

Appendix S

Biodiversity development assessment report



Roads and Maritime Services

Western Harbour Tunnel and Warringah Freeway Upgrade

Technical working paper: Biodiversity

January 2020

Prepared for

Roads and Maritime

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Executive summary

This Biodiversity development assessment report (BDAR) has been prepared to support the environmental impact statement for the Western Harbour Tunnel and Warringah Freeway Upgrade project (the project). This BDAR has been prepared in accordance with the Biodiversity Assessment Method (BAM), as required by the Secretary's environmental assessment requirements issued by the Secretary of the Department of Planning, Industry and Environment (formerly Department of Planning and Environment). A separate assessment of marine mammals and reptiles, fish and marine habitats has been prepared to support the environmental impact statement for the project, the Technical working paper: Marine ecology (Cardno, 2020).

The preparation of this BDAR has been informed by database searches, desktop review of relevant reports and spatial information, site inspections and targeted field surveys. Field surveys were carried out at sites within the subject land between May 2016 and November 2017, between February and May 2018 and in March 2019.

The land in which biodiversity values have been assessed by this BDAR is known as the subject land. The subject land comprises the construction (temporary) footprint and permanent (operational) footprint being considered by the environmental impact statement.

The project is located in a highly urbanised area which has a long history of modification and disturbance. Vegetation in this report has generally been categorised as either urban/exotic vegetation or native vegetation representative of a particular plant community type (PCT). Almost all vegetation that occurs in the subject land comprises planted trees and shrubs in parkland or roadside settings (urban/exotic vegetation). There is one small area of Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney (PCT 1778) in the subject land; this vegetation is within an exclusion zone and would not be directly impacted by the project.

A total of 7.6 hectares of planted/exotic vegetation, which is not consistent with the definition of any PCTs, was mapped within the subject land, comprising 3.30 hectares of native plantings, 1.11 hectares of urban exotic/native plantings, 2.84 hectares of planted median and 0.35 hectares of weeds and exotics. No native vegetation consistent with the definition of any threatened ecological communities (TECs) has been identified in the subject land, nor were there any groundwater dependent ecosystems.

The BAM credit calculator identified three candidate threatened flora species credit species associated with the PCT identified in the subject land. Of these, none were considered to have a moderate to high likelihood of occurrence or were recorded in the subject land.

Four threatened flora species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Biodiversity Conservation Act 2016* (BC Act) were recorded within or immediately next to the subject land: *Acacia terminalis* subsp. *terminalis* (Sunshine Wattle), *Eucalyptus nicholii* (Narrow-leaved Black Peppermint), *Eucalyptus scoparia* (Wallangarra White Gum) and *Syzygium paniculatum* (Magenta Lilly Pilly). All were found in landscaped areas near the Warringah Freeway. The single individual of *Acacia terminalis* subsp. *terminalis* is possibly natural regrowth, and this plant would be subject to further assessment and offsetting under the BAM (OEH, 2017). *Syzygium paniculatum* would not be impacted by the project and therefore does not require offsetting. The planted individuals of *Eucalyptus nicholii* and *Eucalyptus scoparia* are not considered to be of conservation significance and were not assessed further under the BAM.

The credit calculator identified 19 candidate threatened fauna ecosystem credit species and 22 candidate threatened fauna species credit species. Of these, one threatened fauna species listed under both the BC Act and EPBC Act was recorded in the subject land: the Grey-headed Flying-fox (*Pteropus poliocephalus*). One Migratory species listed under the EPBC Act was recorded in the subject land: White-bellied Sea Eagle (*Haliaeetus leucogaster*). An additional five threatened fauna species listed under the BC Act were considered to have a high

likelihood of occurrence in the subject land: Eastern Bentwing-Bat (*Miniopterus schreibersii oceanensis*), Little Bentwing-Bat (*Miniopterus australis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Southern Myotis (*Myotis macropus*) and Powerful Owl (*Ninox strenua*).

One threatened fauna population is known to occur in the subject land on occasion: the population of Little Penguins (*Eudyptula minor*) in the Manly Point Area, listed as an Endangered Population under the BC Act. While the subject land offers foraging habitat to Little Penguins, the nesting habitat at Manly is located about 10 kilometres to the north-east. Some of the marine and intertidal habitats in the subject land offer marginal habitat resources to threatened shorebirds.

Where feasible, the design of the project within the preferred corridor has been refined to avoid or minimise impacts on biodiversity. Specific design and construction responses to avoid and minimise adverse impacts on biodiversity include avoiding direct impacts to native vegetation and threatened species habitat.

The direct biodiversity impacts of the project include:

- Removal of 7.29 hectares of vegetation comprising native and exotic plantings (0.31 hectares of native plantings within the subject land would be retained within an exclusion zone)
- Removal of one individual of *Acacia terminalis* subsp. *terminalis*, listed as Endangered under the EPBC Act and BC Act
- Removal of planted individuals of non-local threatened flora species
- Removal of 7.29 hectares of potential foraging and sheltering habitat for threatened fauna species – this does not comprise a substantial portion of foraging habitat available in the wider locality
- It is unlikely that threatened fauna species would be subject to injury/mortality; however, there is the potential for mortality of other fauna species.

The indirect biodiversity impacts of the project include:

- Indirect impacts to the small area of native vegetation located within an exclusion zone at Berrys Bay construction support site (WHT7) (being Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney (PCT 1778))
- Noise, vibration and light spill from construction support sites that could affect fauna inhabiting vegetation in nearby terrestrial habitats. This is most likely to occur along the edge of the foreshore on Berrys Bay (close to Berrys Bay construction support site (WHT7)) and Balls Head Bay (close to Sydney Harbour north cofferdam (WHT6)). Buildings, wharves, jetties, tunnels and other built structures at White Bay, Birchgrove, Berrys Bay, Balls Head and White Bay could also be indirectly impacted by noise, light spill and dust near roosting/nesting fauna, including microbats
- Transport of weeds and pathogens from the site to adjacent vegetation.

Two threatened species that are identified by the BAM to be at risk of serious and irreversible impacts are known or are considered to have a high likelihood of occurrence in the subject land: Eastern Bentwing-bat and Little Bentwing-bat. For these two species, only the breeding habitat is subject to assessment to determine serious and irreversible impact. No breeding habitat for Eastern Bentwing-bat or Little Bentwing-bat was identified in the subject land. As such, there is no further assessment of serious and irreversible impacts to these species required by the BDAR.

Prescribed biodiversity impacts in the BAM that are relevant to the project are:

- Impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation – the consequence of removing a small area of potential foraging resources for the local and bioregional persistence of threatened species is considered negligible

- Impacts of development on the habitat of threatened species or ecological communities associated with human made structures – construction of the project may impact upon roosting habitat for threatened microbats that are known or considered likely to roost in human-made structures within the subject land, including tunnels, wharves, jetties and buildings
- Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities – construction activities may result in a potential decrease in water quality and degradation of marine and intertidal habitats, which could adversely impact foraging habitat for threatened species that may use the habitats, including the Little Penguin and White-bellied Sea-Eagle.

Biodiversity management measures that would be implemented in accordance with Roads and Maritime Biodiversity Guidelines would include:

- Minimising vegetation and habitat removal
- Managing weed and pest species and pathogens
- Minimising shading and artificial light impacts
- Completing pre-clearing surveys for microbat roosts on any built structures to be demolished, including jetties/wharves
- Measures to address indirect impacts associated with tunnelling and piling activities near to the Eastern Bentwing-bat roost in the Coal Loader tunnel (Waverton) during autumn and winter.

As the project would require the removal of threatened flora species from the subject land, Roads and Maritime Services (Roads and Maritime) are required to offset these impacts on biodiversity. Two species credits are required to offset the impacts of the project on *Acacia terminalis* subsp. *terminalis*. There are no ecosystem credits required, because no native vegetation consistent with PCTs would be subject to direct impacts from the project.

Glossary of terms and abbreviations

Terms

Term	Meaning
Accredited person	A person accredited under the BC Act (section 6.10) who has been engaged by the proponent to prepare a Biodiversity development assessment report in accordance with the BAM (BC Act 2016). Referred to in the BAM as 'assessor' (OEH, 2017a). Accredited persons that have been engaged by the proponent are listed in Section 1.6 and Section 2.8 of this report.
Areas of geological significance	Geological features such as karst, caves, crevices, cliffs.
Assessor	Refer to Accredited person above.
Avoid	Measures taken by a proponent such as careful site selection or actions taken through the design, planning, construction and operational phases of the development to completely avoid impacts on biodiversity values or certain areas of biodiversity. Refer to the BAM for operational guidance.
Biodiversity Assessment Method (BAM)	The assessment manual that outlines how an accredited person assesses impacts on biodiversity at development sites.
Benchmarks	The quantitative measures that represent the 'best-attainable' condition, which acknowledges that native vegetation within the contemporary landscape has been subject to both natural and human-induced disturbance. Benchmarks are defined for specified variables for each PCT. Vegetation with relatively little evidence of modification generally has minimal timber harvesting (few stumps, coppicing, cut logs), minimal firewood collection, minimal exotic weed cover, minimal grazing and trampling by introduced or overabundant native herbivores, minimal soil disturbance, minimal canopy dieback, no evidence of recent fire or flood, is not subject to high frequency burning, and has evidence of recruitment of native species.
Biodiversity certification	Has the same meaning as in the BC Act (OEH, 2017a).
Biodiversity credit report	The report produced by the Credit Calculator that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site, or on land to be biodiversity certified, or that sets out the number and class of biodiversity credits that are created at a biodiversity stewardship site (OEH, 2017a).
Biodiversity offsets	Management actions that are carried out to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development (OEH, 2017a).
Biodiversity stewardship site	Has the same meaning as in the BC Act (OEH, 2017a).
Biodiversity values	Has the same meaning as Clause 1.5(2) of the BC Act (OEH, 2017a).
BioNet Atlas	The OEH database of flora and fauna records (formerly known as the NSW Wildlife Atlas). The Atlas contains records of plants, mammals, birds, reptiles, amphibians, some fungi, some invertebrates (such as insects and snails listed under the BC Act) and some fish. (OEH, 2017a).

Term	Meaning
Credit Calculator	The computer program that provides decision support to assessors and proponents by applying the BAM, in particular by using the data required to be entered and the equations in Appendix 6 and Appendix 9 to calculate the number and class of biodiversity credits required to offset the impacts of a development or created at a biodiversity stewardship site (OEH, 2017).
Critically endangered ecological community	An ecological community specified as critically endangered in Schedule 2 of the BC Act and/or listed under Part 13, Division 1, Subdivision A of the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) (OEH, 2017a).
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to the project Secretary's environmental assessment requirements for cumulative impact assessment requirements.
Development site	An area of land that is subject to a proposed development that is under the <i>Environmental Planning and Assessment Act 1979</i> . The term development site is also taken to include clearing site except where the reference is to a small area development or a major project development (OEH, 2017a).
Development footprint	The area of land that is directly affected by a proposed development, including access roads, and areas used to store construction materials. The term development footprint is also taken to include clearing footprint except where the reference is to a small area development or a major project development (OEH, 2017a). The term 'development footprint' is analogous with the term 'subject land'.
Direct impact	Where an event or circumstance is a direct consequence of the action (Commonwealth of Australia, 2012).
Ecosystem credits	A measurement of the value of threatened ecological communities, threatened species habitat for species that can be reliably predicted to occur with a PCT, and PCTs generally. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at a biodiversity stewardship site (OEH, 2017a).
Ecosystem credit species	Threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for ecosystem credits.
Endangered Ecological Community (EEC)	An ecological community specified as endangered in Schedule 2 of the BC Act, or listed under the EPBC Act (OEH, 2017a).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (OEH, 2017).
Habitat component	The component of habitat that is used by a threatened species for either breeding, foraging or shelter (OEH, 2017a).
Interim Biogeographically Regionalisation of Australia (IBRA) subregion	A subregion of a bioregion identified under the IBRA system (OEH, 2017a).
Indirect impact	Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter (Commonwealth of Australia, 2012).

Term	Meaning
Matter of National Environmental Significance (MNES)	A Matter of National Environmental Significance (MNES) protected by a provision of Part 3 of the EPBC Act.
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (OEH, 2017a).
Mitigation measure	Action to reduce the severity of an impact.
Population	A group of organisms, all of the same species, occupying a particular area.
Residual impact	An impact on biodiversity values after all reasonable measures have been taken to avoid and minimise the impacts of development. Under the BAM, an offset requirement is calculated for the remaining impacts on biodiversity values (OEH, 2017).
Species credit species	Threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for species credits (OEH, 2017a).
Species/ ecosystem credit species	A threatened species whereby part of their habitat is assessed as a species credit (eg breeding habitat) and the remaining habitat is assessed as an ecosystem credit (eg foraging habitat).
Species credits	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Biodiversity Data Collection (OEH, 2019c).
Subject land	Land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land. It includes land that may be a development site, clearing site, proposed for biodiversity certification or land that is proposed for a biodiversity stewardship agreement (OEH, 2017a). The term 'subject land' is analogous with the term 'development footprint'.
Target species	A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.

Abbreviations

Term	Meaning
AOBV	Areas of Outstanding Biodiversity Value
BAM	Biodiversity Assessment Method
BC Act	<i>Biodiversity Conservation Act 2016 (NSW)</i>
BDAR	Biodiversity development assessment report
CEEC	Critically Endangered Ecological Community
DECC	Department of Environment and Climate Change
DoEE	Department of the Environment and Energy
DPI	The former Department of Primary Industries, now Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources)
DBH	Diameter at Breast Height
EEC	Endangered Ecological Community
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW)</i>
EPBC Act	<i>Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i>
FM Act	<i>Fisheries Management Act 1994 (NSW)</i>
IBRA	Interim Biogeographically Regionalisation of Australia
MNES	Matters of National Environmental Significance
OEH	The former Office of Environment and Heritage, now part of the Department of Planning, Industry and the Environment (Environment, Energy and Science)
PCT	Plant Community Type
SEARs	Secretary's environmental assessment requirements
TEC	Threatened Ecological Community
TSC Act	<i>Threatened Species Conservation Act 1995 (now repealed)</i>

1 Introduction

This section provides an overview of the Western Harbour Tunnel and Warringah Freeway Upgrade (the project), including its key features and location. It also outlines the Secretary's environmental assessment requirements addressed in this technical working paper.

1.1 Overview

The Greater Sydney Commission's *Greater Sydney Region Plan – A Metropolis of Three Cities* (Greater Sydney Commission, 2018) proposes a vision of three cities where most residents have convenient and easy access to jobs, education and health facilities and services. In addition to this plan, and to accommodate for Sydney's future growth the NSW Government is implementing the *Future Transport Strategy 2056* (Transport for NSW, 2018), a plan that sets the 40 year vision, directions and outcomes framework for customer mobility in NSW. The Western Harbour Tunnel and Beaches Link program of works is proposed to provide additional road network capacity across Sydney Harbour and to improve transport connectivity with Sydney's northern beaches. The Western Harbour Tunnel and Beaches Link program of works include:

- The Western Harbour Tunnel and Warringah Freeway Upgrade project which comprises a new tolled motorway tunnel connection across Sydney Harbour, and an upgrade of the Warringah Freeway to integrate the new motorway infrastructure with the existing road network, and to connect to the Beaches Link and Gore Hill Freeway Connection project
- The Beaches Link and Gore Hill Freeway Connection project which comprises a new tolled motorway tunnel connection across Middle Harbour from the Warringah Freeway and Gore Hill Freeway to Balgowlah and Killarney Heights and including the surface upgrade of Wakehurst Parkway from Seaforth to Frenchs Forest and upgrade and integration works to connect to the Gore Hill Freeway at Artarmon.

A combined delivery of the Western Harbour Tunnel and Beaches Link program of works would unlock a range of benefits for freight, public transport and private vehicle users. It would support faster travel times for journeys between the Northern Beaches and south, west and north-west of Sydney Harbour. Delivering the program of works would also improve the resilience of the motorway network, given that each project provides an alternative to heavily congested harbour crossings.

1.2 The project

Roads and Maritime Services (Roads and Maritime) is seeking approval under Division 5.2, Part 5 of the *Environmental Planning and Assessment Act 1979* to construct and operate the Western Harbour Tunnel and Warringah Freeway Upgrade, which would comprise two main components:

- A new crossing of Sydney Harbour involving twin tolled motorway tunnels connecting the M4-M5 Link at Rozelle and the existing Warringah Freeway at North Sydney (the Western Harbour Tunnel)
- Upgrade and integration works along the existing Warringah Freeway, including infrastructure required for connections to the Beaches Link and Gore Hill Freeway Connection project (the Warringah Freeway Upgrade).

Key features of the Western Harbour Tunnel component of the project are shown in

Figure 1-1 and would include:

- Twin mainline tunnels about 6.5 kilometres long and each accommodating three lanes of traffic in each direction, connecting the stub tunnels from the M4-M5 Link at Rozelle to the Warringah Freeway and to the Beaches Link mainline tunnels at Cammeray. The crossing

of Sydney Harbour between Birchgrove and Waverton would involve a dual, three lane, immersed tube tunnel

- Connections to the stub tunnels at the M4-M5 Link project in Rozelle and to the mainline tunnels at Cammeray (for a future connection to the Beaches Link and Gore Hill Freeway Connection project)
- Surface connections at Rozelle, North Sydney and Cammeray, including direct connections to and from the Warringah Freeway (including integration with the Warringah Freeway Upgrade), an off ramp to Falcon Street and an on ramp from Berry Street at North Sydney
- A ventilation outlet and motorway facilities (fitout and commissioning only) at the Rozelle Interchange
- A ventilation outlet and motorway facilities at the Warringah Freeway in Cammeray
- Operational facilities including a motorway control centre at Waltham Street, within the Artarmon industrial area and tunnel support facilities at the Warringah Freeway in Cammeray
- Other operational infrastructure including groundwater and tunnel drainage management and treatment systems, signage, tolling infrastructure, fire and life safety systems, lighting, emergency evacuation and emergency smoke extraction infrastructure, CCTV and other traffic management systems.

Key features of the Warringah Freeway Upgrade component of the project are shown in Figure 1-2 and would include:

- Upgrade and reconfiguration of the Warringah Freeway from immediately north of the Sydney Harbour Bridge through to Willoughby Road at Naremburn
- Upgrades to interchanges at Falcon Street in Cammeray and High Street in North Sydney
- New and upgraded pedestrian and cyclist infrastructure
- New, modified and relocated road and shared user bridges across the Warringah Freeway
- Connection of the Warringah Freeway to the portals for the Western Harbour Tunnel mainline tunnels and the Beaches Link tunnels via on and off ramps, which would consist of a combination of trough and cut and cover structures
- Upgrades to existing roads around the Warringah Freeway to integrate the project with the surrounding road network
- Upgrades and modifications to bus infrastructure, including relocation of the existing bus layover along the Warringah Freeway
- Other operational infrastructure, including surface drainage and utility infrastructure, signage, tolling, lighting, CCTV and other traffic management systems.

A detailed description of the project is provided in Chapter 5 (Project description) and construction of the project is described in Chapter 6 (Construction work) of the environmental impact statement. The project alignment at the Rozelle Interchange shown in Figure 1-1 and Figure 1-3 reflects the arrangement presented in the environmental impact statement for the M4-M5 Link, and as amended by the proposed modifications. The project would be constructed in accordance with the finalised M4-M5 Link detailed design (refer to Section 2.1.1 of Chapter 2 (Assessment process) of the environmental impact statement for further details).

The project does not include ongoing motorway maintenance activities during operation or future use of residual land occupied or affected by project construction activities, but not required for operational infrastructure. These would be subject to separate planning and approval processes at the relevant times.

Subject to the project obtaining planning approval, construction is anticipated to commence in 2020 and is expected to take around six years to complete.

