forest' (PCT 3654) or 'South Coast Lowland Blackbutt Forest' (PCT 3662). Therefore, the records of *P. ventricosa* on BioNet (DPE 2023b) do not indicate that PCT 4009 represents habitat for this species. It is concluded that areas supporting PCTs 4009 are unlikely to support either of the two subject species. The description of PCT 4009 as having a "…*dense ground cover of tall sedges found on boggy low-lying flats*…", which matches the landscape position of this PCT within the study area, is distinct from the free draining soils which support the two subject species.

'Illawarra Blackbutt Moist Forest' (PCT 3154, equivalent to legacy PCT694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion) is mapped by GHD as occurring in the south-western and north-western portions of the study area (**Figure 3**). Mapped areas of this PCT supported a variable canopy including *Syncarpia glomulifera* (Turpentine), *Eucalyptus botryoides X saligna* (Blue Gum / Bangalay hybrids), *E. paniculata* (Grey Ironbark), *E. longifolia* (Wollybutt) and *E. baueriana* (Blue Box). Neither of the two subject species are identified within the TBDC (DPE 2023a) as being associated with PCT 3154. Similarly, these species have not been recorded within habitat mapped as this PCT based upon BioNet records (DPE 2023b) and regional vegetation mapping (STVM, DPE 2022). It is concluded that areas supporting PCTs 3154 are unlikely to support either of the two subject species. However, the match between the vegetation mapped as PCT 3154 within the study area and the description of this PCT within the BioNet Vegetation Classification (DPE 2023c) is moderate at best. However, no more suitable candidate PCT was apparent. It is noted that *P. ventricosa* has previously been recorded within other PCTs belonging to the 'Wet Sclerophyll Forests (Shrubby sub-formation)' vegetation formation. Therefore, areas mapped as PCT 3154 are considered to have potential to support *P. ventricosa*. This habitat within the study area was included in the systematic survey of potential habitat for the species conducted at the subject land in April 2023.

'South Coast Lowland Woollybutt Grassy Forest' (PCT 3330, equivalent to legacy PCT 1326 Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion) is mapped by GHD in the central western portions of the study area in association with the highest elevations within the study area (**Figure 3**). Neither of the two subject species are identified within the TBDC (DPE 2023a) as being associated with PCT 3330. Similarly, these species have not been recorded within habitat mapped as this PCT based upon BioNet records (DPE 2023b) and regional vegetation mapping (STVM, DPE 2022). It is concluded that areas supporting PCTs 3330 are unlikely to support either of the two subject species. This conclusion is supported by the

description of this PCT as occurring in association with soils with *"…partially impeded drainage on the south coast*", which matches the landscape position of this PCT within the study area. This is distinct from the free draining soils which typically support the two subject species.

Conclusions

Based upon the site inspections conducted, a review of habitat information and records pertaining to the two subject species, and my own knowledge and expertise, one of the PCTs mapped within the subject land, 'South Coast Sands Bangalay Forest' (PCT 3638 equivalent to legacy PCT 659), represents potential habitat for *Caladenia tessellata* and *Pterostylis ventricosa*. Adopting a precautionary approach, the area mapped as 'Illawarra Blackbutt Moist Forest' (PCT 3154, equivalent to legacy PCT 694) are also considered to support potential habitat for *P. ventricosa*. This precautionary approach is recommended due to the only moderate match between the described PCT and the habitat within the study area and the previous records of the species from the same vegetation formation.

Therefore, where impacts to 'South Coast Sands Bangalay Forest' (PCT 3638) are proposed as part of the BDAR, targeted surveys for *C. tessellata* and *P. ventricosa* should be conducted across the full extent of the PCT. Similarly, where impacts to 'Illawarra Blackbutt Moist Forest' (PCT 3154) are proposed as part of the BDAR, targeted surveys for *P. ventricosa* should be conducted across the full extent of the PCT. The author participated in targeted surveys for *C. tessellata* and *P. ventricosa* across all potential habitat (associated PCTs) for the species within the development footprint in April and October 2023, as well as adjoining areas of other PCTs. No *C. tessellata* or *P. ventricosa* were observed during these surveys.