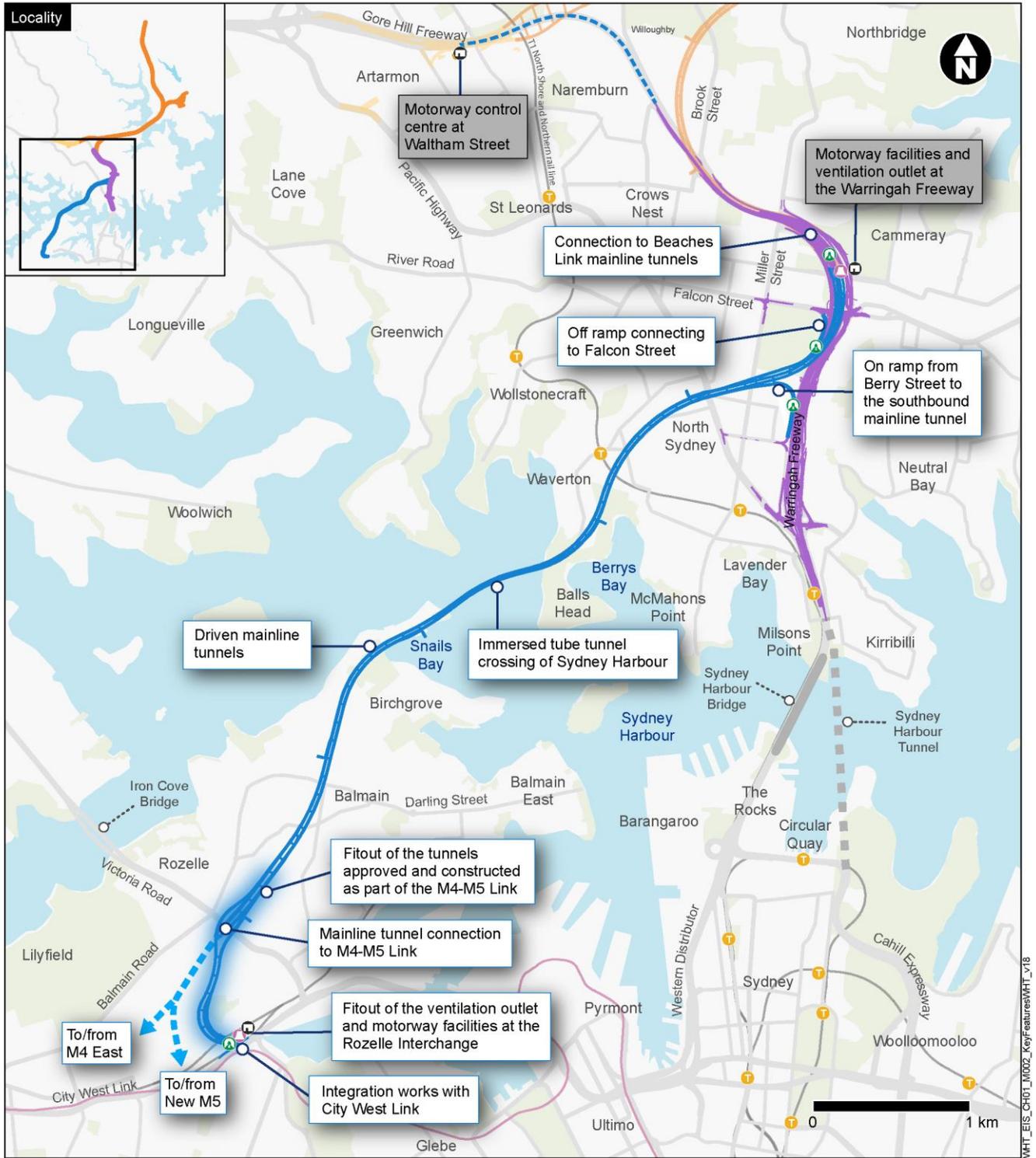
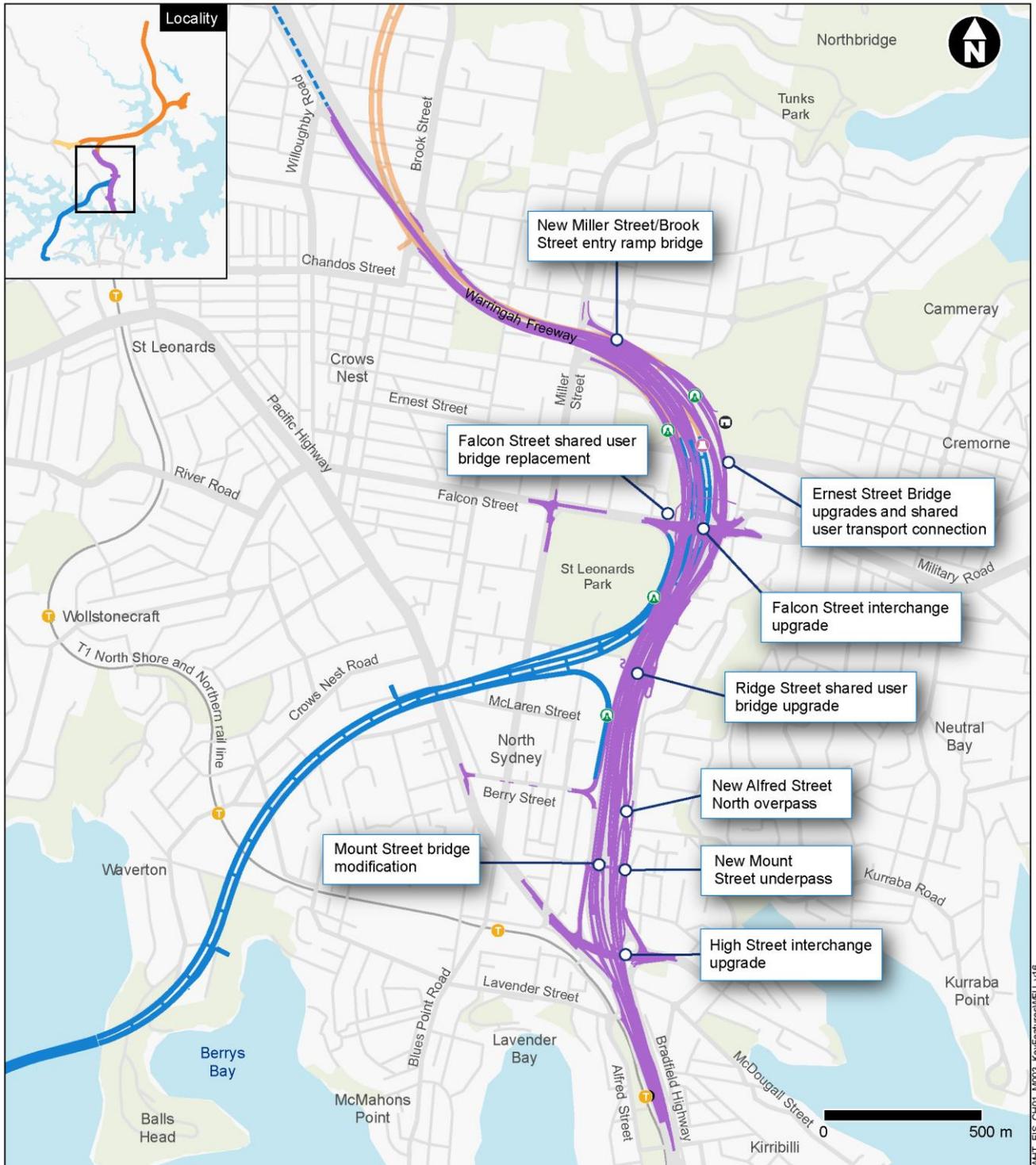


Figure 1-1 Key features of the Western Harbour Tunnel component of the project



Legend

Operational features

- Warringah Freeway Upgrade
- Western Harbour Tunnel
- Communications cable for motorway control centre
- A Surface connection
- D Permanent operational facility
- V Ventilation outlet

Connecting projects

- Beaches Link

Existing rail network

- Heavy rail
- T Train station

Figure 1-2 Key features of the Warringah Freeway Upgrade component of the project

1.3 Key construction activities

The area required to construct the project is referred to as the construction footprint. The majority of the construction footprint would be located underground within the mainline tunnels. However, surface areas would be required to support tunnelling activities and to construct the tunnel connections, tunnel portals and operational ancillary facilities.

Key construction activities would include:

- Early works and site establishment, with typical activities being property acquisition and condition surveys, utilities installation, protection, adjustments and relocations, installation of site fencing, environmental controls (including noise attenuation and erosion and sediment control) and traffic management controls, vegetation clearing, earthworks and demolition of structures, establishment of construction support sites including acoustic sheds and associated access decline acoustic enclosures (where required), construction of minor access roads and the provision of property access, temporary relocation of pedestrian and cycle paths and bus stops, temporary relocation of swing moorings within Berrys Bay and relocation of the historic vessels
- Construction of Western Harbour Tunnel, with typical activities being excavation of tunnel construction accesses, construction of driven tunnels, cut and cover and trough structures, and construction of cofferdams, dredging activities in preparation for the installation of immersed tube tunnels, casting and installation of immersed tube tunnels and civil finishing and tunnel fitout
- Construction of operational facilities comprising of a motorway control centre at Waltham Street in Artarmon, motorway and tunnel support facilities and ventilation outlets at the Warringah Freeway in Cammeray, construction and fitout of the project operational facilities that form part of the M4-M5 Link Rozelle East Motorway Operations Complex, a wastewater treatment plant at Rozelle and the installation of motorway tolling infrastructure
- Construction of the Warringah Freeway Upgrade, with typical activities being earthworks, bridgeworks, construction of retaining walls, stormwater drainage, pavement works and linemarking and the installation of road furniture, lighting, signage and noise barriers
- Testing of plant and equipment, and commissioning of the project, backfill of access declines, removal of construction support sites, landscaping and rehabilitation of disturbed areas and removal of environmental and traffic controls.

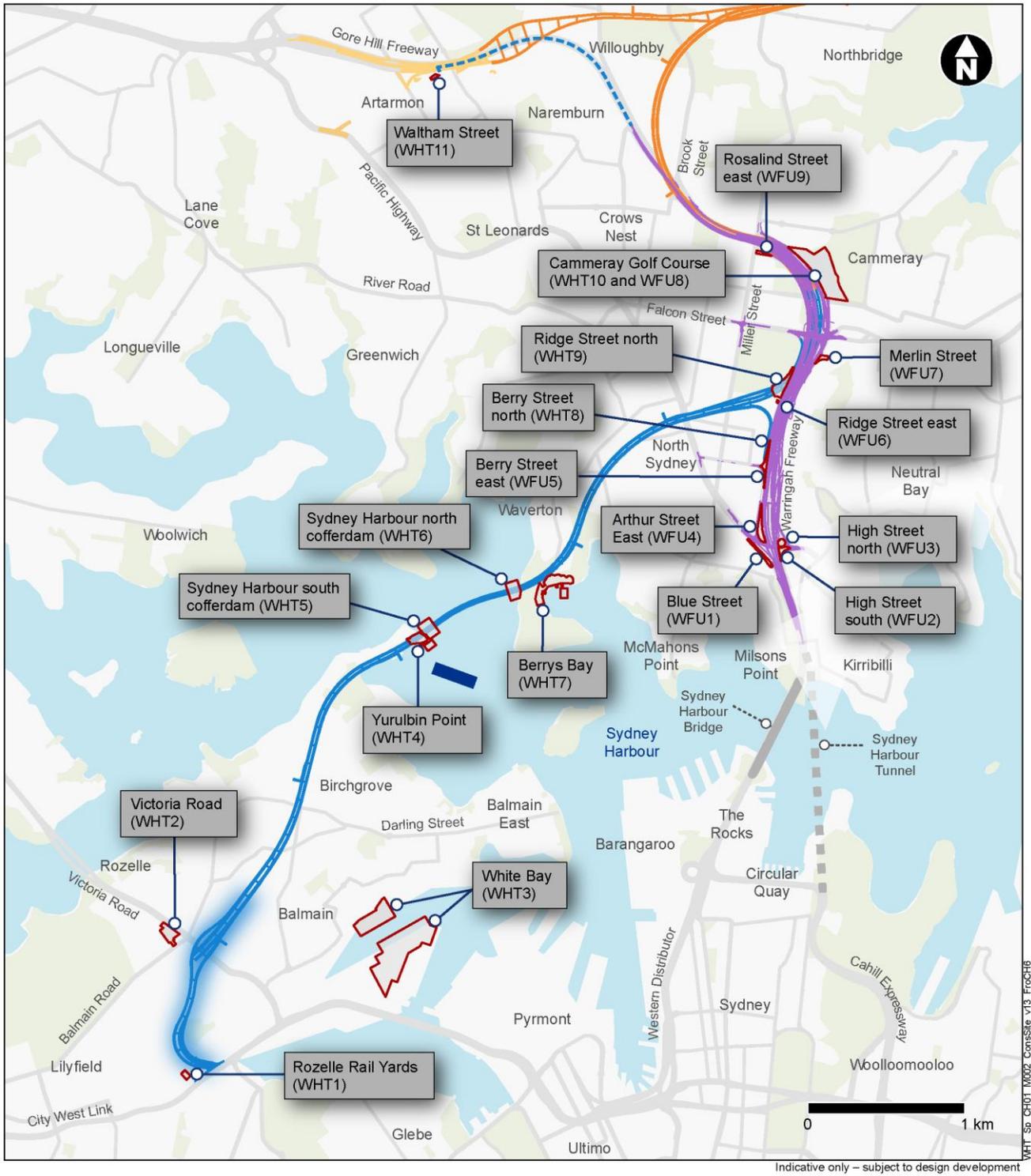
Temporary construction support sites would be required as part of the project (refer to Figure 1-3), and would include tunnelling and tunnel support sites, civil surface sites, cofferdams, mooring sites, wharf and berthing facilities, laydown areas, parking and workforce amenities. Construction support sites for Western Harbour Tunnel would include:

- Rozelle Rail Yards (WHT1)
- Victoria Road (WHT2)
- White Bay (WHT3)
- Yurulbin Point (WHT4)
- Sydney Harbour south cofferdam (WHT5)
- Sydney Harbour north cofferdam (WHT6)
- Berrys Bay (WHT7)
- Berry Street north (WHT8)
- Ridge Street north (WHT9)
- Cammeray Golf Course (WHT10)
- Waltham Street (WHT11).

During the construction of the Warringah Freeway Upgrade, smaller construction support sites would be required to support the construction works (as shown on Figure 1-3). These include:

- Blue Street (WFU1)
- High Street south (WFU2)
- High Street north (WFU3)
- Arthur Street east (WFU4)
- Berry Street east (WFU5)
- Ridge Street east (WFU6)
- Merlin Street (WFU7)
- Cammeray Golf Course (WFU8)
- Rosalind Street east (WFU9).

A detailed description of construction works for the project is provided in Chapter 6 (Construction work) of the environmental impact statement.



Legend

Construction features

- █ Western Harbour Tunnel
- █ Warringah Freeway Upgrade
- Communications cable for motorway control centre
- Fit out and commissioned as part of Western Harbour Tunnel, constructed as part of WestConnex M4-M5 Link

- Construction support sites
- Mooring site

Connecting projects

- █ Beaches Link
- █ Gore Hill Freeway Connection

Figure 1-3 Overview of construction support sites

1.4 Project location

The project would be located within the Inner West, North Sydney and Willoughby local government areas, connecting Rozelle in the south with Naremburn in the north.

Commencing at the Rozelle Interchange, the mainline tunnels would pass under Balmain and Birchgrove, then cross Sydney Harbour between Birchgrove and Balls Head. The tunnels would then continue under Waverton and North Sydney, linking directly to the Warringah Freeway to the north of the existing Ernest Street bridge.

The motorway control centre would be located at Waltham Street, Artarmon, with a trenched communications cable connecting the motorway control centre to the Western Harbour tunnel along the Gore Hill Freeway and Warringah Freeway road reserves.

The Warringah Freeway Upgrade would be carried out on the Warringah Freeway from around Fitzroy Street at Milsons Point to around Willoughby Road at Naremburn. Upgrade works would include improvements to bridges across the Warringah Freeway, and upgrades to surrounding roads.

1.5 Purpose of this report

This report has been prepared to support the environmental impact statement for the project and to address the environmental assessment requirements of the Secretary of the Department of Planning, Industry and Environment (formerly Department of Planning and Environment) ('the Secretary's environmental assessment requirements'). This report aims to:

- Identify the biodiversity values on land proposed to be developed for the project
- Determine the impacts of the project on biodiversity values
- Quantify and describe the biodiversity credits required to offset the residual impacts of the project.

This report also identifies how Roads and Maritime (the proponent) proposes to avoid and minimise impacts on biodiversity, and describes any potential impacts of the project that could be characterised as serious and irreversible.

This report has been prepared to meet the requirements of:

- Secretary's environmental assessment requirements, relating to biodiversity, as specified in Section 1.6
- Biodiversity Assessment Method (BAM) (Office of Environment and Heritage (OEH), 2017a), as specified in Section 1.8.

The assessment of the potential impacts to marine mammals and reptiles, fish and marine habitats as a result of the project has been addressed within Technical working paper: Marine ecology (Cardno, 2020).

1.6 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements relating to biodiversity and where these requirements are addressed in this report are outlined in Table 1-1.

Table 1-1 Secretary's environmental assessment requirements – Biodiversity

Requirement	Where addressed
1. Biodiversity impacts related to the proposal are to be assessed in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR).	This report.
2. The BDAR must include information in the form detailed in the <i>Biodiversity Conservation Act 2016</i> (s. 6.12), <i>Biodiversity Conservation Regulation 2017</i> (s. 6.8) and Biodiversity Assessment Method including details of the measures proposed to address the offset obligation as follows: <ol style="list-style-type: none"> the total number and classes of biodiversity credits required to be retired for the developments/project; the number of classes of like-for-like biodiversity credits proposed to be retired; the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; any proposal to fund a biodiversity conservation action; and any proposal to make a payment to the Biodiversity Conservation Fund. 	This report. Offsets are discussed in Section 7 of this report.
3. If requesting the application of the variation rules, the BDAR must contain details of what reasonable steps have been taken to attempt to obtain the required like-for-like biodiversity credits.	Not applicable.
4. The BDAR must be prepared by a person accredited in accordance with the Accreditation scheme for the Application of the Biodiversity Assessment Method Order 2017 under s. 6.10 of the <i>Biodiversity Conservation Act 2016</i> .	This BDAR has been prepared by Jane Rodd and Kate Carroll, both accredited persons under the <i>Biodiversity Conservation Act 2016</i> (BC Act) (Accreditation number BAAS17030 and BAAS17070).
5. In accordance with sections 9.1 and 9.2 of the Biodiversity Assessment Method the BDAR must assess all direct and indirect impacts of the proposal on native vegetation, threatened ecological communities and threatened species habitat.	Section 5 of this report.
6. Impacts on biodiversity values that cannot be assessed using the Biodiversity Assessment Method must also be otherwise assessed. The values include: <ol style="list-style-type: none"> marine mammals; wandering seabirds; and matters of national significance listed under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>. 	Section 5 of this report, which provides a summary of the Technical working paper: Marine ecology (Cardno, 2020).
7. Species declared as threatened under the <i>Biodiversity Conservation Act 2016</i> and recorded recently (since 1990) within approximately 1.5 kilometres of the project's development corridor should be considered as likely to be affected by the proposal.	Sections 3.6 and 5 of this report.

1.7 Legislative context

1.7.1 Biodiversity Conservation Act 2016

The purpose of the *Biodiversity Conservation Act 2016* (BC Act) is to 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.

The BC Act replaced the *Threatened Species Conservation Act 1995* (TSC Act) on 25 August 2017. The BC Act incorporates broadly similar objectives to those identified in the TSC Act, and additionally seeks to establish a framework for assessment and offsetting of development impacts as well as investment in biodiversity conservation, specifically:

- The NSW Biodiversity Offsets Scheme, established under Part 6 of the BC Act
- The BAM, established under Section 6.7 of the BC Act. The purpose of the BAM is to assess certain impacts on threatened species and threatened ecological communities (TECs), and their habitats, and the impact on biodiversity values, where required under the BC Act.

The NSW Biodiversity Offsets Scheme applies to State significant infrastructure projects, unless the Secretary of the Department of Planning, Industry and Environment, as well as the Chief Executive of the Department of Planning, Industry and Environment (Environment, Energy and Science) determine that the project is not likely to have a significant impact. Under the NSW Biodiversity Offsets Scheme, an accredited assessor must apply the BAM to the proposal.

1.7.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is Commonwealth legislation that provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as Matters of National Environmental Significance (MNES). MNES identified in the EPBC Act include:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Threatened species and communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines).

In accordance with sections 67 and 67A of the EPBC Act, any works that have the potential to result in an impact on any MNES or on Commonwealth land are considered 'controlled actions' and require a referral to the Federal Minister for the Environment for approval.

1.8 Biodiversity Assessment Method requirements

The BAM (OEH, 2017a) is the assessment manual that outlines how an accredited person assesses impacts on biodiversity at development sites. The BAM provides:

- A consistent method for the assessment of biodiversity on a proposed development or major project, or clearing site
- Guidance on how a proponent can avoid and minimise potential biodiversity impacts
- The number and class of biodiversity credits that need to be offset to achieve a standard of 'no net loss' of biodiversity.

An accredited assessor must document the results of the BAM in a Biodiversity development assessment report (BDAR). The BDAR identifies how the proponent proposes to avoid and minimise impacts, any potential impact that could be characterised as serious and irreversible (according to specified principles) and the offset obligation required to offset the likely biodiversity impacts of the development or clearing proposal, expressed in biodiversity credits.

The requirements for a BDAR (major projects) are listed in Appendix 10 of the BAM. Table 1-2 identifies where each requirement has been met in this report.

Table 1-2 Minimum information requirements for a BDAR (OEH, 2017a)

BAM Requirement		Where addressed in this BDAR
Section	Information to be included	
Introduction	Identification of development site* footprint, including: <ul style="list-style-type: none"> Operational footprint Construction footprint indicating clearing associated with temporary construction facilities and infrastructure. 	Section 1.2 Section 1.3 Section 2.2
	General description of development site*.	Section 1.1
	Sources of information used in the assessment, including reports and spatial data.	Section 2.3
Landscape features	<ul style="list-style-type: none"> Interim Biogeographically Regionalisation of Australia (IBRA) bioregions and subregions, NSW landscape region and area (ha) Native vegetation extent in the assessment area Cleared areas Evidence to support differences between mapped vegetation extent and aerial imagery Rivers and streams classified according to stream order Wetlands within, next to and downstream of the site Connectivity features Areas of geological significance and soil hazard features Site context components, including: <ul style="list-style-type: none"> Identification of method applied (ie linear or site-based) Per cent native vegetation cover in the landscape (development site*). 	Section 3.1
Native vegetation	Describe Plant Community Types (PCTs) within the development site*.	Section 3.3
	Perform a vegetation integrity assessment of the development site*.	Not applicable
Threatened species	Identify ecosystem credit species associated with PCTs on the development site*.	Not applicable
	Identify species credit species on the development site*.	Section 3.6
Avoid and minimise impacts	Demonstration of efforts to avoid and minimise impact on biodiversity values.	Section 4
	Assessment of direct and indirect impacts unable to be avoided at the development site*.	Section 5

BAM Requirement		Where addressed in this BDAR
Section	Information to be included	
	Details of the adaptive management strategy proposed to monitor and respond to impacts on biodiversity values that are uncertain.	Not applicable
Impact summary	Identification and an assessment of the impacts which are potential serious and irreversible impacts.	Section 5.3
	Identification of impacts requiring offsets.	Section 7
	Identification of impacts not requiring offsets.	Section 7
	Identification of areas not requiring further assessment.	Section 7
	Ecosystem credits and species credits that measure the impact of the development on biodiversity values.	Section 7
Biodiversity credit report	Credit classes for ecosystem credits and species credits at the development site*.	Section 3.6

* note – the term 'development site' is a term used by the BAM, which for the purposes of this assessment, is analogous with the terms 'subject land' and 'development footprint'

2 Methodology

2.1 Overview

The preparation of this BDAR has been informed by database searches, desktop review of relevant reports and spatial information, site inspections and targeted field surveys.

The scope of work for this BDAR was to:

- Carry out a desktop review of databases, reports, aerial photographs and vegetation and habitat mapping relevant to the subject land (refer to Section 2.2.1 for a definition of the subject land)
- Describe flora and fauna species, populations, ecological communities and habitat that occur or are considered likely to occur in the subject land, including:
 - Terrestrial flora species and populations
 - Terrestrial and arboreal fauna species and populations
 - Wandering seabirds, shorebird species (ie birds that inhabit the shorelines of coasts and inland water bodies during most of their lifecycles) and Little Penguin
- Determine the presence or likely occurrence of threatened species, population and ecological communities (or their habitats) as listed under the BC Act and EPBC Act to occur in the subject land
- Assess impacts of the project on native vegetation, threatened species, populations, ecological communities and their habitats, and groundwater dependent ecosystems that occur in the subject land
- Identify and describe environmental management measures using the principles of ‘avoid, minimise, mitigate’
- Outline any offsetting requirements.

The assessment of the potential impacts to marine mammals, reptiles, fish and marine habitats as a result of the project has been addressed within Technical working paper: Marine ecology (Cardno, 2020).

2.2 Subject land for this assessment

The land in which biodiversity values have been assessed by this BDAR is known as the subject land. The subject land sits within a larger assessment area.

2.2.1 Definition of subject land

The term ‘subject land’ is analogous with the term ‘construction footprint’ that is used in the environmental impact statement, and with the term ‘development footprint’ that is prescribed by the BAM. The subject land is shown in Figure 2-1.

The subject land comprises the construction (temporary) footprint and design (operational) footprint being considered by the environmental impact statement. The subject land consists of land (at surface level) that would be directly impacted by construction and operation of the project, and would support activities such as vegetation clearing, earthworks, establishment of access roads and construction support sites, installation of utilities, construction of surface roads and tunnels, and surface operation facilities.

The subject land is located within two kilometres of Sydney's Central Business District, and as such, is heavily urbanised. Land uses within the subject land include:

- Residential development within the suburbs of Rozelle, Balmain, Birchgrove, Waverton and North Sydney
- Commercial development, predominately in the suburb of North Sydney
- Industrial areas in Rozelle, White Bay and Artarmon
- Public parks and open space such as Yurulbin Park (Birchgrove) and the Coal Loader Centre of Sustainability (Waverton)
- A portion of Sydney Harbour between Birchgrove and Waverton and a number of bays including Rozelle Bay, White Bay, Snails Bay, Berrys Bay and Balls Head Bay.