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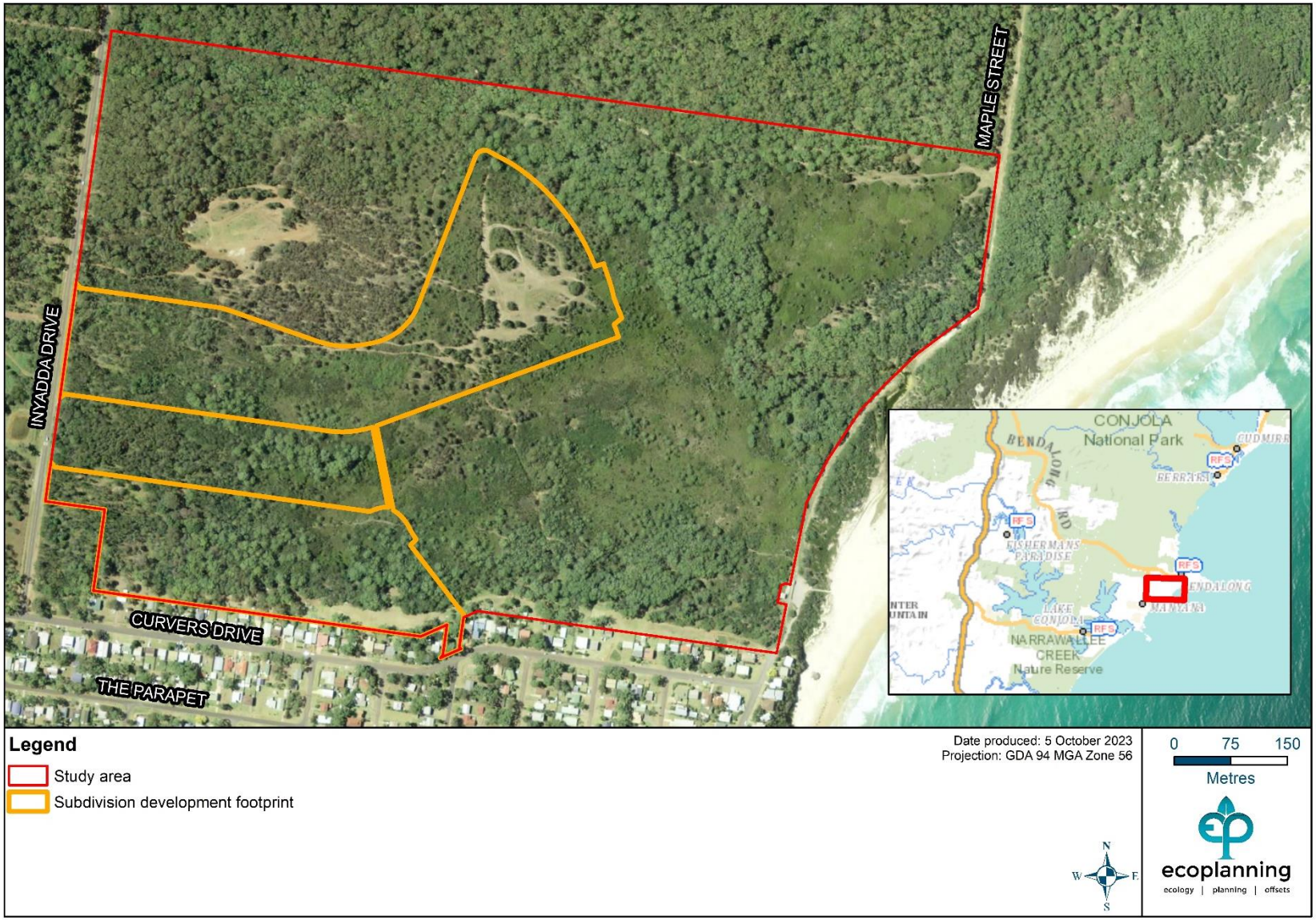