The only area of mapped native vegetation within the subject land is located in the south-west of the Berrys Bay construction support site (WHT7). This mapped native vegetation occurs within an exclusion zone and no vegetation clearing would occur within this area.

2.2.2 Definition of assessment area

In accordance with the BAM for assessing linear-shaped developments, a buffer of 500 metres was applied to the subject land to determine the assessment area. Consideration of the assessment area (that surrounds the subject land) is required as the assessment area may contain biodiversity values that are important for informing the likely habitat suitability of the subject land. The assessment area is shown in Figure 2-1.

In accordance with the requirements of the BAM, Figure 2-1 also shows landscape features including:

- IBRA region and subregion
- Local government areas
- Rivers and streams classified according to stream order (Strahler, 1952)
- Native vegetation cover.

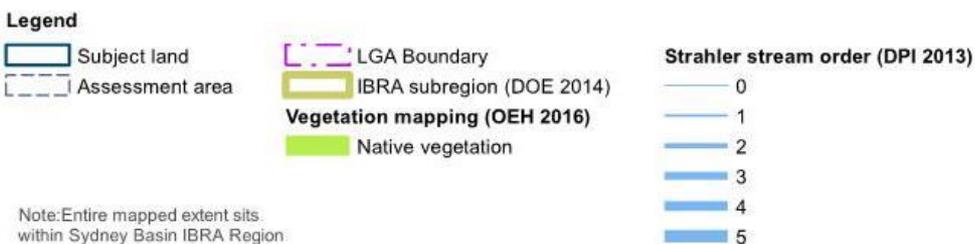
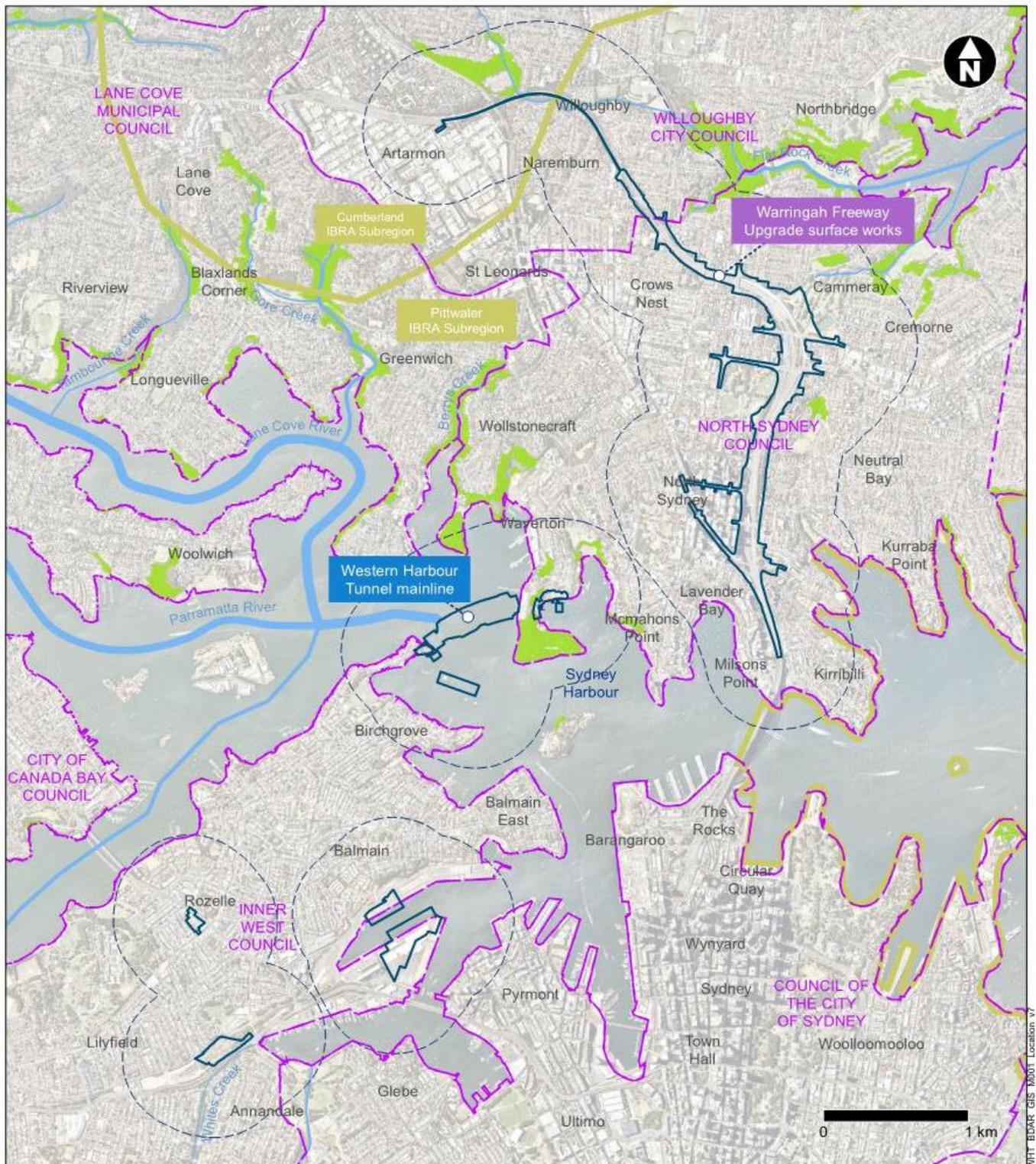


Figure 2-1 Location of the subject land

2.3 Assessment guidelines and information sources

The assessment presented in this BDAR was carried out in accordance with the requirements of the BAM (OEH, 2017a). Other assessment guidelines used to inform this BDAR include:

- *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Department of Primary Industries (DPI, 2012)
- *NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft Nov 2004* (NSW Department of Environment and Conservation, 2004)
- *Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013* (DPI, 2013)
- *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries, 2003)
- *Aquatic Ecology in Environmental Impact Assessment – EIA Guideline* (Lincoln Smith, 2003)
- *Matter of National Environmental Significance Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia, 2013)
- *Commonwealth Survey Guidelines for Australia’s Threatened Bats* (Department of Environment Water Heritage and the Arts, 2010b)
- *Referral guideline for management actions in Grey-head and Spectacled Flying-fox camps* (Commonwealth of Australia, 2015).

Relevant sources of information used to inform this BDAR include:

- *HarbourLink Option Alignment Ecological Constraints* (WSP | Parsons Brinckerhoff, 2016)
- *Harbourlink Terrestrial Biodiversity Survey Report* (WSP, 2018)
- *Western Harbour Tunnel and Warringah Freeway Upgrade Project Freshwater ecology impact assessment* (Cardno, 2020) (provided in Appendix D)
- *Western Harbour Tunnel and Warringah Freeway Upgrade Technical working paper: Marine ecology* (Cardno, 2020)
- *Soil Landscapes of the Sydney 1:100 000 Sheet* (Chapman and Murphy, 1989)
- *The Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area* (version 3.0) (OEH, 2016).

2.4 Background research

2.4.1 Literature review

A review of relevant information was carried out to provide an understanding of ecological values occurring or potentially occurring in the subject land and wider region. Reports, vegetation maps, topographic maps, aerial photography and literature reviewed included the following:

- *Soil Landscapes of the Sydney 1:100 000 Sheet* (Chapman and Murphy, 1989)
- *The Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area* (version 3.0) (OEH, 2016)
- *Sydney Harbour: A systematic review of the science 2014* (Hedge et al., 2013).

Background research included review of the findings and recommendations of the preliminary ecological constraint report and biodiversity surveys carried out by WSP | Parsons Brinckerhoff and WSP:

- *HarbourLink Option Alignment Ecological Constraints* (WSP | Parsons Brinckerhoff, 2016)
- *Harbourlink Terrestrial Biodiversity Survey Report* (WSP, 2018).

2.5 Determination of candidate species

Candidate threatened species for assessment were identified using the BAM credit calculator and supplemented with database searches.

A list of candidate species was generated using the BAM credit calculator, based on one vegetation zone of 0.13 hectares of PCT 1778 located at Berrys Bay.

Database searches were carried out to identify State and Commonwealth records of threatened entities and Commonwealth MNES that occur or have the potential to occur near the subject land (Table 2-1). Databases were first interrogated by WSP before their site inspections and more recently by Arcadis, to ensure currency of the database search results.

Two analyses of the April 2019 Bionet Atlas of NSW Wildlife database searches were conducted by Arcadis:

- Assessment of the likelihood of occurrence of all species recorded within 10 kilometres of the subject land
- Assessment of the likelihood of occurrence of species declared as threatened under the BC Act and recorded recently (since 1990) within around 1.5 kilometres of the subject land (as required by the Secretary's environmental assessment requirements).

The likelihood of each threatened flora and fauna species identified in database searches to occur in the subject land was assessed using information on the known geographic distribution and habitat requirements of each species (Appendix A).

The results of the EPBC Protected Matters Search Tool are provided in Appendix B.

Table 2-1 Database searches carried out

Database	Search date	Area searched	Reference
Bionet Atlas of NSW Wildlife	8 and 16 June 2016 (WSP, 2018) 31 May 2017 (WSP, 2018)	An area within 10 kilometres of the subject land as defined by WSP.	The Department of Planning, Industry and Environment (Environment, Energy and Science) (formerly OEH) http://www.bionet.nsw.gov.au/
	1 April 2019	An area within 10 kilometres of the subject land. An area within 1.5 kilometres of the subject land (post-1990 records only).	
EPBC Protected Matters Search Tool	31 May 2017 (WSP, 2018)	An area within 10 kilometres of the subject land as defined by WSP.	Department of the Environment and Energy http://www.environment.gov.au/epbc/protected-matters-search-tool
	20 March 2019	An area within 10 kilometres of the subject land.	

Database	Search date	Area searched	Reference
Threatened biodiversity profile search	Interrogated throughout the preparation of this report.	Searches carried out for species and ecosystems known or likely to occur in subject land.	The Department of Planning, Industry and Environment (Environment, Energy and Science) (formerly OEH) http://www.environment.nsw.gov.au/threatenedspeciesapp/

In addition, consideration was given to records of threatened species occurring in the North Sydney local government area, in the northern extent of the project, as provided by North Sydney Council's *Wildlife Watch* program. The locations of various threatened species were recorded between 2000 and 2018.

2.6 Field surveys

Field surveys were carried out at sites within the subject land by WSP ecologists between May 2016 and November 2017 and by Arcadis ecologists between February 2018 and March 2019 (Table 2-2).

Table 2-2 Sites surveyed to inform this BDAR

Survey area	Surveyor	Date	Purpose of survey
Yurulbin Point construction support site (WHT4), Berrys Bay construction support site (WHT7)	WSP	May-June 2016	To assess the extent and condition of vegetation and fauna habitat, especially for threatened species and ecological communities.
Yurulbin Point construction support site (WHT4), Berrys Bay construction support site (WHT7)	WSP	May 2016	To assess the extent and condition of vegetation and fauna habitat, especially for threatened species and ecological communities.
Artarmon	WSP	July 2016	To assess the extent and condition of vegetation and fauna habitat, especially for threatened species and ecological communities.
Balls Head Reserve, Berrys Bay construction support site (WHT7), Yurulbin Point construction support site (WHT4), Berry Island Reserve, Robinsons Point, Snails Bay).	WSP	March 2017	To identify the presence of threatened shorebirds and/or their habitat.

Survey area	Surveyor	Date	Purpose of survey
Warringah Freeway	WSP	October 2017	To assess the extent and condition of vegetation and fauna habitat, especially for threatened species and ecological communities, and to conduct targeted threatened flora surveys.
Yurulbin Point construction support site (WHT4)	Arcadis	February 2018	To verify existing vegetation mapping and to characterise the vegetation present.
Berrys Bay construction support site (WHT7)	Arcadis	February 2018	To verify existing vegetation mapping and to characterise the vegetation present; to conduct inspections of potential bat roosting habitat and targeted surveys for threatened microbats.
The Coal Loader Centre of Sustainability, Waverton	Arcadis	May 2018	To describe the features of the existing microbat roost located within the Coal Loader tunnel.
Rozelle Bay near Rozelle Rail Yards (WHT1), Snails Bay near Yurulbin Point construction support site (WHT4), Yurulbin Point construction support site (WHT4)	Arcadis	May 2018	To ground-truth and describe intertidal habitats within the subject land, based on previous mapping by Creese et.al. (2003) and information presented in Technical working paper: Marine ecology (Cardno, 2020).
The Coal Loader Centre of Sustainability, Waverton, near Sydney Harbour north cofferdam (WHT6)	Arcadis	June 2018	To verify the presence and estimate the number of roosting microbats within the Coal Loader tunnel.
Balls Head Bay, near Sydney Harbour north cofferdam (WHT6)	Arcadis	June 2018	To verify the location and assess a known Southern Myotis (<i>Myotis macropus</i>) roost.
Warringah Freeway (Jeaffreson Jackson Reserve/Falcon Street shared user bridge, Cammeray) and Berry Street, North Sydney	Arcadis	March 2019	To verify existing vegetation mapping and to characterise the vegetation and fauna habitat present.

2.6.1 Vegetation surveys

Vegetation surveys were carried out across the subject land by WSP ecologists, as documented in WSP (2018), and Arcadis ecologists (as summarised in Table 2-2), to verify existing vegetation mapping and to characterise the vegetation present at each site that was surveyed.

2.6.1.1 Random meander survey

Random meanders are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the surveyor randomly meanders throughout the subject land recording dominant and key plant species (eg threatened species, weeds), boundaries between various vegetation communities and condition of vegetation. WSP (2018) conducted random meander surveys in the vegetation of the subject land in 2016 and 2017, and Arcadis conducted random meander surveys in parts of the subject land between 2017 and 2019.

The time spent in each vegetation community was generally proportional to the size of the community and its species richness. This survey technique was used to verify vegetation boundaries and stratification from the desktop analysis (WSP, 2018).

2.6.1.2 BAM vegetation integrity plots

No BAM vegetation integrity plot surveys were carried out, as none of the vegetation to be directly impacted by the project falls within the description of any PCTs listed in the BioNet Vegetation Classification Database (OEH, 2019b). Although a small area of PCT 1778 is mapped in the south-western corner of the Berrys Bay construction support site (WHT7), this vegetation is within an exclusion zone and would not be subject to direct impacts from the project.

2.6.2 Threatened species surveys

Targeted threatened species surveys were carried out within the subject land by WSP ecologists between May 2016 and November 2017 and by Arcadis ecologists between February 2018 and March 2019. The survey techniques, optimum survey period and dates of targeted surveys for threatened flora and fauna species are summarised in Table 2-3 and Table 2-4, respectively.

Given that the subject land is highly urbanised and native vegetation has largely been cleared for the development for residential, commercial and industrial land uses, intact habitat is generally absent from the subject land.

As such, threatened species surveys in the subject land were limited to targeted surveys for threatened flora and fauna known to occur in modified and disturbed environments, such as birds and bats. Some survey sites were located outside of the subject land for this project. However, given the mobile nature of the target species (eg bats and owls), the results have been considered in this assessment.

2.6.2.1 Threatened flora surveys

WSP ecologists conducted targeted surveys for 18 threatened flora species identified as having a moderate to high likelihood of occurring in the larger study area for the *HarbourLink Terrestrial Biodiversity Survey Report* (WSP, 2018). Three of these threatened flora species were targeted within areas in the subject land. Of the three threatened flora species targeted, only one was considered likely to occur in the subject land based on the habitat assessment (Appendix A).

The BAM outlines survey requirements for threatened species including requirements for seasonal surveys to maximise the likelihood of recording a species if present. The optimum survey period and dates for each threatened flora species targeted by these surveys are summarised in Table 2-3.

Table 2-3 Threatened flora species survey techniques, locations and timing

Species	BC Act status*	EPBC Act status*	Survey technique	Survey location	Seasonal survey requirements#	Survey timing
<i>Acacia terminalis</i> subsp. <i>terminalis</i> (Sunshine Wattle)	E	E	Random meander	Waverton/Birchgrove and Warringah Freeway	Any season	10–12 May 2016 22 June 2016 9,10, 27, 30, 31 October 2017 18 March 2019
<i>Eucalyptus camfieldii</i> (Heart-leaved Stringybark)	V	V	Random meander	Waverton/Birchgrove	Any season	10–12 May 2016 22 June 2016 9,10, 27, 30, 31 October 2017
<i>Microtis angusii</i> (Angus's Onion Orchid)	E	E	Random meander	Highly disturbed areas with limited or no vegetation	October-May	9,10, 27, 30, 31 October 2017

*V=Vulnerable, E=Endangered

Optimal time of year for survey is based on survey months provided in Bionet

2.6.2.2 Threatened fauna surveys

Targeted seasonal surveys were completed for threatened fauna species identified as having a moderate to high likelihood of occurring within the subject land, which mainly included species known to occur in modified and disturbed environments. Terrestrial fauna survey locations are shown in Figure 2-2.

Threatened fauna surveys completed within the subject land were carried out as described below and, where applicable, considered the methodology detailed in the *NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (Department of Environment and Conservation, 2004) and *Survey Guidelines for Australia's Threatened Birds* (Department of Environment Water Heritage and the Arts, 2010). Threatened species survey locations are shown in Figure 2-2. The optimum survey period and dates surveyed for each threatened fauna species targeted by these surveys are summarised in Table 2-4.

2.6.2.2.1 Diurnal bird surveys

A bird survey was completed targeting diurnal species by actively walking through a site over a period of 20 minutes. All birds were identified to the species level, either through direct observation or identification of calls. Bird surveys were completed during different times of the day, but generally occurred during morning hours or evening. Birds were also recorded opportunistically during all other surveys.

In addition, targeted surveys were conducted for threatened shorebirds within intertidal habitats in the subject land and wider assessment area. Shorebird surveys were carried out at Robinsons Point and Yurulbin Park (Birchgrove), Snails Bay, Balls Head Reserve (Waverton), Berrys Bay and Berry Island Reserve (Wollstonecraft).

2.6.2.2.2 Microbat survey and roosting habitat assessment

A diurnal inspection of all existing sheds and buildings located within the subject land at Berrys Bay construction support site (WHT7) was carried out. Inside each structure, wall cavities, ceiling cavities, beams, upright pylons, crevices and any other areas considered to contain potential microbat roosting habitat (for species known to roost in man-made structures) were inspected. These areas were examined for signs of past or current microbat use (evidence of guano) and their value as roosting habitat was assessed. The outside of each structure was examined for potential microbat entry and exit points.

Ecologists with spotlights were then stationed at these potential microbat exit points from dusk, to determine whether any microbats were leaving the buildings. Handheld Anabats (bat detectors) were used to record the echolocation calls of any microbats exiting the buildings.

A diurnal inspection of the one Coal Loader tunnel which is known to support roosting microbats over winter was carried out. The tunnel roof and visible cavities were inspected with a torch, and the number of microbats present was estimated. The tunnel roof is about six metres high, and many cavities were obscured from sight at ground level, and so it is likely that additional microbats were present and not able to be counted.

A known Southern Myotis (*Myotis macropus*) roost, located within one kilometre of the subject land, was visited to determine its proximity to proposed construction activities, to allow an assessment of potential indirect impacts on this roosting habitat. To protect this roost, its location is not shown on Figure 2-2.

Bat call analyses were completed by Nathan Cooper of WSP and Carl Corderm of Arcadis, with the presentation of data considering the guidelines of the Australasian Bat Society. *Bat calls of New South Wales: Region based guide to the echolocation calls of microchiropteran bats*, (Pennay et al., 2004) was used as a reference collection for bat call identification.

2.6.2.2.3 Opportunistic sightings

At all survey locations, all fauna species and evidence of fauna presence observed was recorded by WSP and Arcadis ecologists. An inventory of fauna species recorded in the subject land by Arcadis was compiled (Appendix C).

Opportunistic fauna surveys involved:

- Direct visual observations of animal activity
- Aural recognition of bird and frog calls
- Indirect evidence of fauna (such as scats, nests, burrows, hollows, tracks, scratches and diggings).

An inventory of fauna species recorded by WSP during field investigations is provided in *Harbourlink Terrestrial Biodiversity Survey Report* (WSP, 2018).

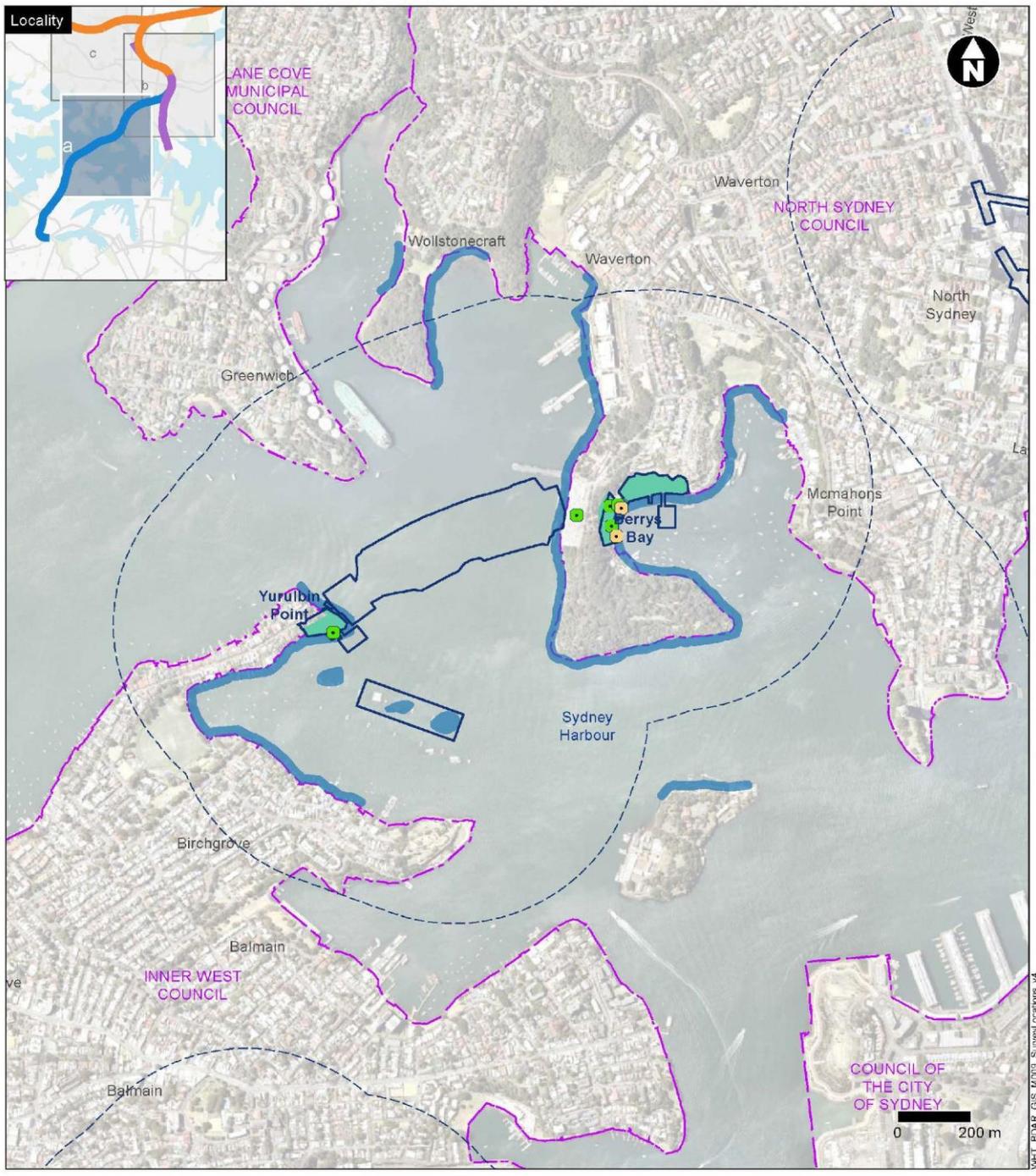


Figure 2-2 Threatened species survey locations (map a)

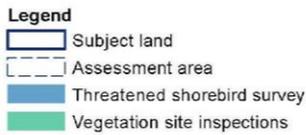
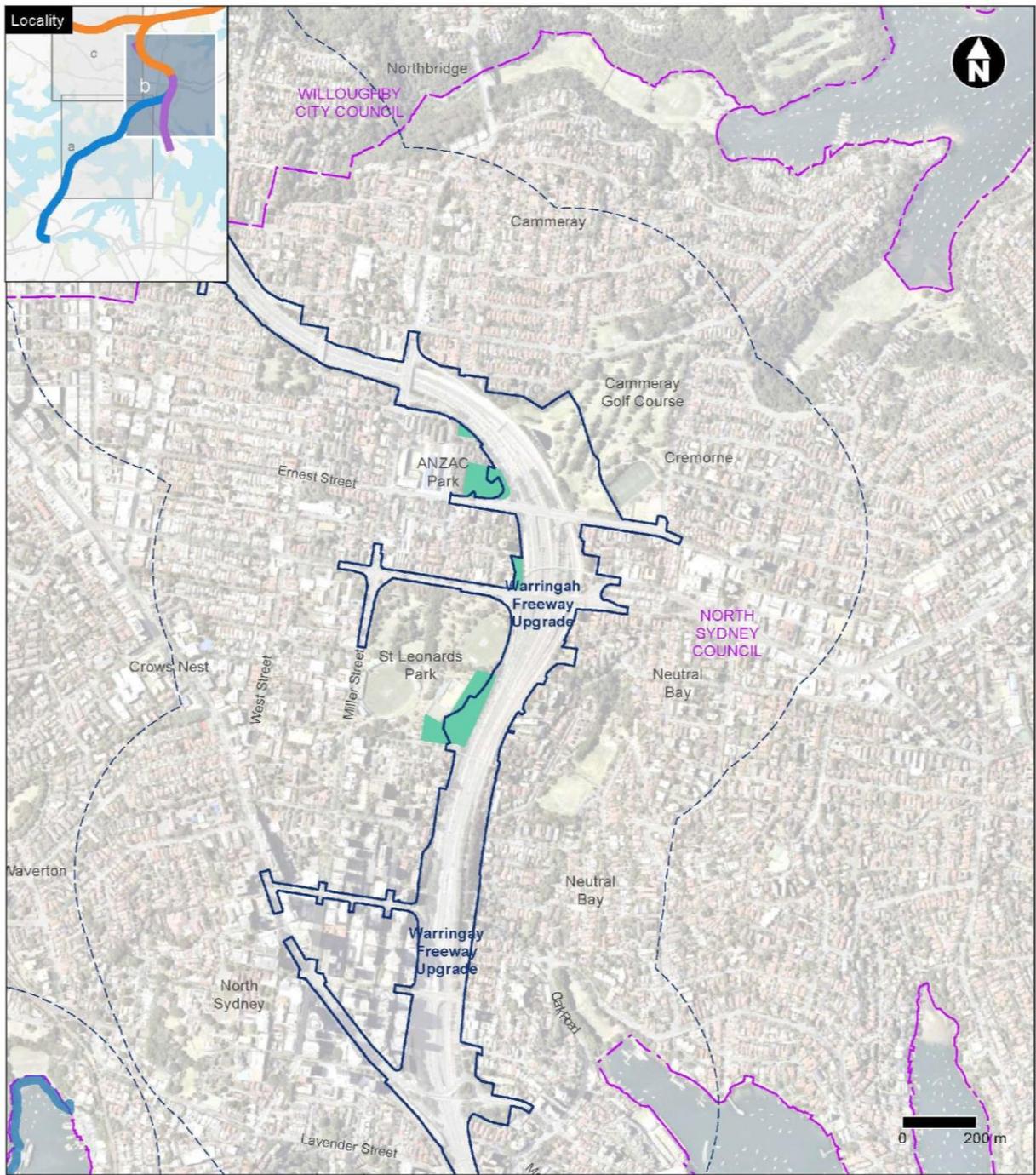
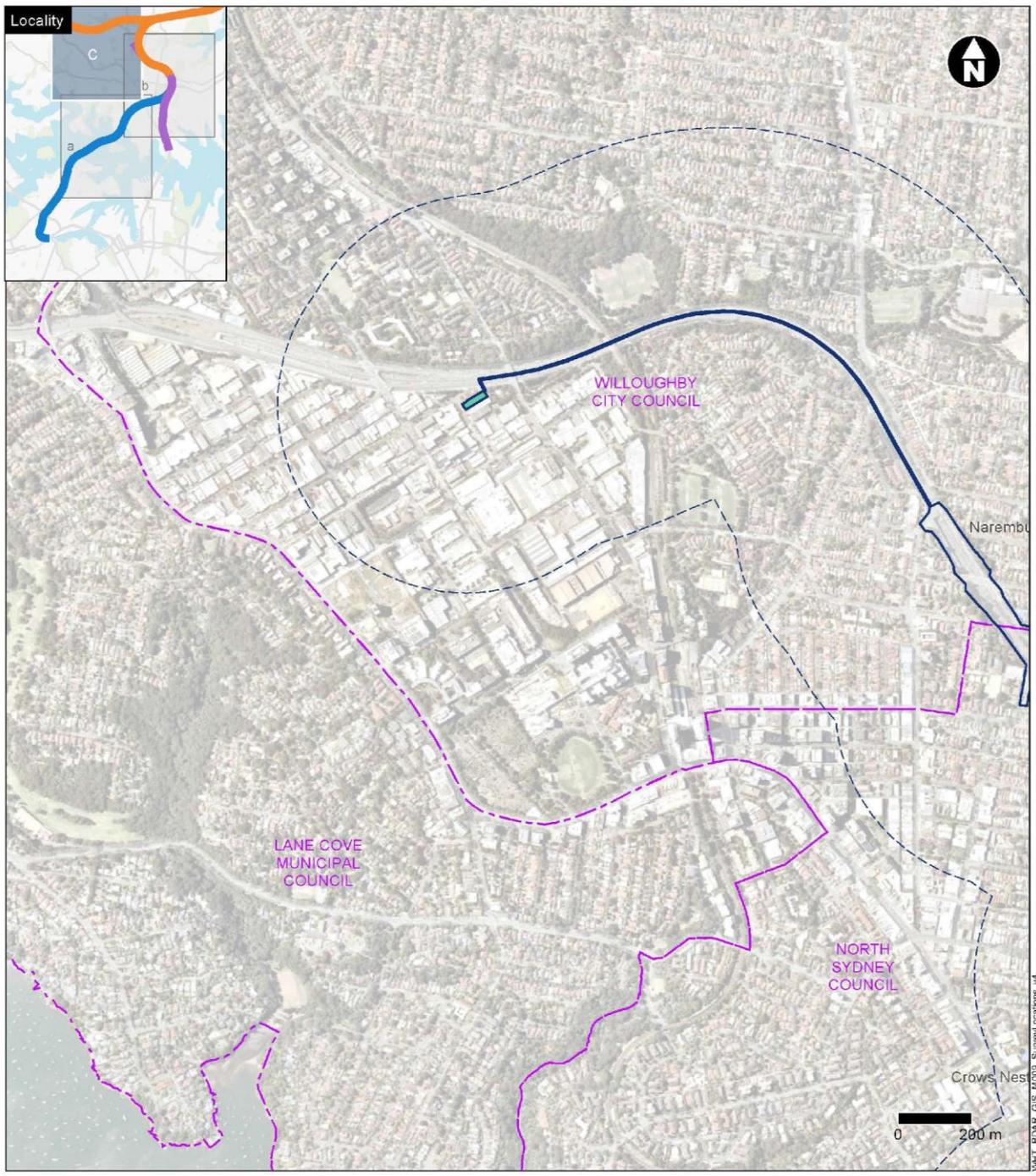


Figure 2-2 Threatened species survey locations (map b)



Legend
 [Blue outline] Subject land
 [Dashed purple outline] Assessment area
 [Solid purple outline] Vegetation site inspections

Figure 2-2 Threatened species survey locations (map c)

Table 2-4 Threatened fauna species survey techniques, locations and timing

Species	BC Act status*	EPBC Act status*	Survey technique	Survey effort	Survey location	Seasonal survey requirements#	Survey timing
Sooty Oystercatcher (<i>Haematopus fuliginosus</i>)	V	-	Targeted shorebird survey	Standard 20 minute search of a 2 hectare area	Birchgrove Waverton (Yurulbin Park, Balls Head Reserve, Berrys Bay and Berry Island Reserve)	All year	23–24 March 2017
Australian Pied Oystercatcher (<i>Haematopus longirostris</i>)	E	-	Targeted shorebird survey	Standard 20 minute search of a 2 hectare area	Birchgrove Waverton (Yurulbin Park, Balls Head Reserve, Berrys Bay and Berry Island Reserve)	All year	23–24 March 2017
White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>)	V	-	Targeted shorebird survey	Standard 20 minute search of a 2 hectare area	Birchgrove Waverton (Yurulbin Park, Balls Head Reserve, Berrys Bay and Berry Island Reserve)	N/A – general July to December – breeding habitat	23–24 March 2017
Eastern Osprey (<i>Pandion cristatus</i>) (syn. <i>P. haliaetus</i>)	V	-	Targeted shorebird survey	Standard 20 minute search of a 2 hectare area	Birchgrove Waverton (Yurulbin Park, Balls Head Reserve, Berrys Bay and Berry Island Reserve)	N/A – general April to November – breeding	23–24 March 2017 19 April to 4 May 2017 17, 18 August 2017
Little Bentwing-bat (<i>Miniopterus australis</i>)	V	-	Diurnal inspection of potential roosting habitat	1 day	Berrys Bay	N/A – general December to February – breeding habitat	15 February 2018
			Anabat surveys at dusk	1 night			

Species	BC Act status*	EPBC Act status*	Survey technique	Survey effort	Survey location	Seasonal survey requirements#	Survey timing
Eastern Bentwing-bat (<i>Miniopterus orianae oceanensis</i>)	V	-	Diurnal inspection of potential roosting habitat	1 day	Berrys Bay	N/A – general December to February – breeding habitat	15 February 2018 25 June 2018
			Anabat surveys at dusk	1 night			
Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>)	V	-	Diurnal inspection of potential roosting habitat	1 day	Berrys Bay.	N/A	15 February 2018
			Anabat surveys at dusk	1 night			
Southern Myotis (<i>Myotis macropus</i>)	V	-	Diurnal inspection of potential roosting habitat	1 day	Berrys Bay	October to March	15 February 2018
			Anabat surveys at dusk	1 night			

*V=Vulnerable, E=Endangered

Optimal time of year for survey is based on survey months provided in Bionet

2.7 Fauna habitat assessment

2.7.1 Terrestrial habitat assessment

Habitat assessments were carried out to assess the likelihood of threatened terrestrial species (those species known or predicted to occur within the locality, as identified during the literature review and database searches) to occur within the subject land.

Habitat characteristics assessed included:

- Structure and floristics of the canopy, understorey and ground vegetation, including the presence of flowering and fruiting trees that provide potential foraging resources
- Presence of hollow-bearing trees that provide roosting and breeding habitat for arboreal mammals, birds and reptiles
- Presence of the ground cover vegetation, leaf litter, rock outcrops and fallen timber and potential to provide protection for ground-dwelling mammals, reptiles and amphibians
- Presence of waterways (ephemeral or permanent) and water bodies
- Presence of intertidal and foreshore habitat that provide foraging habitat for waders and shorebirds.

2.7.2 Intertidal habitat assessment

Groundtruthing of the distribution of intertidal habitats was carried out by Arcadis ecologists on 15 May 2018. The purpose of this ground truthing was to verify the presence of habitats that may be used by threatened shorebirds and waders, including mud and sandflats, rocky shores and mangroves.

2.7.3 Aquatic habitat assessment

A freshwater aquatic habitat assessment has been completed by Cardno (2020) (Appendix D).

The freshwater aquatic habitat assessment was based on water quality and geomorphology studies carried out for Technical working paper: Surface water quality and hydrology (Jacobs, 2020a). The assessment was informed by the results of inspections carried out at seven locations across the four waterways (or their catchments) that fall within the subject land: Whites Creek, Willoughby Creek, Flat Rock Creek and Quarry Creek. Site names and location details are summarised in Table 2-5 and shown in Appendix D. The sites included a 100 metre reach of waterway centred at each location point.

WSP ecologists also visited Flat Rock Creek in spring/summer of 2016, and the description of this waterway, as provided in *HarbourLink Terrestrial Biodiversity Survey Report* (WSP, 2018), has been incorporated into this BDAR.

Table 2-5 Locations of waterway inspections

Site code	Site name	Site details
1a	Whites Creek upstream	Upstream of the subject land
1b	Whites Creek downstream	Downstream of the subject land
2b	Willoughby Creek downstream	Downstream of the subject land
4b	Quarry Creek (Flat Rock Creek tributary)	Downstream of the subject land
5a	Flat Rock Creek upstream	Upstream of the subject land

Site code	Site name	Site details
5b	Flat Rock Creek downstream	Downstream of the subject land, upstream of Quarry Creek
5c	Flat Rock Creek downstream	Downstream of the subject land and site 5b

2.7.4 Marine habitat assessment

A separate report has been prepared that describes the marine environments within the subject land and assesses potential impacts of the project on marine fauna species that may inhabit these environments (refer to the Technical working paper: Marine ecology (Cardno, 2020), provided as Appendix T of the Western Harbour Tunnel and Warringah Freeway Upgrade environmental impact statement). The information presented in this technical paper that is relevant to wandering seabirds, shorebirds and Little Penguin has been incorporated in this BDAR where relevant.

2.8 Personnel

This BDAR has been prepared by Arcadis ecologists and reviewed by WSP. An overview of the qualifications and roles of the Arcadis authors are provided in Table 2-6.

This BDAR has been informed by habitat assessments and field investigations conducted by WSP (2018), with content from WSP incorporated primarily into Sections 2 and 3 of this BDAR. Arcadis has carried out additional or supplementary field investigations where required.

All work was carried out under the appropriate licences, including scientific licences as required under Part 2 of the BC Act.

Table 2-6 Personnel involved in preparation of biodiversity assessment

Personnel	Qualifications	Role
Jane Rodd	Bachelor of Science (Ecology), BAM accredited assessor	Senior Ecologist – site inspections, report preparation
Laura Hoffman	Bachelor of Science	Senior Ecologist – site inspections, report preparation
Kate Carroll	Bachelor of Science (Hons), BAM accredited assessor	Senior Ecologist – site inspections, report preparation
Sian Tetther	Bachelor of Science	Graduate Ecologist – report preparation
Peter Rand	Bachelor of Applied Science	Environment Technical Director – report review
Selga Harrington (WSP)	Bachelor of Science (Hons), BAM accredited assessor	External report review

2.9 Biodiversity impact calculations

The biodiversity impacts of the project have been calculated in accordance with the BAM (OEH, 2017), using the BAM credit calculator or the relevant equations specified in the BAM. The impacts of a development and gains in biodiversity values at biodiversity stewardship sites are measured in biodiversity credits. Credits are calculated based on three primary factors:

- The biodiversity risk weighting that applies to the PCT, TEC or threatened species

- The condition of the PCT, TEC or threatened species habitat to be cleared, based on the vegetation integrity score calculated for the vegetation zone(s)
- The area of habitat or number of individuals to be cleared.

For flora species credits that are calculated based on number of individuals, only the biodiversity risk weighting and number of individuals are used to calculate credit values.

The biodiversity risk weighting applied to each PCT, TEC or threatened species is used to evaluate the ecological risks to threatened entities from the biodiversity offsets scheme. Biodiversity risk weightings range from 1 (low) to 3 (very high). The biodiversity risk weighting is comprised of two components (OEH, 2017):

- Sensitivity to loss – this considers the increased threat posed to an entity from offsetting the loss of habitat or population
- Sensitivity to potential gain – this considers the ability of a species to respond to improvements in habitat condition at an offset site.

The vegetation integrity score is a measure of the condition of native vegetation and is assessed for each vegetation zone by calculating the scores for a range of condition attributes collected in plots within the vegetation zone against the benchmark values for the associated PCT. The further assessment of native vegetation is not required beyond Section 5.4 of the BAM (OEH, 2017), and an assessment of threatened species habitat according to Section 6.2 and paragraph 6.2.1.4 of the BAM (OEH, 2017) is not required if an assessor determines that a PCT has a vegetation integrity of:

- Less than 15 if the PCT is a Critically Endangered Ecological Community (CEEC) or Endangered Ecological Community (EEC)
- Less than 17 if the PCT is threatened species habitat or vulnerable ecological community
- Less than 20 if the PCT is not representative of a TEC or associated with threatened species habitat.

The calculation of biodiversity risk weighting and vegetation integrity scores are described in further detail in the BAM (OEH, 2017a).

2.10 Limitations

This assessment is based on the condition of the subject land at the time of field investigations and the information provided by Roads and Maritime on the project design and constructability at the date of publication of this document.

This BDAR considers terrestrial flora and fauna, reptiles and seabirds only. Freshwater and marine fish, mammals and reptiles have been assessed separately by qualified and experienced aquatic ecologists. The freshwater aquatic assessment is provided in Appendix D of this report, while the marine aquatic assessment is appended to the environmental impact statement. The results of these assessments have been included in this BDAR where relevant (ie where results pertain to shorebirds, wandering seabirds and the Little Penguin).

The limitations on field assessment identified by WSP (2018) are as follows:

- Detailed desktop assessment was carried out before field surveys to identify the threatened biodiversity likely to occur in the locality and determine the field survey effort required for the scale of the project and its ecological context for a constraints assessment. However, the precise range of habitats used by some species is not well understood. Furthermore, the discovery of previously unknown populations of threatened species, even well outside their known range, is always possible. This applies particularly to cryptic species of plants and animals and plant species that can persist as soil seedbanks and easily go undetected despite intensive survey (WSP, 2018)
- No sampling technique can totally eliminate the possibility that a species is present within the study area. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be

present within the subject land during surveys. As the actual distribution and the range of habitat used by some species is not fully understood, there is always a small possibility that other species could occur within the study despite being considered to have a low likelihood of occurrence based on their known range and known habitats (WSP, 2018)

- Given that the subject land is highly urbanised and native vegetation has largely been cleared and developed for residential, commercial and industrial land uses, intact habitat is generally absent from the subject land. As such, threatened species surveys in the subject land were limited to targeted surveys for species known to occur in modified and disturbed environments such as birds and bats
- Access was restricted within some parts of the subject land (eg steep cliffs, private properties), and subsequently, some areas could not be inspected and therefore potential biodiversity values in these locations could not be verified. Where access on foot was restricted or limited but adjacent areas were accessible, vegetation community boundaries, condition and threatened flora and fauna habitat attributes were determined from a distance, often with the aid of binoculars. Where the vegetation could not be viewed, existing vegetation mapping of the area, aerial photography and photographs on Google Street View were reviewed
- The conclusions in this report are based upon data acquired for the subject land and the known distribution and habitat preferences of species. The conclusions are, therefore, merely indicative of the likely biodiversity values of the subject land, based on information available at the time of preparing the report, including the presence or otherwise of species. It should be recognised that, as more information becomes available, assessment of the likely presence of threatened species can change with time (WSP, 2018).

3 Existing environment

Elements of this section of the BDAR have drawn on the *Harbourlink Terrestrial Biodiversity Survey Report* (WSP, 2018).

3.1 Landscape features

The BAM requires the assessment of landscape features to help describe the biodiversity values of the subject land and assess the impacts of the project. Landscape features of the subject land are shown on Figure 3-1 and summarised in Table 3-1.

Table 3-1 Landscape features

Landscape feature	Description
IBRA bioregions and subregions	The subject land is located within the Sydney Basin Bioregion and the Pittwater Subregion as classified under Interim Biogeographic Regionalisation for Australia (IBRA).
NSW landscape regions (Mitchell landscapes)	The subject land intersects areas of the following Mitchell landscapes: <ul style="list-style-type: none"> • Port Jackson Basin – 28.96 hectares • Belrose Coastal Slopes – 8.63 hectares • Pennant Hills Ridges – 36.46 hectares.
Native vegetation extent in the assessment area	A buffer of 500 metres was applied to the subject land, in accordance with the methodology for assessing linear-shaped developments. The application of the 500-metre buffer resulted in an assessment area of around 1304 hectares, as shown in Figure 2-1. The current percentage of native vegetation cover in the assessment area, based on OEH (2016) vegetation mapping, is around 11 per cent (149 hectares out of the 1304-hectare assessment area).
Cleared areas	The subject land is highly urbanised and has mostly been cleared and developed for residential, commercial and industrial land uses.
Rivers and streams	Five waterbodies or watercourses (or their catchments) occur within the subject land: <ul style="list-style-type: none"> • Sydney Harbour • Whites Creek (1st order stream) • Willoughby Creek (1st order stream) • Flat Rock Creek (1st order stream) • Quarry Creek (1st order stream).
Wetlands	There are no wetlands listed under State Environmental Planning Policy (Coastal Management) 2018 or wetlands of international importance within or near the subject land. The closest Wetland of International importance (Ramsar) is Towra Point nature reserve, located around 20 kilometres south of the subject land (refer to EPBC Protected Matters Search Tool results in Appendix B).
Connectivity features	There is limited terrestrial habitat connectivity in the subject land, which is highly urbanised and is characterised by high-density residential, commercial and industrial land uses. As a result, tracts of intact and contiguous native vegetation are absent from the subject land.