Figure 2: The study area

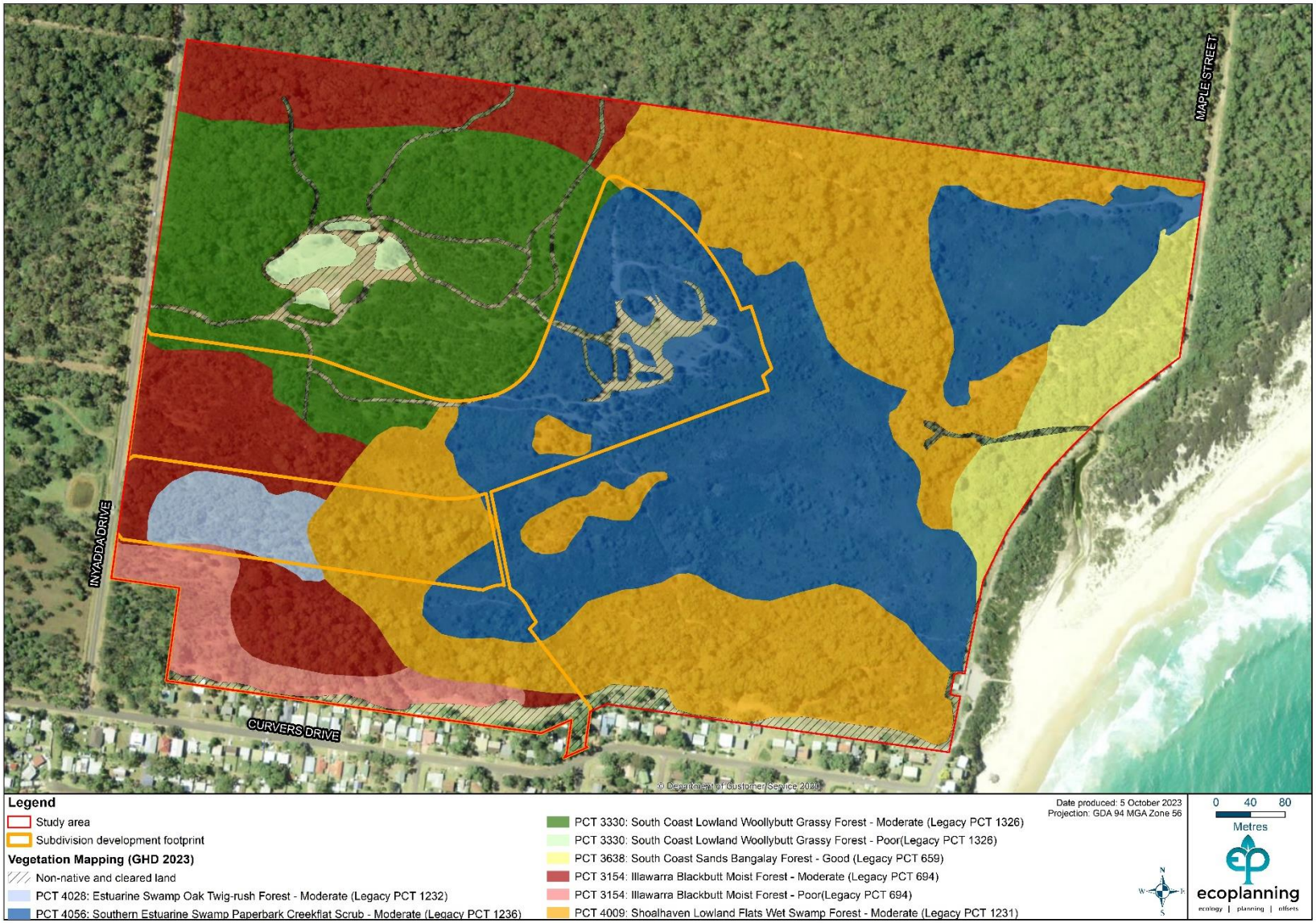

Figure 3: Vegetation mapping for the study area (Source: GHD 2023)

ATTACHMENT B:

BRIAN TOWLE – CURRICULUM VITAE

SENIOR ECOLOGIST | ACCREDITED BAM ASSESSOR

QUALIFICATIONS

- Bachelor of Environmental Science (Hons I), University of NSW, Sydney
- BioBanking Accredited Assessor (No. 0229)
- Biodiversity Assessment Methodology (BAM) Accredited Person (No. 17057)
- Approved Species Expert under the BAM for seven orchid species (*Caladenia tessellata*, *Calochilus pulchellus*, *Corunastylis* sp. Charmhaven, *Cryptostylis hunteriana*, *Genoplesium baueri*, *Genoplesium insigne*, *Pterostylis ventricosa*)

BIOGRAPHY

Brian is a senior ecologist with over 15 years' experience as an environmental consultant. During this time he has worked primarily as a botanist undertaking a range of projects including threatened species monitoring, vegetation monitoring programs, BioBanking agreements, applications for Biodiversity certification, large scale vegetation mapping/modelling projects, targeted surveys and a range of impact assessments.

Brian has highly developed skills in the identification of flora species and ecological communities. In particular, Brian is a recognised expert in the ecology of native orchid species having undertaken research into the ecology of native orchids and authored several publications within peer-reviewed journals. Brian has also been approved as a species expert under the NSW Biodiversity Assessment Method for seven native orchid species.