Landscape feature	Description
Areas of geological significance and soil hazard features	The subject land does not include any areas of geological significance, although some rocky foreshore areas of Sydney Harbour include small sandstone caves and crevices.
Areas of outstanding biodiversity value	<p>Areas of Outstanding Biodiversity Value (AOBVs), as defined under the BC Act, are currently limited to areas previously declared as critical habitat under the TSC Act. There are no AOBVs within the subject land.</p> <p>The closest AOBV is critical habitat for the Little Penguin population in Sydney's North Harbour, around 10 kilometres north east of the subject land.</p>

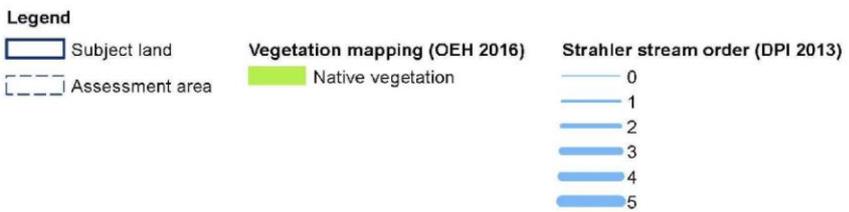
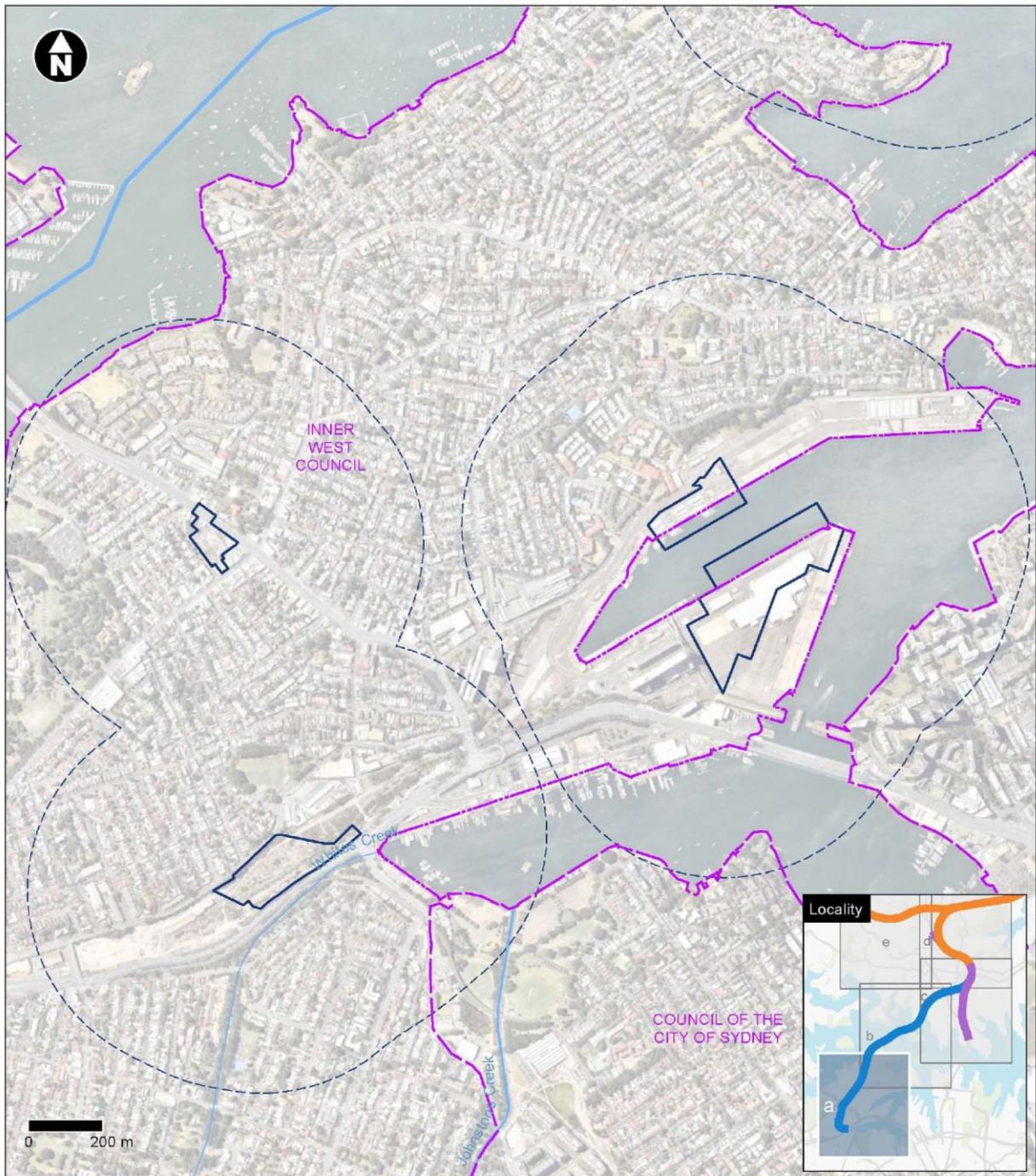


Figure 3-1 Site map (map a)

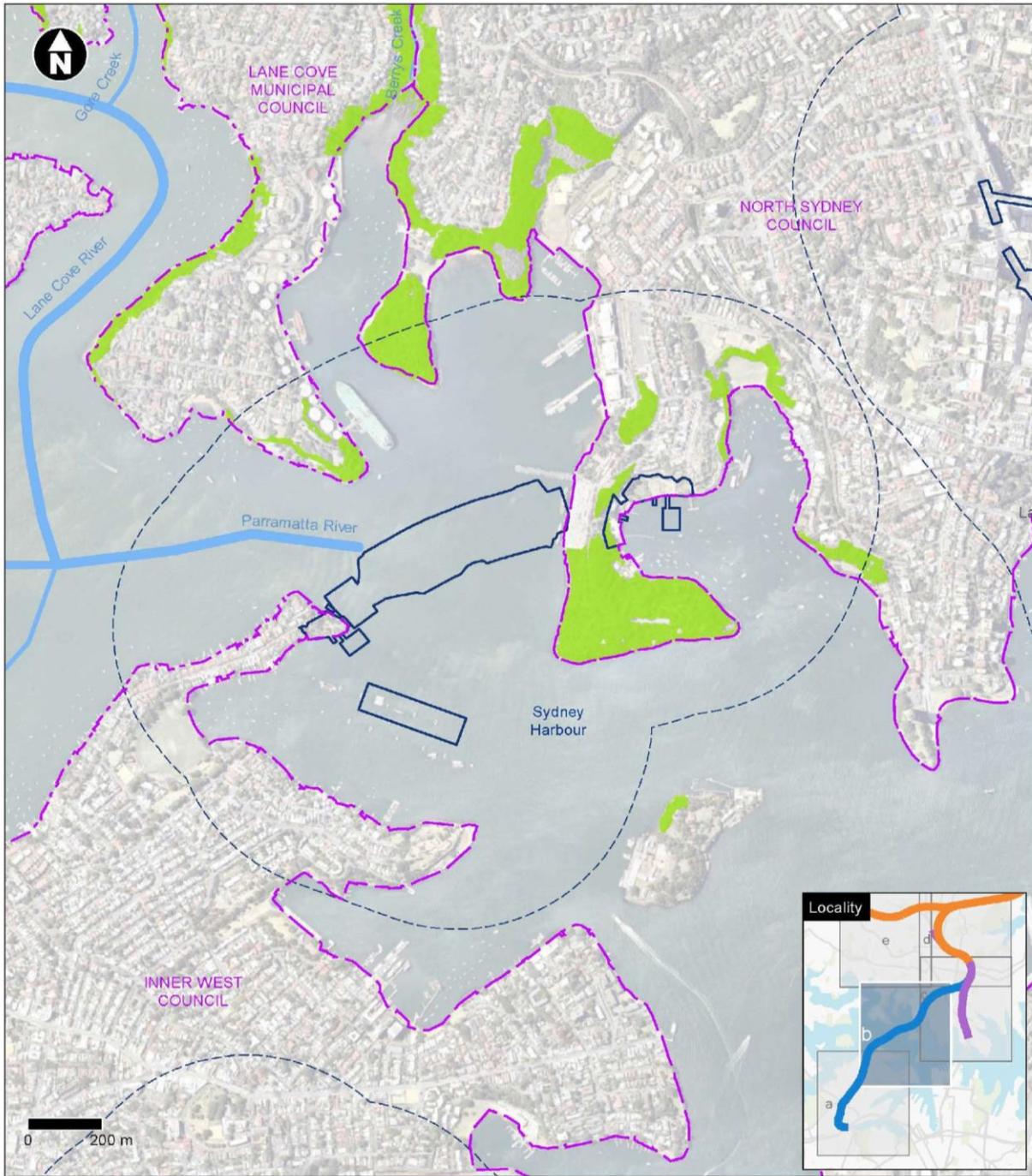


Figure 3-1 Site map (map b)

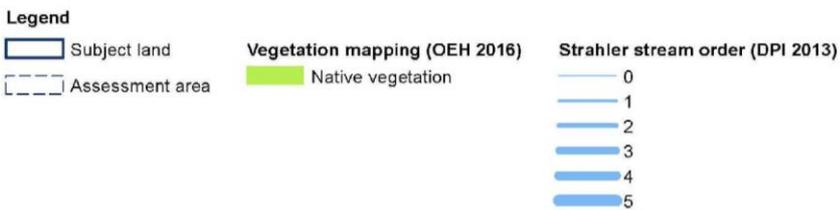
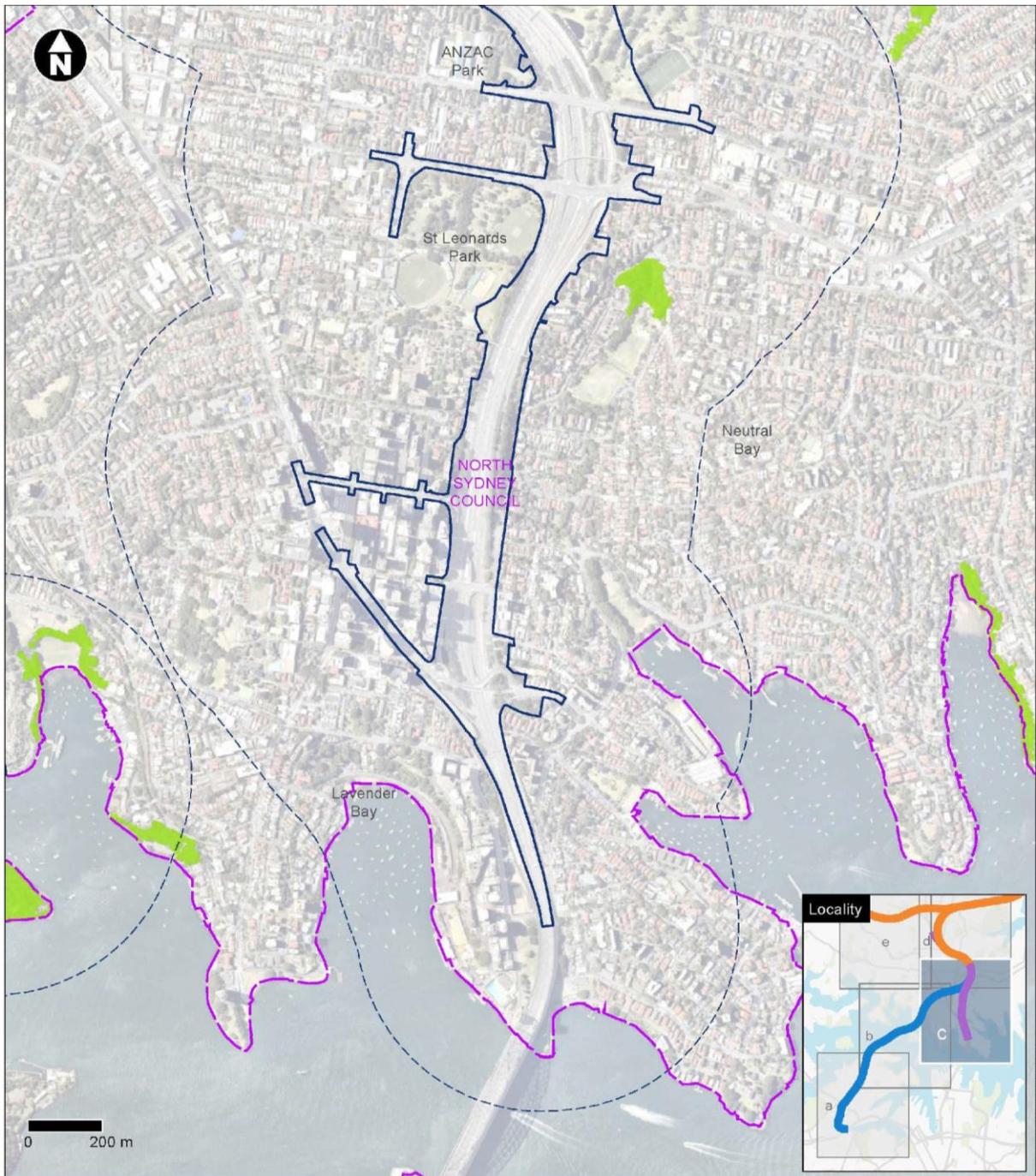


Figure 3-1 Site map (map c)

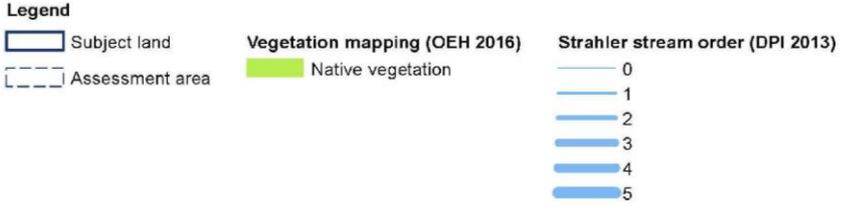
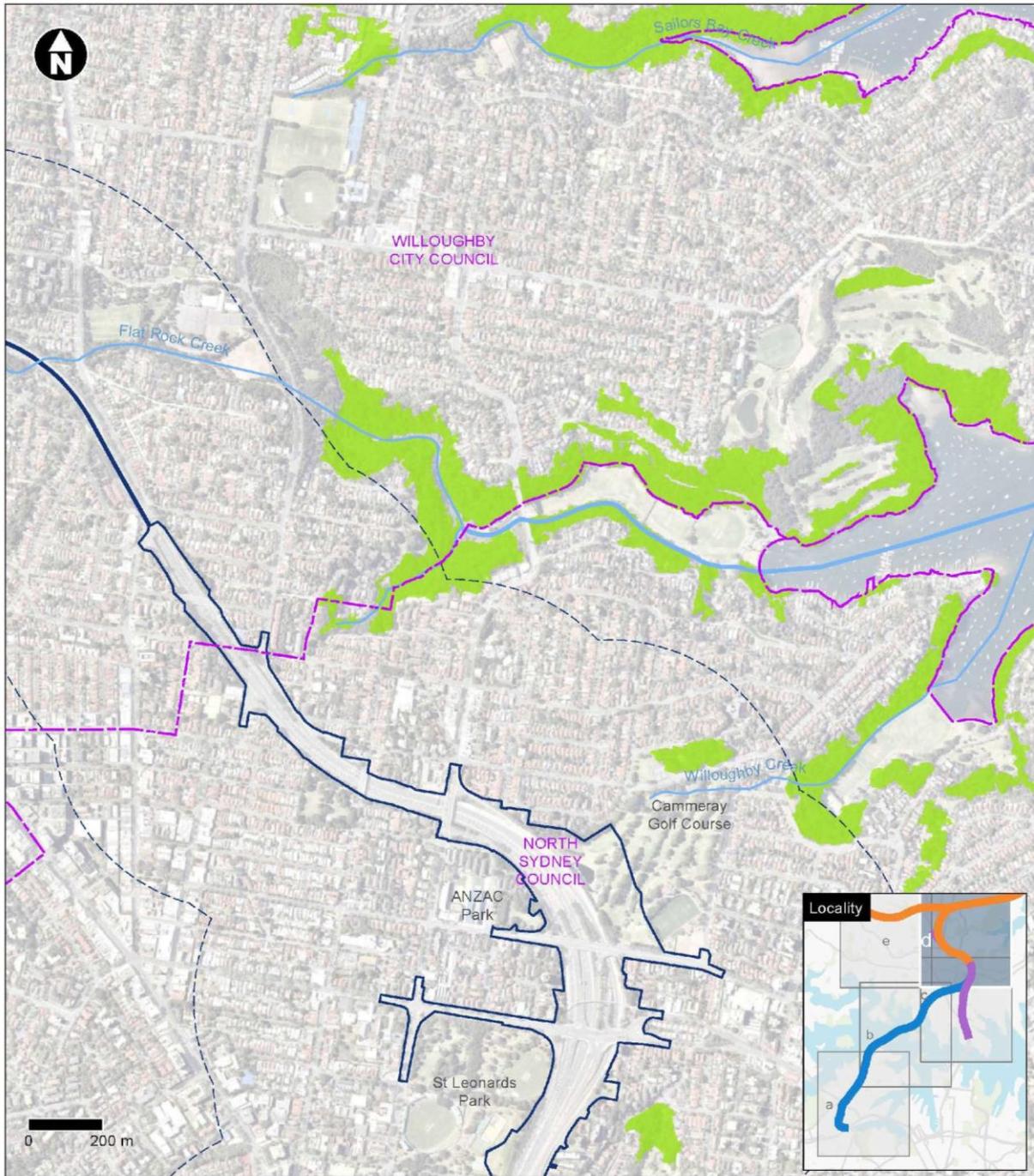


Figure 3-1 Site map (map d)

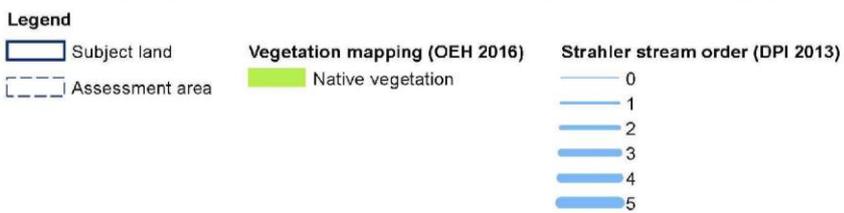
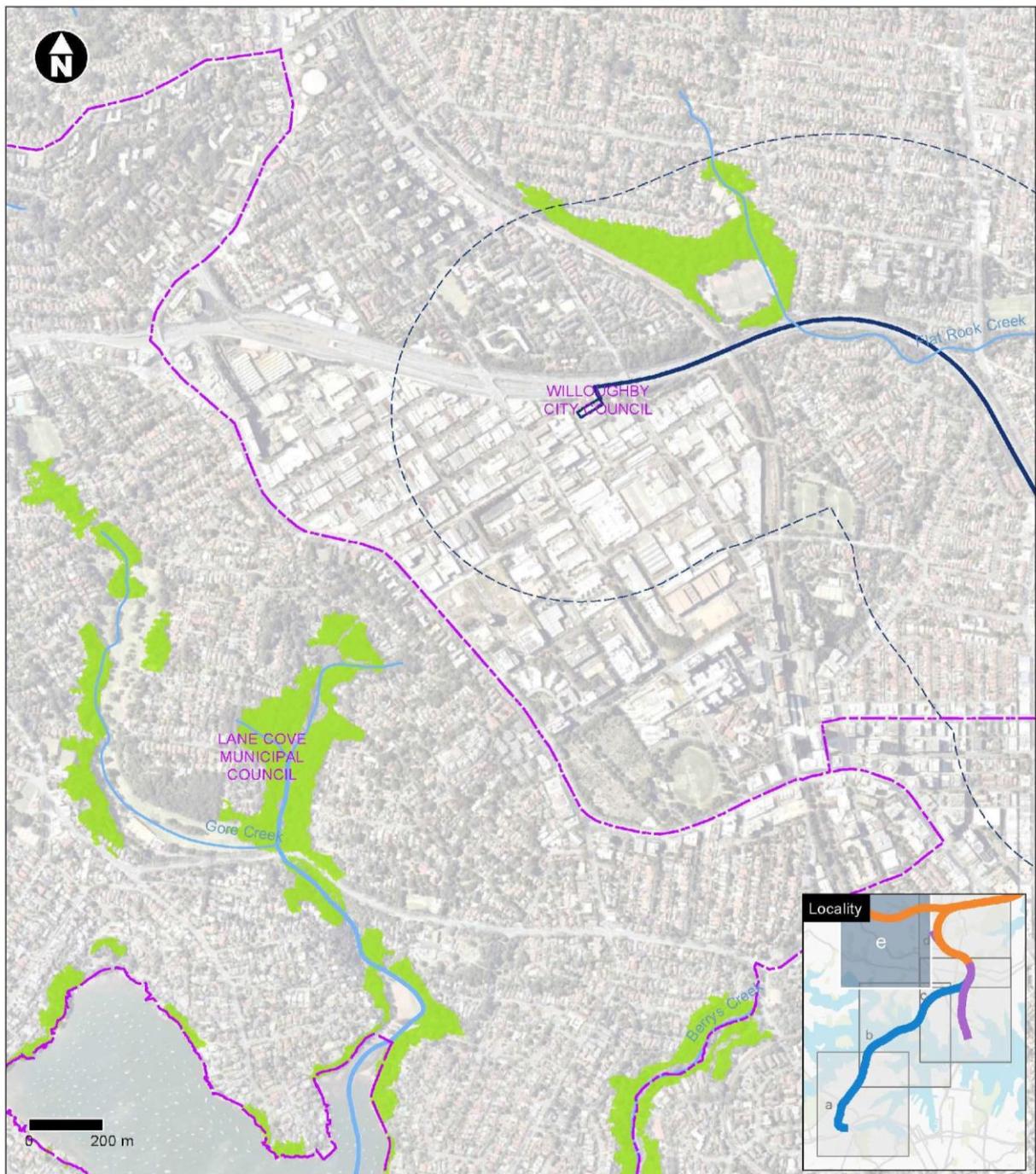


Figure 3-1 Site map (map e)

3.2 Existing vegetation mapping

OEH (2016) mapped the vegetation of the WaterNSW (formerly Sydney Metropolitan Catchment Management Authority) catchment area which encompasses the subject land.

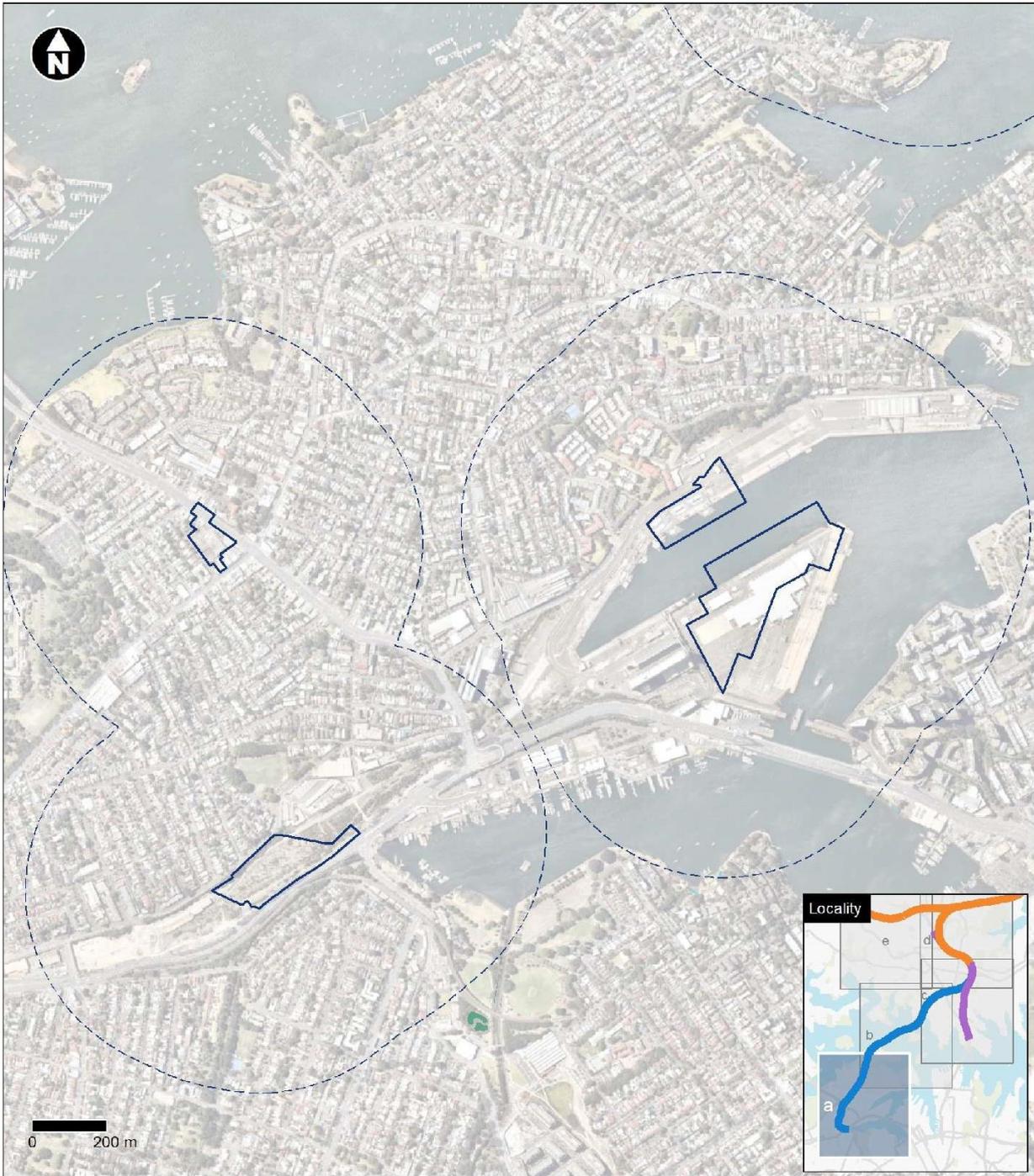
Two vegetation map units are mapped by OEH (2016) within the subject land: Urban Exotic/Native and Coastal Sandstone Foreshores Forest (S_DSF06) (refer to Figure 3-2).

The Urban Exotic/Native vegetation class was applied to polygons greater than 0.1 hectares in size and with a greater than 70 per cent urban land use, with evidence of both exotic and native species in the upper or lower strata. These areas include trees in private residential gardens, street trees in road verges and median strips, and other small isolated stands (OEH, 2016).

The vegetation map units mapped within the subject land by OEH (2016), the corresponding PCTs and area within the subject land are listed in Table 3-2.

Table 3-2 Vegetation mapped in the subject land (OEH, 2016)

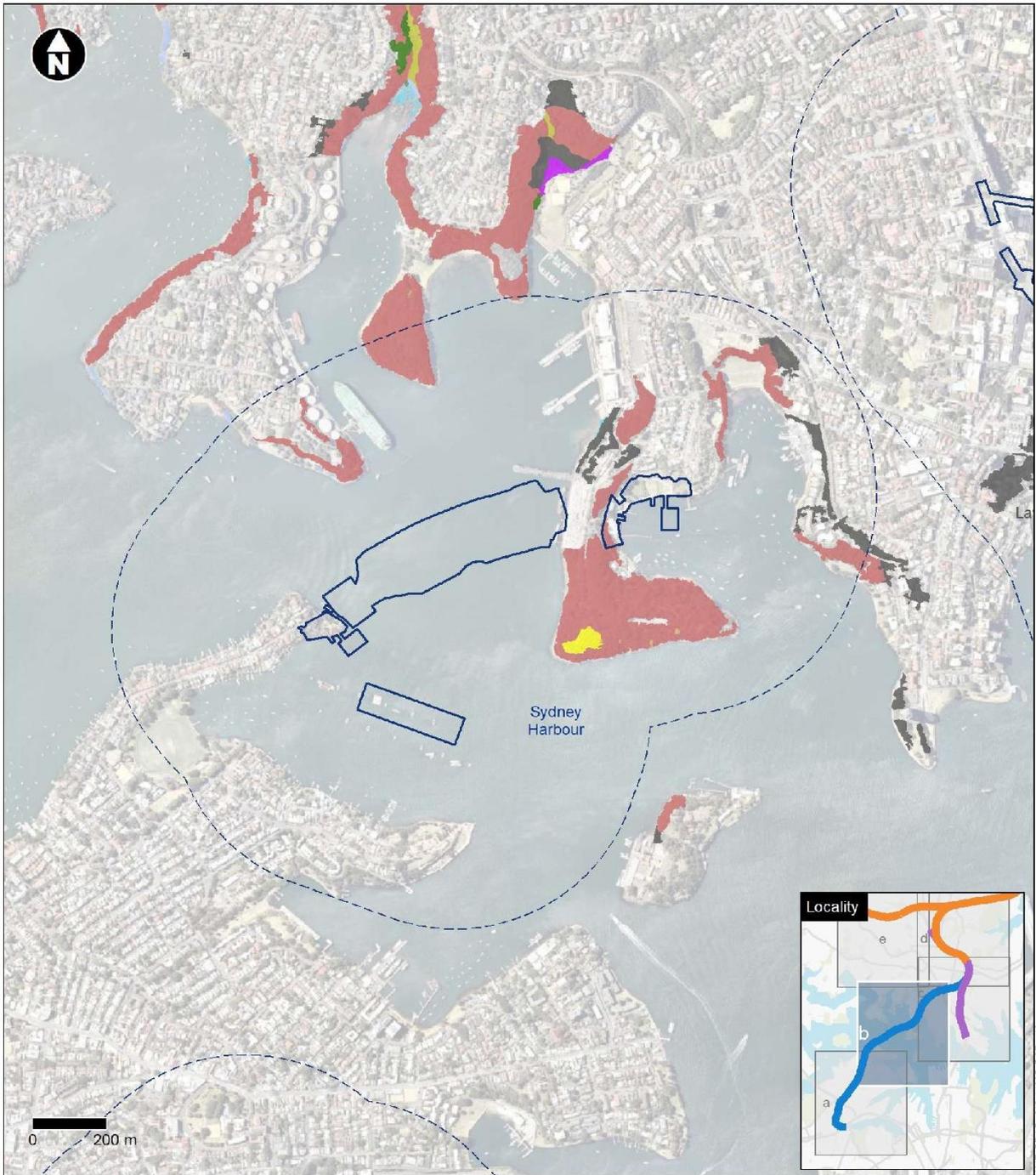
OEH (2016) map unit	Corresponding Plant Community Type (PCT)	Area (ha) mapped within the subject land
Urban Exotic/Native	Not applicable	8.81
S_DSF06 Coastal Sandstone Foreshores Forest	PCT 1778: Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney.	0.16
Total		8.97



Legend

- | | | |
|---|--------------------------------------|--|
|  Subject land | Vegetation mapping (OEH 2016) |  920: Estuarine Mangrove Forest |
|  Assessment area | Plant community types |  1126: Estuarine Saltmarsh |

Figure 3-2 Distribution of vegetation mapped by OEH (2016) (map a)



Legend

- Subject land
- Assessment area

Vegetation mapping (OEH 2016)

Plant community types

- 1126: Estuarine Saltmarsh
- 1234: Estuarine Swamp Oak Forest
- 1778: Coastal Sandstone Foreshores Forest

- 1822: Coastal Headland Banksia Heath
- 1828: Coastal Sandstone Gallery Rainforest
- 1841: Coastal Enriched Sandstone Moist Forest
- 920: Estuarine Mangrove Forest

Other vegetation

- Plantation (native and/or exotic)
- Rock
- Weeds and exotics

Figure 3-2 Distribution of vegetation mapped by OEH (2016) (map b)

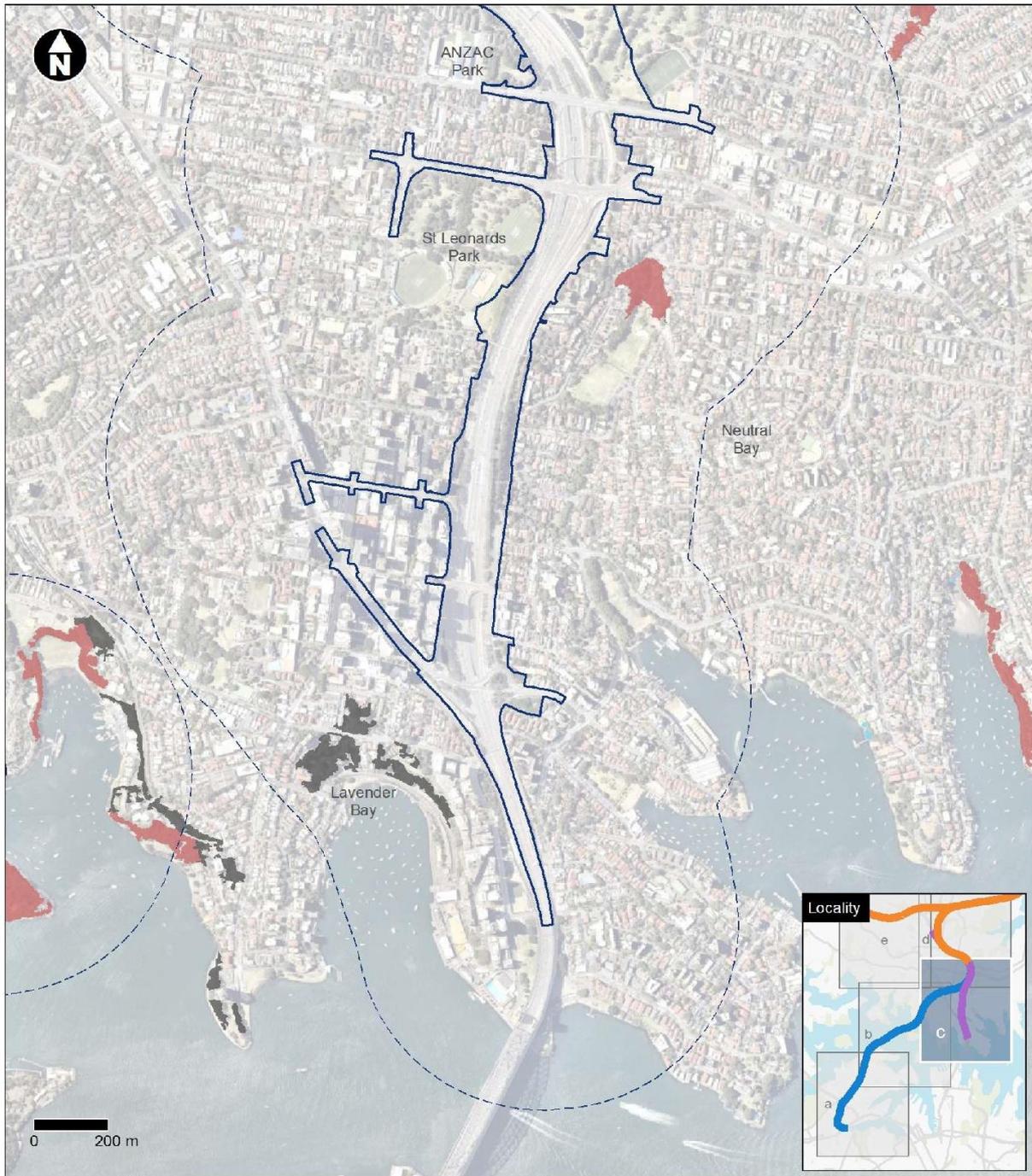


Figure 3-2 Distribution of vegetation mapped by OEH (2016) (map c)

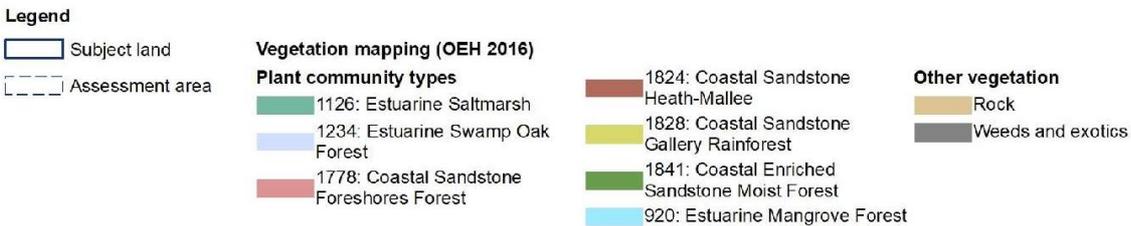
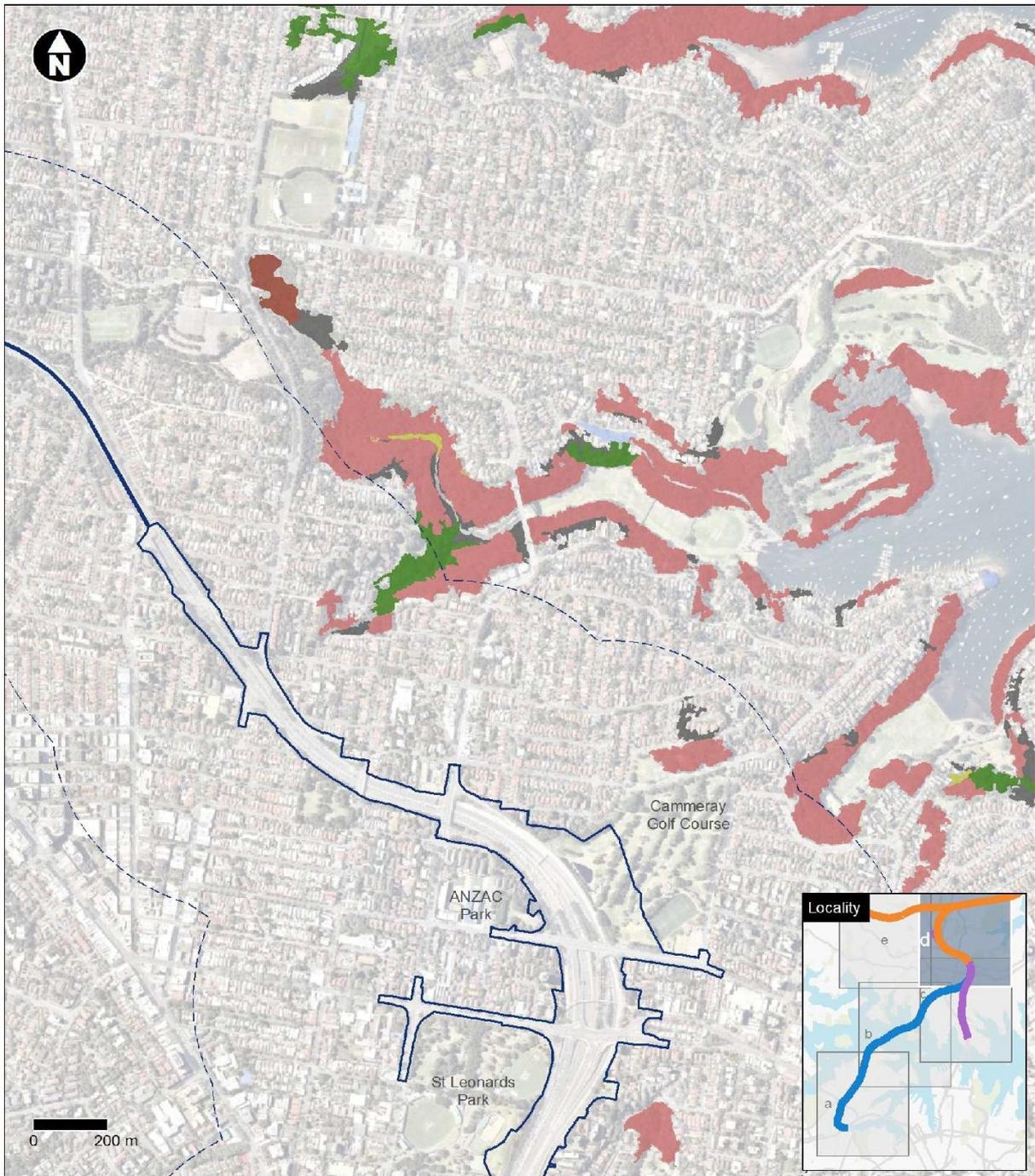


Figure 3-2 Distribution of vegetation mapped by OEH (2016)

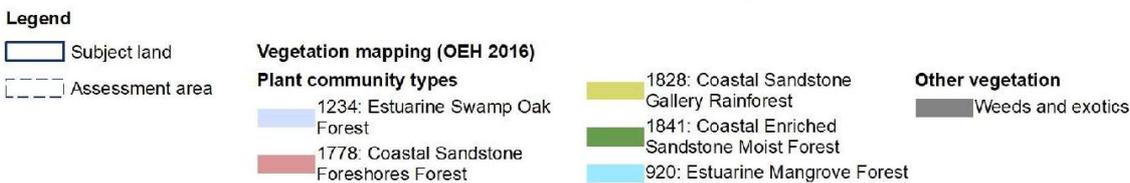


Figure 3-2 Distribution of vegetation mapped by OEH (2016)

3.3 Plant Community Types

The vegetation of the subject land was mapped by WSP (2018) and Arcadis following ground truthing of existing vegetation mapping by OEH (2016).

This identified one Plant Community Type (PCT) and four disturbed vegetation types within the subject land (refer to Table 3-3 and Figure 3-3). The ground truthing by WSP (2018) and Arcadis resulted in the refinement in the total area of hectares of the PCTs and other vegetation types in the subject land.

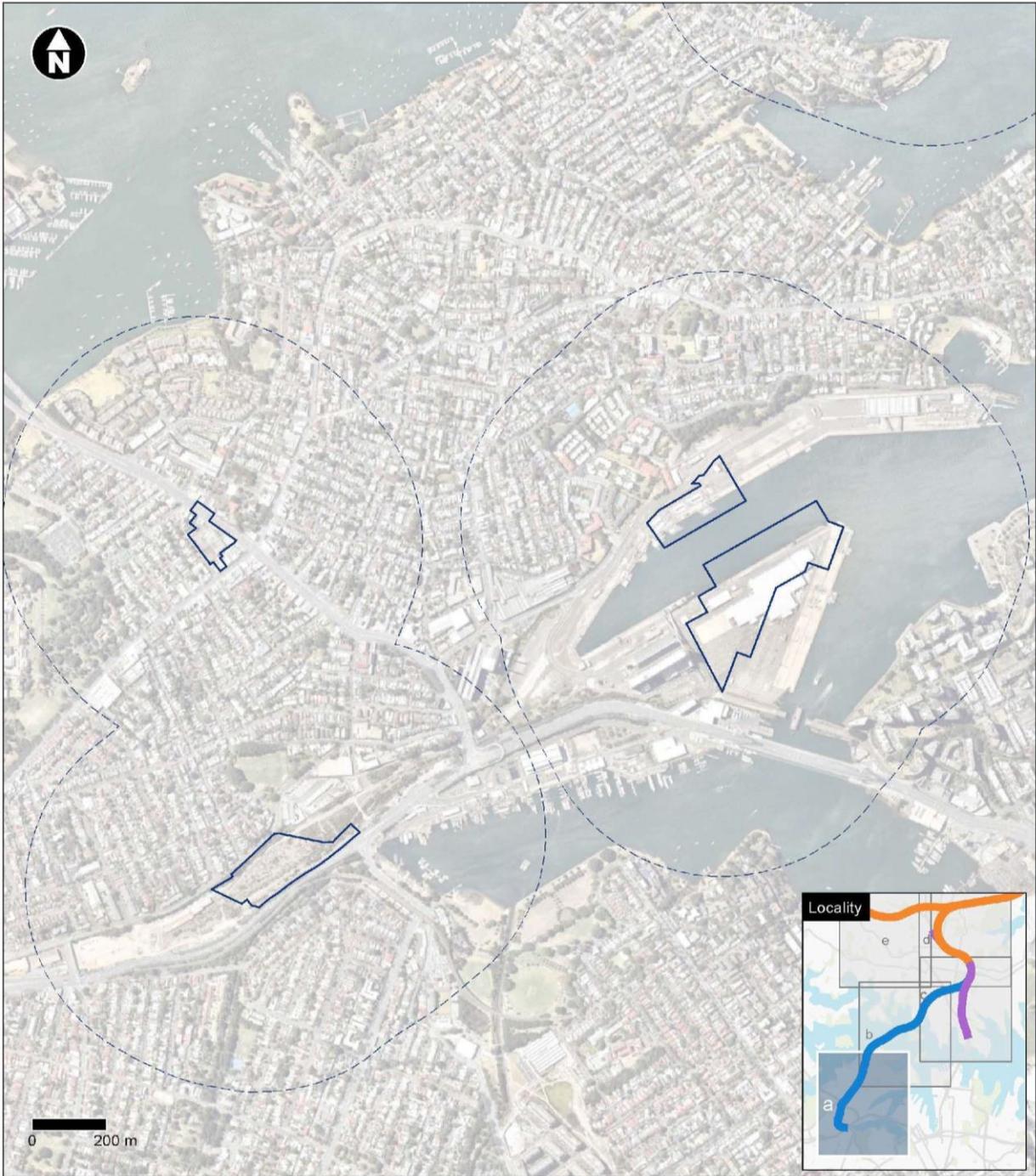
Table 3-3 PCTs and other vegetation identified in the subject land by WSP (2018) and Arcadis

PCT code	PCT name	Corresponding OEH (2016) map unit	Conservation status	Area (ha) mapped within the subject land
1778	Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney.	S_DSF06 Coastal Sandstone Foreshores Forest	Not listed	0.13
Total Native Vegetation				0.13
N/A	Native Plantings	N/A	N/A	3.30
N/A	Native Plantings (Planted Medians)	N/A	N/A	2.84
N/A	Urban Exotic/Native	N/A	N/A	1.11
N/A	Weeds and Exotics	N/A	N/A	0.35
Total Other Vegetation				7.60

Almost all vegetation that occurs in the subject land (mapped in Figure 3-3) comprises planted trees and shrubs in parkland or roadside settings and does not conform to the definition of any PCT listed in the BioNet Vegetation Classification Database.

There is one PCT occurring within the subject land: Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney (PCT 1778). The subject land overlaps the edge of a larger area of this PCT which extends southwards to Balls Head. This vegetation is within an exclusion zone and would not be directly impacted by the project.

Given that there would be no direct impacts from the project to this vegetation, PCT 1778 was not sampled or included in BAM calculations for the project. A description of this PCT in the subject land is provided below in Section 3.3.1.