Brian has worked in a range of ecosystems across NSW, and in parts of QLD, from the coast to the far western plains including arid woodlands, shrublands and grasslands, wet sclerophyll forests, rainforests, and coastal swamps. This experience has exposed him to a diversity of flora and fauna distributed across these ecosystems.

Brian has a sound knowledge of environmental and planning legislation, and has applied this understanding and his ecological expertise to a range of projects including as an expert witness for the Land and Environment Court. Brian has worked for a range of clients ranging from Local Councils, to state agencies and private industry. This has required him to communicate effectively with a range of professionals and the general public in both written and oral form.

RECENT RELEVANT PROJECTS

Saving our Species monitoring project (2019/20) for *Corunastylis* sp. Charmhaven [*Genoplesium branwhiteorum*], *Genoplesium insigne* and *Thelymitra adorata*, NSW DPE. Involved population monitoring, targeted surveys, threat monitoring and seed collection for these Critically Endangered terrestrial orchid species.

Rare and threatened orchids of the Central Coast LGA, Central Coast Council (2020). Prepared a report to Council summarising the status of all recorded orchid species within the LGA.

Lachlan River Catchment, validation of wetland and groundwater dependent ecosystem modelling, NSW Office of Environment and Heritage & Department of Primary Industries. Undertook field surveys to validate modelled habitat across the Lachlan River catchment.

Calochilus pulchellus and *Caladenia tessellata* Literature reviews and habitat model, NSW Office of Environment and Heritage. Prepared a literature review combining all known research into these Endangered terrestrial orchids and prepared habitat models from existing datasets to identify areas of potential habitat for these species across their known distribution.

Saving our species monitoring – *Callistemon megalongensis, Callistemon purpurascens, Pimelea spicata*, *Prasophyllum fuscum, Thelymitra kangaloonica* and *Zieria involucrata*, NSW Department of Planning and Environment. Involved surveys within areas of habitat for these species to monitor population size, recruitment, and existing threats.

Expert report for *Genoplesium insigne* and *Corunastylis* sp. Charmhaven for the Central Coast Strategic Conservation Plan. Prepared an expert report in accordance with the NSW Biodiversity Assessment Method for two critically endangered orchid species.

Vegetation of the Barwon-Darling and Condamine-Balonne floodplain systems of NSW, Murray Darling Basin Authority. Involved mapping and full floristic surveys of plant community types along the Darling River Floodplain between Wilcannia and Louth.

Metropolitan Colliery Vegetation Monitoring Program 2008 – 2018, Peabody. Monitored Upland Swamp and Riparian vegetation across the Metropolitan and Woronora Special Areas to detect impacts to vegetation associated with subsidence from longwall mining.

Biodiversity Stewardship Site Agreement Report (BSSAR) for ‘Kanowna 1’. Was the accredited assessor for the preparation of the BSSAR for an approximately 530 ha site on the floodplain of the Macintyre River within the Darling Riverine Plains bioregion.

Threatened Flora Project Plan for Whitehaven Coal. Involved preparation of a plan of management for threatened flora species located within offset properties under the management of Whitehaven Coal. Individual plans for protection of habitat and translocation of individuals were also prepared for multiple threatened flora species including *Pomaderris queenslandica, Lepidium monoplocoides, Tylophora linearis* and *Bertya opponens*.

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Appendix F

Biodiversity credit reports

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00029842/BAAS17023/22/00035932

Proposal Name
North Manyana Subdivision 65 lot subdivision_2020 2021 and 2023 plot data_Legacy PCTs

BAM data last updated *
22/06/2023

Assessor Name
Ben Harrington

Assessor Number
BAAS17023

BAM Data version *
61

Proponent Names

Report Created
27/10/2023

BAM Case Status
Finalised

Assessment Revision
3

Assessment Type
Part 4 Developments (General)

Date Finalised
27/10/2023

BOS entry trigger
BOS Threshold: Area clearing threshold

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	Endangered Ecological Community	1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion

Species
Nil

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
No Changes

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
694-Illawarra Escarpment Blackbutt forest	Not a TEC	7.0	165	0	165
1231-Coastal sand Swamp Mahogany forest	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	2.8	0	110	110
1232-Coastal freshwater swamp forest	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.1	2	0	2
1236-Coastal Swamp Paperbark - Swamp Oak scrub	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	6.7	0	221	221
1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	1.4	45	0	45