Legend
 [Blue outline] Subject land
 [Dashed outline] Assessment area

Figure 3-3 Distribution of Plant Community Types and other vegetation in the subject land (map a)



Figure 3-3 Distribution of Plant Community Types and other vegetation in the subject land (map b)



Figure 3-3 Distribution of Plant Community Types and other vegetation in the subject land (map c)

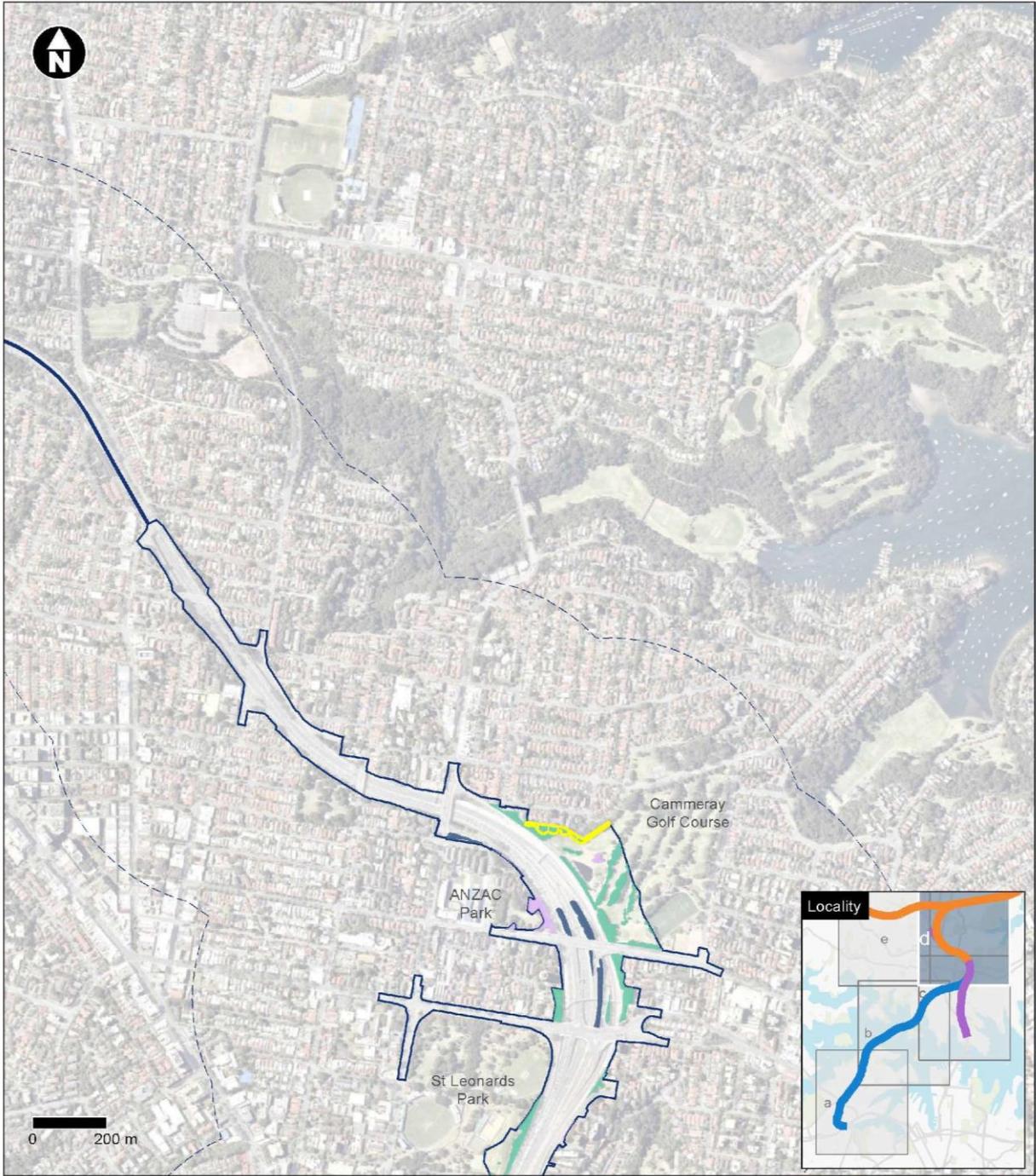
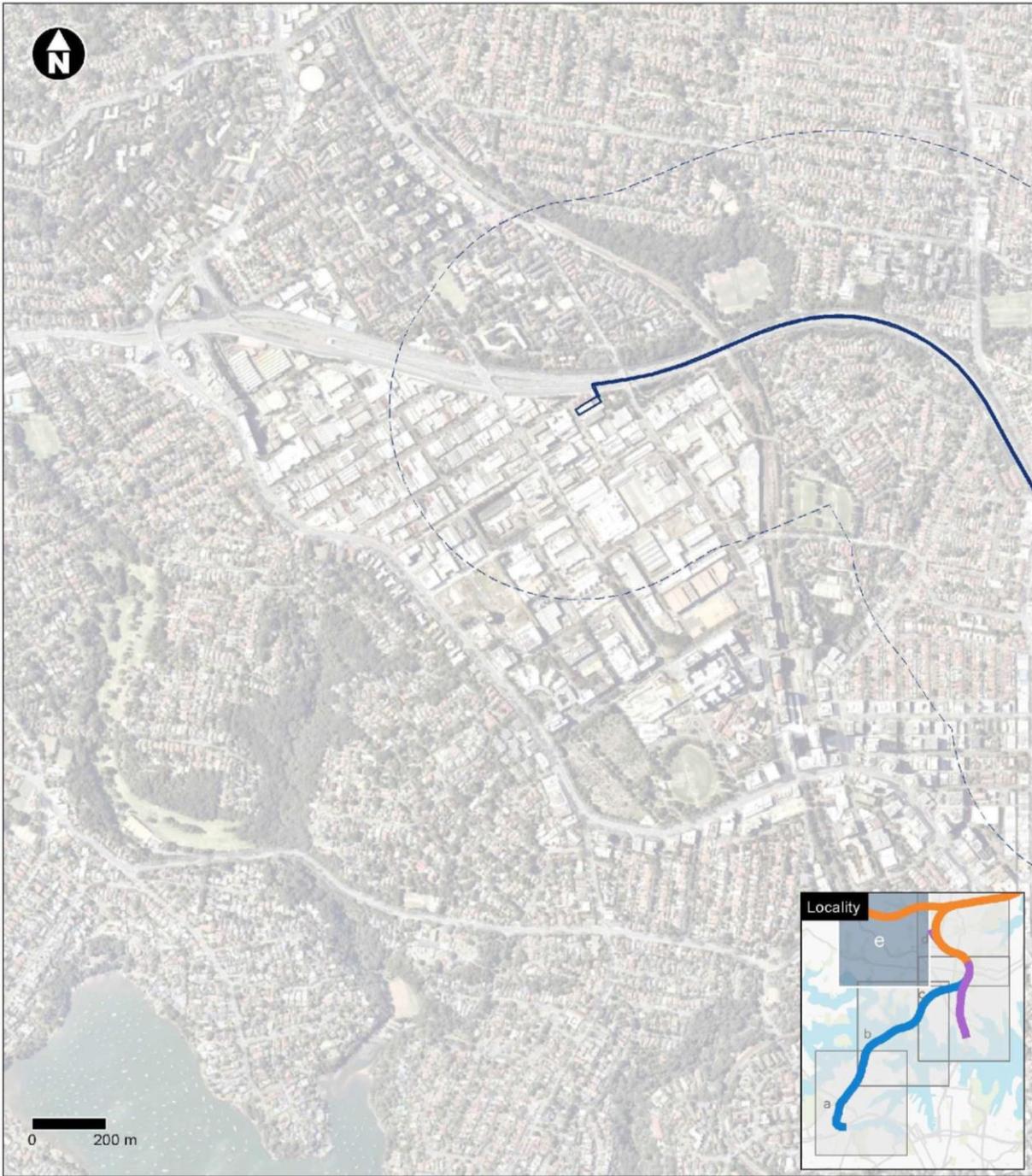


Figure 3-3 Distribution of Plant Community Types and other vegetation in the subject land (map d)



Legend

- Subject land
- Assessment area

Figure 3-3 Distribution of Plant Community Types and other vegetation in the subject land (map e)

3.3.1 Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney

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

Vegetation class: Sydney Dry Sclerophyll Forests

PCT: 1778

Conservation status: Not listed

Estimate of per cent cleared: 90 per cent cleared in the Greater Sydney catchment

Condition: Moderate to Good condition

Extent in the subject land: 0.13 hectares

Plots completed in vegetation zone: 0

Description: This PCT is found on sheltered sandstone slopes along the foreshores of Sydney's major waterways and coastal escarpments. It has an open forest structure, with a moist shrub layer and a ground cover of ferns, rushes and grasses. The canopy is often dominated by *Angophora costata* (Smooth-barked Apple), with *Eucalyptus botryoides* (Bangalay) and *Banksia integrifolia* (Coast Banksia) close to the coast, and *Eucalyptus piperita* (Sydney Peppermint) and *Eucalyptus pilularis* (Blackbutt) in more protected locations. A layer of hardy mesic small trees and shrubs is present, including *Pittosporum undulatum* (Sweet Pittosporum), *Glochidion ferdinandi* (Cheese Tree) and *Elaeocarpus reticulatus* (Blueberry Ash) (OEH, 2019b).

The area of this PCT overlapping the subject land consists of a vegetated slope next to the disused buildings adjoining Berry Bay. The lower part of the slope is disturbed, with exotic small tree and shrub species such as *Ligustrum sinense* (Small-leaved Privet), *Olea europaea* subsp. *cuspidata* (African Olive), *Senna pendula* var. *glabrata* and *Nerium oleander* (Oleander) dominant, and the ground layer characterised by exotic grasses such as *Ehrharta erecta* (Panic Veldt-grass), *Cenchrus clandestinus* (Kikuyu) and the cosmopolitan native *Cynodon dactylon* (Couch). The exotic climber *Cardiospermum grandiflorum* (Balloon Vine) was observed to be smothering some plants.

Further upslope, native trees are dominant, including *Angophora costata*, *Pittosporum undulatum* and *Glochidion ferdinandi*, all characteristic species of the PCT, as well as the planted *Ficus microcarpa*.

The small area of PCT 1778 overlapping the subject land forms part of the northern extent of a larger patch of vegetation that extends southwards across Balls Head Reserve at Waverton, as mapped by OEH (2016).



Plate 1 Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney

3.4 Other vegetation types

A total of 7.60 hectares of vegetation that is not consistent with the definition of any PCT was mapped and described by WSP and Arcadis (refer to Figure 3-3) within the subject land, comprising:

- 3.30 hectares of native plantings
- 2.84 hectares of native plantings within the vegetated medians of Warringah Freeway
- 1.11 hectares of urban exotic/native plantings
- 0.35 hectares of weeds and exotics.

Vegetation is absent from both Victoria Road construction support site (WHT2) and White Bay construction support site (WHT3). Vegetation descriptions have been taken from WSP (2018), with some minor amendments.

3.4.1.1 Native plantings

This vegetation association occurs within highly disturbed areas throughout the subject land, which have been subject to landscaping following development of infrastructure (eg roads, rail, and electricity easements), recreational facilities (eg sports fields, walking tracks), or parking areas as well as residential and commercial areas. These landscaped areas have commonly been planted out with native species but using horticultural specimens with unknown genetic origins.

Of the 3.30 hectares of native plantings in the subject land, 0.31 hectares would be retained within an exclusion zone in the north of Cammeray Golf Course (Figure 3-3).

3.4.1.1.1 Yurulbin Point construction support site (WHT4)

Vegetation in Yurulbin Park at Yurulbin Point, Birchgrove, includes mature trees of *Eucalyptus botryoides* and *Angophora costata* which are diagnostic canopy species of PCT 1778. However, analysis and review of historical mapping and aerial photos, land use maps and management plans indicate the site was used as a shipyard from 1917 until the 1970s and was subsequently landscaped using typical native foreshore species. The vegetation of Yurulbin Park currently consists of planted native trees and shrubs with a mown ground layer dominated by exotic grass species.



Plate 2 Planted native vegetation in Yurulbin Park at Birchgrove

3.4.1.1.2 Warringah Freeway, including construction support sites WFU1 to WFU8

Vegetation adjoining the Warringah Freeway is characterised by linear patches of planted trees adjoining the margin of the existing freeway, alongside road verges and in parklands. None of this vegetation is consistent with a native PCT. Typically, this vegetation type consists of planted native canopy species with a managed exotic grass understorey, with some native shrubs and groundcover plantings. Common species include *Ficus macrophylla* (Moreton Bay Fig), *Lomandra longifolia* (Spiny-headed Mat-rush), *Corymbia citriodora* (Lemon-scented Gum), *Grevillea robusta* (Silky Oak), *Eucalyptus saligna* (Sydney Blue Gum), *Angophora costata*, *Syncarpia glomulifera* (Turpentine) and *Lophostemon confertus* (Brush Box).

3.4.1.2 Native plantings (Planted Medians)

This vegetation type has been assigned to planted vegetation on the median strips between carriageways on the Warringah Freeway, as well as between the carriageways and ramps. These areas could not be accessed on foot, so were inspected from areas next to the Warringah Freeway and using Google Street View. This vegetation consists of a range of planted native trees, mainly eucalypts and figs, with *Corymbia citriodora* and *Ficus microcarpa* the most frequently observed. There are occasional planted shrubs of *Callistemon* spp. and *Acacia* spp., and the ground layer is absent or consists of exotic grasses, including *Cenchrus setaceus* (Fountain Grass).

3.4.1.3 Urban exotic/native plantings

This vegetation occurs as highly modified landscaped vegetation in gardens, parks and road verges within the subject land. These areas generally contain planted native and exotic horticultural specimens or isolated remnant trees.

This vegetation type is mapped at Berrys Bay foreshore, which supports mature Eucalypts and exotic tree species, and alongside the Warringah Freeway, where a combination of native and exotic species including invasive exotic weeds, exotic plantings and native plantings occur. Species recorded within this vegetation type includes *Pinus radiata* (Radiata Pine), *Acacia parramattensis* (Sydney Green Wattle), *Corymbia maculata* (Spotted Gum) and *Callistemon viminalis* (Weeping Bottlebrush).

3.4.1.4 Weeds and exotics

Weeds and/or exotic species were found in one location in the subject lands: east of the Warringah Freeway, to the south of the southbound on ramp exiting High Street. This area includes planted exotic trees such as *Populus deltoides* (Eastern Cottonwood), *Cinnamomum camphora* (Camphor laurel) and *Schinus molle* (Pepper Tree). Grassy weeds also occur at the proposed construction support site on Victoria Road at Rozelle, in association with derelict buildings.

3.5 Threatened ecological communities

A search of the Threatened Biodiversity Data Collection identified 22 TECs listed under the BC Act as known or likely to occur within the Sydney Basin – Pittwater IBRA subregion.

A search of the Department of the Environment and Energy (DoEE) EPBC Protected Matters Search Tool identified 11 TECs listed under the EPBC Act that are known or likely to occur within 10 kilometres of the subject land.

The TECs identified in each database search and their potential to occur in the subject land are listed in Appendix A.

None of the vegetation in the subject land meets the criteria for any TEC listed under the EPBC Act or the BC Act. The closest area of TEC to the subject land as mapped by OEH (2016) is a small area of Swamp Oak Floodplain Forest on the southern shoreline of Balls Head, around 300 metres south of the subject land at Berrys Bay (Figure 3-2).

The subject land and adjoining areas are highly modified and have been historically cleared of native vegetation. Almost all vegetation mapped within the subject land by OEH (2016) is classified as Urban Exotic/Native, and this was confirmed during ground truthing completed for the project. The only area of native vegetation in the subject land is the 0.13 hectares of PCT 1778 overlapping the south-western section of the Berrys Bay construction support site (WHT7). This PCT does not fall within the criteria for any TEC listed under the BC Act or EPBC Act.

3.6 Threatened species

A number of threatened flora and fauna species were predicted to occur in the subject land, based on candidate threatened species generated by the BAM credit calculator, and the results of database searches.

Four threatened flora species and two threatened fauna species were recorded in or adjacent to the subject land during targeted surveys for the project. An additional six threatened fauna species were considered highly likely to occur in the subject land, due to the presence of potential habitat and/or the species being previously recorded in (or near) the subject land. No additional threatened flora species were considered highly likely to occur in the subject land, due to the absence of preferred habitat.

Threatened species predicted and known to occur in the subject land are discussed in further detail below.

3.6.1 Threatened flora species

3.6.1.1 Species credit species

The BAM credit calculator identified three candidate threatened flora species credit species: *Allocasuarina portuensis*, *Leptospermum deanei* and *Melaleuca biconvexa*. None of these threatened flora species are considered to have a high or moderate likelihood of occurrence in the subject land, due to the absence of preferred habitat for these species.

Justification for the likelihood of occurrence determined for each species is provided in Appendix A of this report.

3.6.1.2 Species recorded within 1.5 kilometres of the subject land

In addition to the BAM credit calculator outputs (as described in Section 3.6.1.1), the Secretary's environmental assessment requirements require assessment of all threatened species recorded recently (since 1990) within 1.5 kilometres of the subject land.

Six threatened flora species listed under the BC Act have been recorded recently (since 1990) within 1.5 kilometres of the subject land (Table 3-4). None of these six species were identified as candidate species by the BAM credit calculator.

One species, *Acacia terminalis* subsp. *terminalis*, was confirmed as a candidate species as it is known to occur in the subject land (see Appendix A for justification of likelihood of occurrence of each species). This species was subject to targeted seasonal surveys in accordance with the BAM.

The other five additional threatened flora species recorded within 1.5 kilometres of the subject land, which were not identified by the BAM calculator, are *Epacris purpurascens* var. *purpurascens*, *Eucalyptus nicholii*, *Rhodamnia rubescens*, *Syzygium paniculatum* and *Tetratheca juncea*. *Eucalyptus nicholii* and *Syzygium paniculatum* were both recorded in or near the subject land, but only as a planted non-local native species. *Rhodamnia rubescens* and *Tetratheca juncea* are considered to have a low likelihood of occurrence within or near the subject land, based on the known distribution and habitat requirements of these species.

Table 3-4 Threatened flora species recorded within 1.5 kilometres of the subject land (Bionet Atlas Database)

Scientific name	Common name	BC Act status*	EPBC Act status*	Identified by BAM credit calculator	Likelihood of occurrence	Candidate species
<i>Acacia terminalis</i> subsp. <i>terminalis</i>	Sunshine Wattle	E	E	No	Known	Yes
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	-	V	-	No	Low	No
<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint	V	V	No	Known (but only as planted non-local native)	No

Scientific name	Common name	BC Act status*	EPBC Act status*	Identified by BAM credit calculator	Likelihood of occurrence	Candidate species
<i>Rhodamnia rubescens</i>	Scrub Turpentine	CE	-	No	Low	No
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	E	V	No	Known (but only as planted non-local native)	No
<i>Tetradlea juncea</i>	Black-eyed Susan	V	V	No	Low	No

*V = Vulnerable, E = Endangered

There are also records of nine fungi species recorded recently (since 1990) within 1.5 kilometres of the subject land (Table 3-5). In the region, these fungi species are only known to occur in the Lane Cove Bushland Park, and all are considered to have a low likelihood of occurrence in the subject land.

Table 3-5 Threatened fungi species recorded within 1.5 kilometres of the subject land (Bionet Atlas Database)

Scientific name	BC Act status*	EPBC Act status*	Identified by BAM credit calculator	Likelihood of occurrence	Candidate species
<i>Hygrocybe collucera</i>	E	-	Yes	Low	No
<i>Hygrocybe griseoramosa</i>	E	-	Yes	Low	No
<i>Hygrocybe reesia</i>	V	-	Yes	Low	No

*V = Vulnerable, E = Endangered

3.6.1.3 Threatened flora species recorded in the subject land

Four threatened flora species listed under the EPBC Act and BC Act were recorded in or immediately next to the subject land by WSP (2018) and Arcadis (refer to Table 3-6 and Figure 3-4).

Table 3-6 Threatened flora recorded in the subject land

Species	BC Act status*	EPBC Act status*	Occurrence in subject land	Type of credit
<i>Acacia terminalis</i> subsp. <i>terminalis</i> (Sunshine Wattle)	E	E	Known to occur in the subject land. A single individual was recorded by Arcadis in a landscaped area adjoining the western side of the Warringah Freeway in North Sydney.	Species credit species
<i>Eucalyptus nicholii</i> (Narrow-leaved Black Peppermint)	V	V	Known to occur in the subject land. Recorded by WSP (2018) as planted individual street trees in landscapes areas next to the Warringah Freeway.	Species credit species
<i>Eucalyptus scoparia</i> (Wallangarra White Gum)	E	V	Known to occur in the subject land. Recorded by WSP (2018) as planted individual street trees in landscapes areas next to the Warringah Freeway.	Species credit species
<i>Syzygium paniculatum</i> (Magenta Lilly Pilly)	E	V	Known to occur adjacent to the subject land. Recorded by WSP (2018) as a street tree just outside the boundary of the subject land in landscaped areas next to the Warringah Freeway.	Species credit species

*V = Vulnerable, E = Endangered

The single individual of *Acacia terminalis* subsp. *terminalis* is possibly natural regrowth and discussed further in Section 3.6.1.3.1.

The remaining three species were recorded well outside their known geographic range and/or known habitat. As these species occur as individual trees, it is assumed that these trees have been planted, and do not naturally occur within the subject land. *Syzygium paniculatum* is adjacent to the subject land and would not be impacted by the project. The two eucalyptus species are located in the subject land. However, these planted individuals are not considered to be of conservation significance and have not been assessed further under the BAM.

3.6.1.3.1 *Acacia terminalis* subsp. *terminalis*

Acacia terminalis subsp. *terminalis* is listed as an Endangered species under the BC Act and EPBC Act.

One individual of *Acacia terminalis* subsp. *terminalis* was recorded in a disturbed landscaped area between the Falcon Street shared user bridge and the Warringah Freeway in Jeaffreson Jackson Reserve, Cammeray. The single plant recorded was observed to be in poor health at the time of survey in March 2019, with most branches dead and live foliage only present on one branch (Plate 3).

The single plant was recorded in landscaped roadside areas characterised by planted native species and it is possible that it was planted. However, seedlings of *Acacia terminalis* subsp. *terminalis* are known to grow on the edge of roads and tracks in long unburnt vegetation, and it is possible that physical disturbance triggers recruitment (DECCW, 2010). Given that the individual of *Acacia terminalis* subsp. *terminalis* is located within the known range of the species, it is assumed to be of wild provenance and is therefore assessed further in Section 5 of this BDAR.



Plate 3 *Acacia terminalis* subsp. *terminalis* recorded next to the Warringah Freeway, Cammeray (Falcon Street shared user bridge)

A species polygon was prepared for *Acacia terminalis* subsp. *terminalis* by applying a 30 metre buffer to the point record (Figure 3-4) The area within the 30 metres buffer includes areas of hardstand within the Warringah Freeway, Falcon Street and the Falcon Street shared user bridge. These hardstand areas have been removed from the species polygon as shown in Figure 3-4.