694-Illawarra Escarpment Blackbutt forest

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region

	North Coast Wet Sclerophyll Forests This includes PCT's: 661, 686, 694, 827, 1217, 1237, 1244, 1285, 1504, 1841, 1843, 1915, 3067, 3073, 3078, 3088, 3102, 3136, 3145, 3147, 3171, 3177	North Coast Wet Sclerophyll Forests >=50% and <70%	694_Moderate	Yes	118	Jervis, Bateman, Ettrema, Illawarra and Jervis. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	North Coast Wet Sclerophyll Forests This includes PCT's: 661, 686, 694, 827, 1217, 1237, 1244, 1285, 1504, 1841, 1843, 1915, 3067, 3073, 3078, 3088, 3102, 3136, 3145, 3147, 3171, 3177	North Coast Wet Sclerophyll Forests >=50% and <70%	694_Poor	Yes	47	Jervis, Bateman, Ettrema, Illawarra and Jervis. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1231-Coastal sand Swamp Mahogany forest	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 837, 839, 926, 971, 1064, 1092, 1227, 1230, 1231, 1232, 1235, 1649, 1715, 1716, 1717, 1718, 1719, 1721, 1722, 1723, 1724, 1725, 1730, 1795, 1798, 3272, 3906, 3983, 3985, 3986, 3988, 3989, 3990, 3995, 3997, 3998, 4000, 4001, 4004, 4006, 4009, 4013, 4019, 4020, 4021, 4044, 4047, 4057	-	1231_Moderate	No	110	Jervis, Bateman, Ettrema, Illawarra and Jervis. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1232-Coastal freshwater swamp forest	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	-	1232_Moderate	Yes	2	Jervis, Bateman, Ettrema, Illawarra and Jervis. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1236-Coastal Swamp Paperbark - Swamp Oak scrub	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	-	1236_Moderate	No	221	Jervis, Bateman, Ettrema, Illawarra and Jervis. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion This includes PCT's: 838, 1326, 3269, 3327, 3330, 4052	-	1326_Moderate	Yes	45	Jervis, Bateman, Ettrema, Illawarra and Jervis. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Cercartetus nanus / Eastern Pygmy-possum	**694_Moderate, 694_Poor, 1231_Moderate, 1236_Moderate, 1326_Moderate**	17.9	565.00

Credit Retirement Options

Like-for-like credit retirement options

	Spp	IBRA subregion
Cercartetus nanus / Eastern Pygmy-possum	**Cercartetus nanus /** Eastern Pygmy-possum	Any in NSW

BAM Predicted Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00029842/BAAS17023/22/00035932	North Manyana Subdivision 65 lot subdivision_2020 2021 and 2023 plot data_Legacy PCTs	22/06/2023
Assessor Name	**Report Created**	**BAM Data version ***
Ben Harrington	27/10/2023	61
Assessor Number	**Assessment Type**	**BAM Case Status**
BAAS17023	Part 4 Developments (General)	Finalised
Assessment Revision	**BOS entry trigger**	**Date Finalised**
3	BOS Threshold: Area clearing threshold	27/10/2023

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Threatened species reliably predicted to utilise the site. No surveys are required for these species. Ecosystem credits apply to these species.

Common Name	Scientific Name	Vegetation Types(s)
Australasian Bittern	Botaurus poiciloptilus	1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
Barking Owl	Ninox connivens	1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Black Bittern	Ixobrychus flavicollis	1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
Dusky Woodswallow	Artamus cyanopterus cyanopterus	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub

Dusky Woodswallow	Artamus cyanopterus cyanopterus	1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Eastern Chestnut Mouse	Pseudomys gracilicaudatus	1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
Eastern Coastal Free-tailed Bat	Micronomus norfolkensis	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Eastern False Pipistrelle	Falsistrellus tasmaniensis	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Eastern Osprey	Pandion cristatus	1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
Flame Robin	Petroica phoenicea	1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Freckled Duck	Stictonetta naevosa	1232-Coastal freshwater swamp forest
Gang-gang Cockatoo	Callocephalon fimbriatum	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Glossy Black-Cockatoo	Calyptorhynchus lathami	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Golden-tipped Bat	Phoniscus papuensis	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest

Greater Broad-nosed Bat	Scoteanax rueppellii	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Grey-headed Flying-fox	Pteropus poliocephalus	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Large Bent-winged Bat	Miniopterus orianae oceanensis	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Little Eagle	Hieraaetus morphnoides	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Little Lorikeet	Glossopsitta pusilla	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Masked Owl	Tyto novaehollandiae	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest

Masked Owl	Tyto novaehollandiae	1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
New Holland Mouse	Pseudomys novaehollandiae	1231-Coastal sand Swamp Mahogany forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
Powerful Owl	Ninox strenua	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Regent Honeyeater	Anthochaera phrygia	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Rosenberg's Goanna	Varanus rosenbergi	1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
Scarlet Robin	Petroica boodang	1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Spotted Harrier	Circus assimilis	1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
Spotted-tailed Quoll	Dasyurus maculatus	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Square-tailed Kite	Lophoictinia isura	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest

Square-tailed Kite	Lophoictinia isura	1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Swift Parrot	Lathamus discolor	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Turquoise Parrot	Neophema pulchella	1236-Coastal Swamp Paperbark - Swamp Oak scrub
Varied Sittella	Daphoenositta chrysoptera	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
White-bellied Sea-Eagle	Haliaeetus leucogaster	1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
White-throated Needletail	Hirundapus caudacutus	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Yellow-bellied Glider	Petaurus australis	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion

Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	694-Illawarra Escarpment Blackbutt forest
		1231-Coastal sand Swamp Mahogany forest
		1232-Coastal freshwater swamp forest
		1236-Coastal Swamp Paperbark - Swamp Oak scrub
		1326-Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion

Threatened species Manually Added

None added

Threatened species assessed as not within the vegetation zone(s) for the PCT(s)

Refer to BAR for detailed justification

Common Name	Scientific Name	Justification in the BAM-C

BAM Candidate Species Report

Proposal Details

Assessment Id 00029842/BAAS17023/22/00035932	Proposal Name North Manyana Subdivision 65 lot subdivision_2020 2021 and 2023 plot data_Legacy PCTs	BAM data last updated * 22/06/2023
Assessor Name Ben Harrington	Report Created 27/10/2023	BAM Data version * 61
Assessor Number BAAS17023	Assessment Type Part 4 Developments (General)	BAM Case Status Finalised
Assessment Revision 3	Date Finalised 27/10/2023	BOS entry trigger BOS Threshold: Area clearing threshold

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

List of Species Requiring Survey

Name	Presence	Survey Months
Burhinus grallarius Bush Stone-curlew	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Callocephalon fimbriatum Gang-gang Cockatoo	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Calyptorhynchus lathami Glossy Black-Cockatoo	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Cercartetus nanus Eastern Pygmy-possum	Yes (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Chalinolobus dwyeri Large-eared Pied Bat	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Cryptostylis hunteriana Leafless Tongue Orchid	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Haliaeetus leucogaster White-bellied Sea-Eagle	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Heleioporus australiacus Giant Burrowing Frog	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Hieraaetus morphnoides Little Eagle	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern)	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Litoria aurea Green and Golden Bell Frog	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Lophoictinia isura Square-tailed Kite	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Melaleuca biconvexa Biconvex Paperbark	No (surveyed)	☑ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Mixophyes balbus Stuttering Frog	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Myotis macropus Southern Myotis	No (surveyed)	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Neophema chrysogaster Orange-bellied Parrot	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Ninox connivens Barking Owl	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Ninox strenua Powerful Owl	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Pandion cristatus Eastern Osprey	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Petauroides volans Southern Greater Glider	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Petaurus norfolcensis Squirrel Glider	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Petroica rodinogaster Pink Robin	No (surveyed)	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Phascogale tapoatafa Brush-tailed Phascogale	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Phascolarctos cinereus Koala	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Potorous tridactylus Long-nosed Potoroo	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Pteropus poliocephalus Grey-headed Flying-fox	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Pterostylis gibbosa Illawarra Greenhood	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☑ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Pterostylis ventricosa Pterostylis ventricosa	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☑ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Rhodamnia rubescens Scrub Turpentine	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Syzygium paniculatum Magenta Lilly Pilly	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☑ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Tyto novaehollandiae Masked Owl	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Wilsonia rotundifolia Round-leafed Wilsonia	No (surveyed)	☑ Jan ☐ Feb ☐ Mar ☑ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Threatened species Manually Added

None added

Threatened species assessed as not on site

Refer to BAR for detailed justification

Common name	Scientific name	Justification in the BAM-C
Large Bent-winged Bat	Miniopterus orianae oceanensis	Habitat constraints
Pterostylis vernalis	Pterostylis vernalis	Habitat constraints
Regent Honeyeater	Anthochaera phrygia	Habitat constraints
Square Raspwort	Haloragis exalata subsp. exalata	Habitat constraints
Swift Parrot	Lathamus discolor	Habitat constraints

Appendix G

Vegetation Management Plan

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→ The Power of Commitment