Legend
 [Solid blue outline] Subject land
 [Dashed blue outline] Assessment area

Figure 3-4 Threatened species recorded (map a)

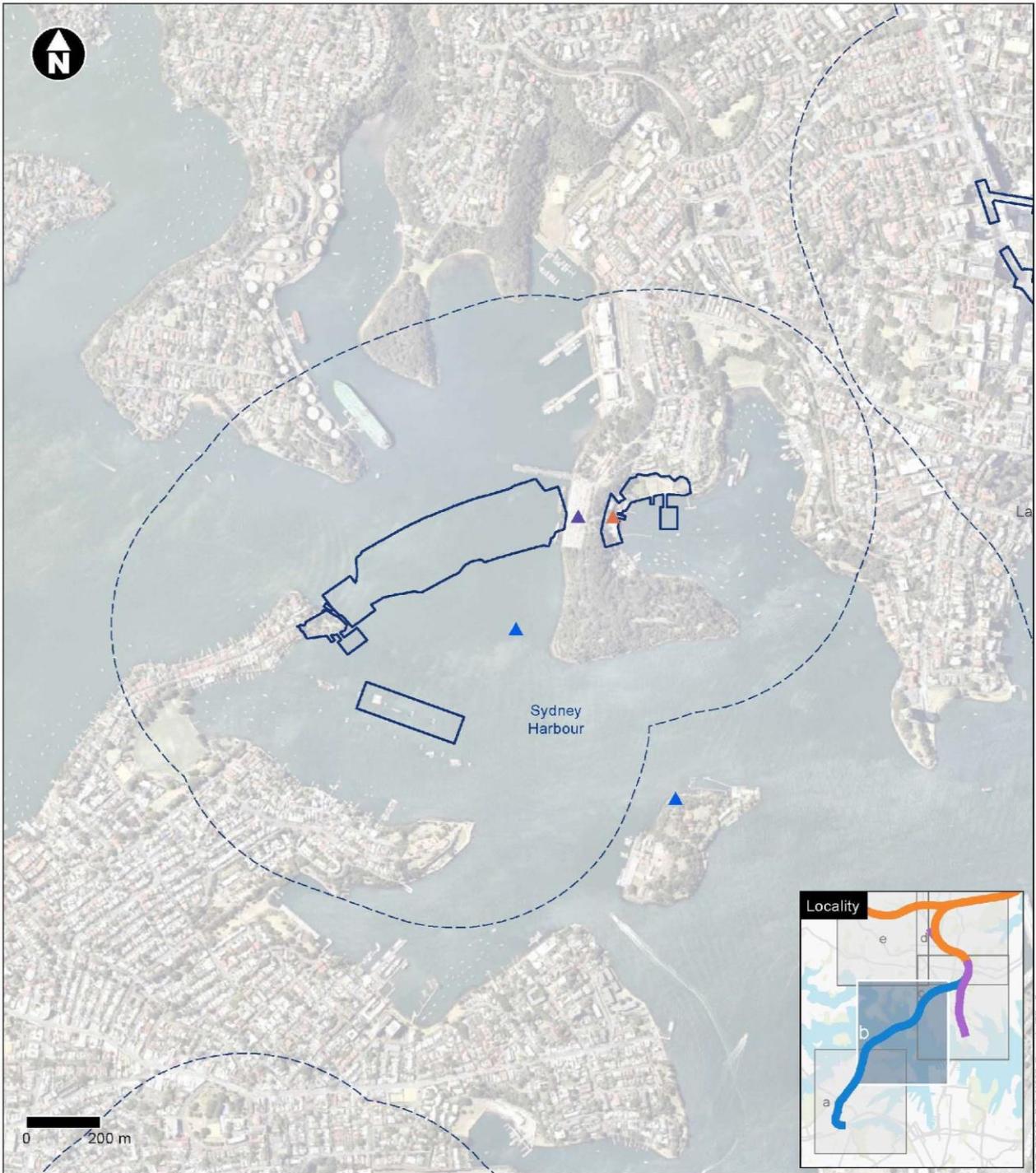


Figure 3-4 Threatened species recorded (map b)

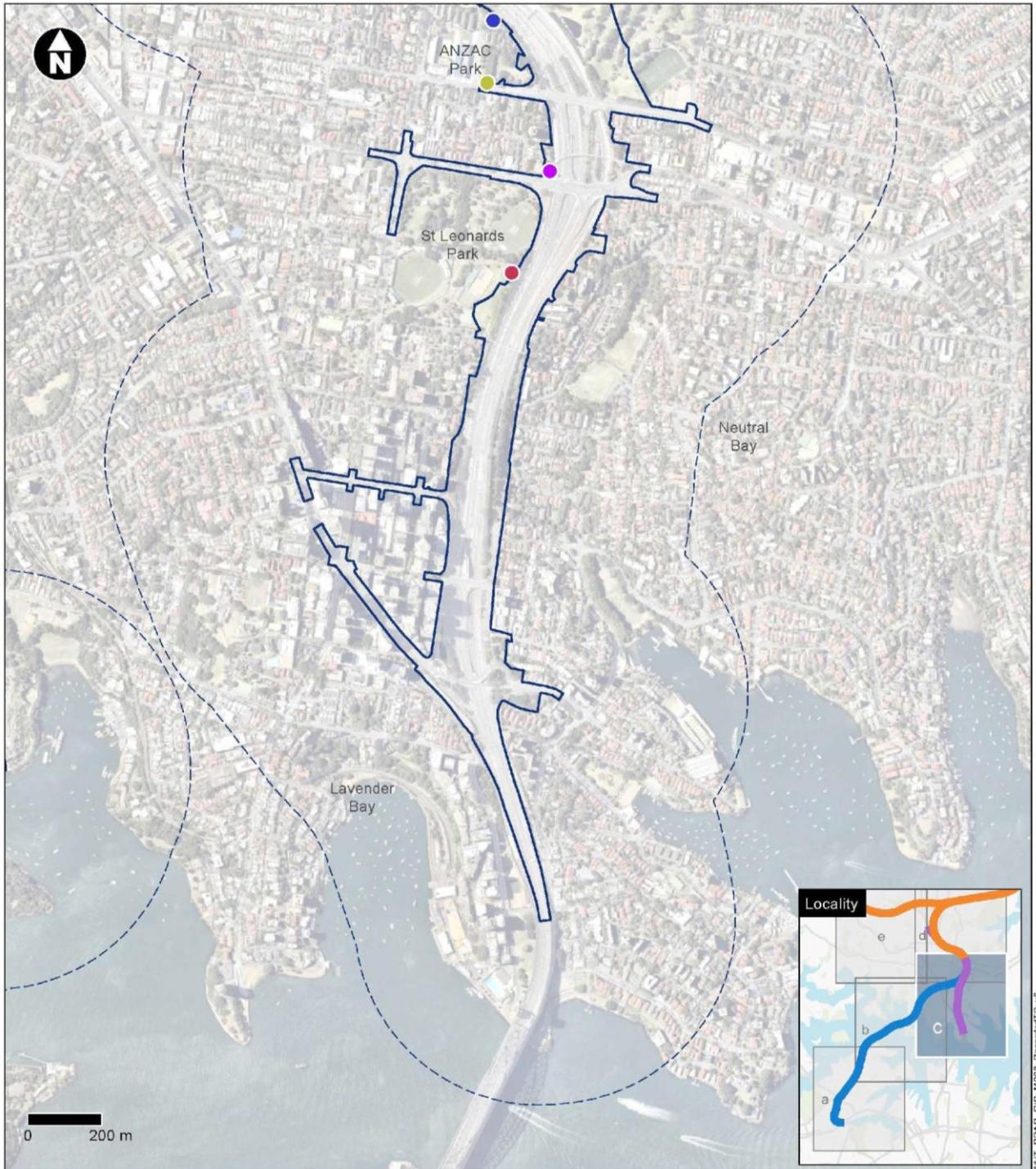
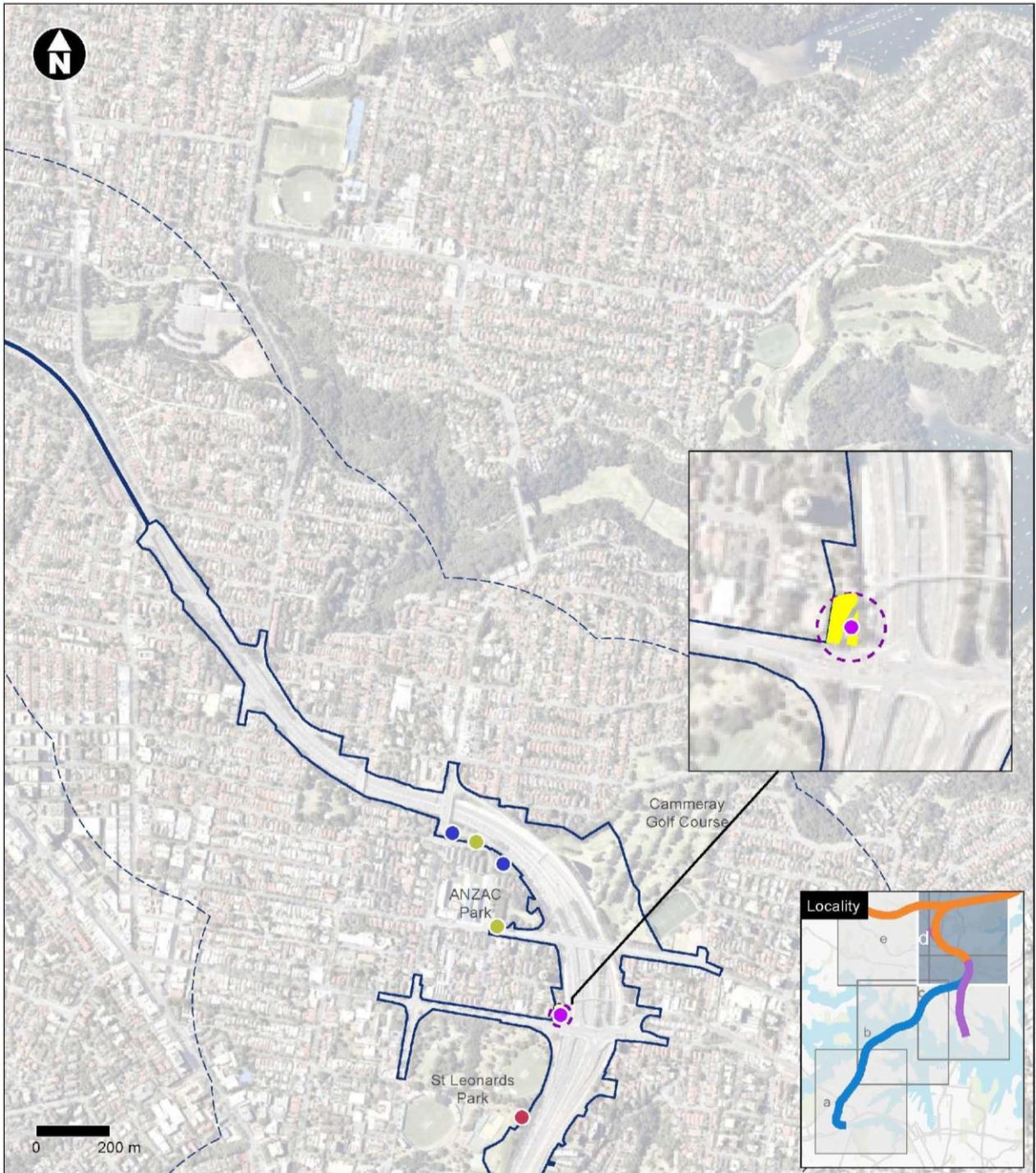


Figure 3-4 Threatened species recorded (map c)



Legend

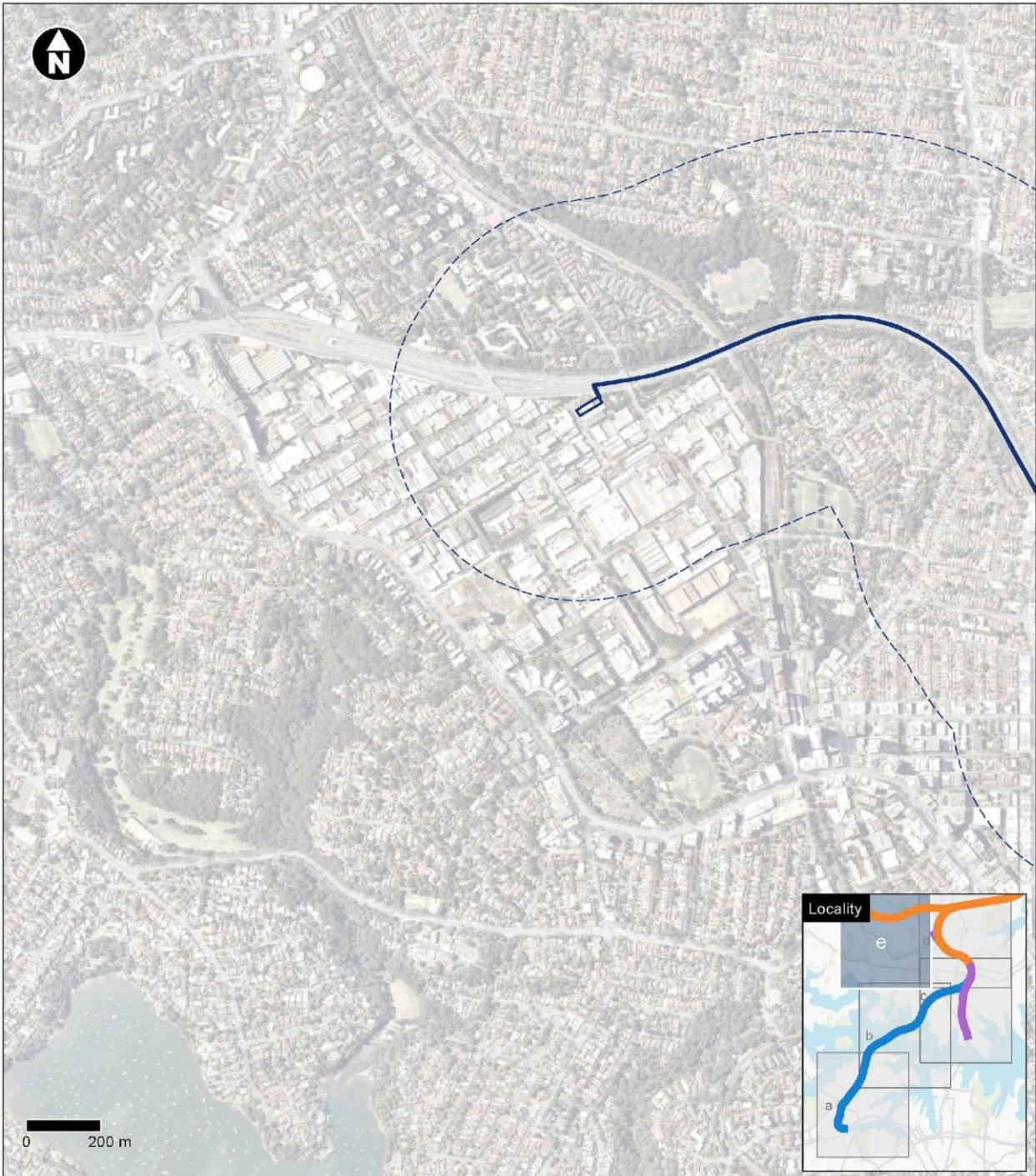
- Subject land
- Assessment area

- Threatened flora species**
- *Eucalyptus nicholii*
 - *Eucalyptus scoparia*
 - *Syzygium paniculatum*
 - *Acacia terminalis subsp terminalis*

- Threatened fauna species**
- ▲ Eastern Bentwing-bat
 - ▲ Grey-headed Flying-fox
 - ▲ White-bellied Sea Eagle

- Acacia terminalis subsp terminalis* 30 m buffer
- Acacia terminalis subsp terminalis* species polygon

Figure 3-4 Threatened species recorded (map d)



Legend
 [Solid blue line] Subject land
 [Dashed blue line] Assessment area

Figure 3-4 Threatened species recorded (map e)

3.6.2 Threatened fauna species

3.6.2.1 Species credit species

The credit calculator identified 22 candidate threatened fauna species credit species (Table 3-7). Of these 22 candidate threatened fauna species, six were recorded or considered highly likely to occur in the subject land, due to the presence of potential habitat:

- Grey-headed Flying-fox
- Eastern Bentwing-bat
- Little Bentwing-bat
- Southern Myotis
- White-bellied Sea-Eagle
- Powerful Owl.

All except Southern Myotis are listed as both species credit and ecosystem credit species. However, no suitable breeding habitat, to which species credits would apply, was recorded in the subject land. Accordingly, these species are listed as ecosystem credit species in Section 3.6.2, and discussed in further detail in Section 3.6.2.4.

Southern Myotis was not recorded in the subject land during targeted surveys. However, it is known to occur in the surrounding assessment area. The subject land supports potential marginal roosting habitat for the species, due to the presence of jetties, wharves and other man-made structures along the harbour foreshore, including the large Coal Loader wharf at Waverton (near Sydney Harbour north cofferdam (WHT6)), and smaller wharves and jetties at Yurulbin Point construction support site (WHT4) and Berrys Bay construction support site (WHT7).

Justification for the likelihood of occurrence determined for each species is provided in Appendix A of this report. Marine seabirds, shorebirds and waders are not included in the list of candidate species (as these species are not assessed under the BAM), and are instead described in Section 3.7.4.

Table 3-7 Candidate threatened fauna species

Common name	Scientific name	BC Act status*	EPBC Act status*	Sensitivity to gain class [#]	Biodiversity risk weighting [#]
Regent Honeyeater	<i>Anthochaera phrygia</i>	CE	CE	High	3
Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas	<i>Callocephalon fimbriatum</i> - endangered population	EP	-	High	2
Glossy Black-Cockatoo (breeding habitat)	<i>Calyptorhynchus lathami</i>	V	-	High	2
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V	-	High	2
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	V	V	Very high	3

Common name	Scientific name	BC Act status*	EPBC Act status*	Sensitivity to gain class#	Biodiversity risk weighting#
Little Penguin in the Manly Point area	<i>Eudyptula minor</i>	EP	-	High	2
White-bellied Sea-Eagle (breeding habitat)	<i>Haliaeetus leucogaster</i>	V	-	High	2
Giant Burrowing Frog	<i>Heleioporus australiacus</i>	V	V	Moderate	1.5
Little Eagle	<i>Hieraaetus morphnoides</i>	V	-	Moderate	1.5
Broad-headed Snake	<i>Hoplocephalus bungaroides</i>	E	V	High (foraging) and very high (breeding)	3
Swift Parrot	<i>Lathamus discolor</i>	E	CE	Very high	3
Square-tailed Kite (breeding habitat)	<i>Lophoictinia isura</i>	V	-	Moderate	1.5
Little Bentwing-bat (breeding habitat)	<i>Miniopterus australis</i>	V	-	Very high	3
Eastern Bentwing-bat (breeding habitat)	<i>Miniopterus schreibersii oceanensis</i>	V	-	Very high	3
Southern Myotis	<i>Myotis macropus</i>	V	-	High	2
Powerful Owl (breeding habitat)	<i>Ninox strenua</i>	V	-	High	2
Eastern Osprey (breeding habitat)	<i>Pandion cristatus</i>	V	V	High	2
Long-nosed Bandicoot, North Head	<i>Perameles nasuta</i> – endangered population	EP	-	High	2
Koala	<i>Phascolarctos cinereus</i>	V	V	High	2
Red-crowned Toadlet	<i>Pseudophryne australis</i>	V	-	Moderate	1.5
Grey-headed Flying-fox (breeding habitat)	<i>Pteropus poliocephalus</i>	V	V	High	2
Masked Owl (breeding habitat)	<i>Tyto novaehollandiae</i>	V	-	High	2

* V=Vulnerable, E=Endangered, CE=Critically Endangered, EP=Endangered Population

See section 2.9 for definitions of these terms

3.6.2.2 Ecosystem credit species

The credit calculator identified 19 threatened fauna species as predicted ecosystem credit species (Table 3-8).

Two threatened ecosystem credit species were recorded in the subject land:

- Grey-headed Flying-fox
- White-bellied Sea-Eagle.

An additional four threatened ecosystem credit species are considered to have a high likelihood of occurrence in the subject land:

- Eastern Bentwing-bat
- Powerful Owl
- Little Bentwing-bat
- Eastern Freetail-bat.

These species are discussed in further detail in Section 3.6.2.4.

Justification for the likelihood of occurrence determined for each species is provided in Appendix A of this report.

Table 3-8 Predicted threatened ecosystem credit species with potential habitat within the subject land

Common name	Scientific name	BC Act Status*	EPBC Act Status*	Sensitivity to gain class [#]	Associated PCTs
Regent Honeyeater	<i>Anthochaera phrygia</i>	CE	CE	High	1778
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	V	-	High	1778
Varied Sittella	<i>Daphoenositta chrysoptera</i>	V	-	Moderate	1778
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	V	E	Moderate	1778
Little Lorikeet	<i>Glossopsitta pusilla</i>	V	-	High	1778
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	V	-	High	1778
Little Eagle	<i>Hieraaetus morphnoides</i>	V	-	Moderate	1778
Broad-headed Snake	<i>Hoplocephalus bungaroides</i>	E	V	High	1778
Swift Parrot	<i>Lathamus discolor</i>	E	CE	Moderate	1778
Square-tailed Kite	<i>Lophoictinia isura</i>	V	-	Moderate	1778
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V	-	High	1778

Common name	Scientific name	BC Act Status*	EPBC Act Status*	Sensitivity to gain class [#]	Associated PCTs
Little Bentwing-bat	<i>Miniopterus australis</i>	V	-	High	1778
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V	-	High	1778
Powerful Owl	<i>Ninox strenua</i>	V	-	High	1778
Eastern Osprey	<i>Pandion cristatus</i>	V	M	Moderate	1778
Koala	<i>Phascolarctos cinereus</i>	V	V	High	1778
Grey-headed Flying fox	<i>Pteropus poliocephalus</i>	V	V	High	1778
Masked Owl	<i>Tyto novaehollandiae</i>	V	-	High	1778
Rosenberg's Goanna	<i>Varanus rosenbergi</i>	V		High	1778

* V=Vulnerable, E=Endangered, CE-Critically Endangered, M=Migratory

See section 2.9 for definition of this term

3.6.2.3 Species recorded within 1.5 kilometres of the subject land

In addition to the BAM credit calculator outputs (as described in Sections 3.6.2.1 and 3.6.2.2), the Secretary's environmental assessment requirements require the assessment of all threatened species recorded recently (since 1990) within 1.5 kilometres of the subject land.

Twenty-one threatened fauna species listed under the BC Act have been recorded recently (since 1990) within 1.5 kilometres of the subject land (Table 3-9). Fourteen of these species were identified in the BAM credit calculator. Of these, four were species credit species confirmed as candidate species on the basis of a moderate to high likelihood of occurrence (see Appendix A for justification of likelihood of occurrence of each species). These species were subject to targeted seasonal surveys in accordance with the BAM. Species listed as both ecosystem and species credit species were not considered to be candidate species where breeding habitat was known to be absent.

Table 3-9 Threatened fauna species recorded within 1.5 kilometres of the subject land (Bionet Atlas Database)

Common name	Scientific name	BC Act status*	EPBC Act status*	Identified by BAM calculator	Likelihood of occurrence	Ecosystem or species credit species	Candidate species
Bush Stone-curlew	<i>Burhinus grallarius</i>	E	-	No	Low	Species	No
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V	-	Yes	Low	Species	No
Varied Sittella	<i>Daphoenositta chrysoptera</i>	V	-	Yes	Low	Ecosystem	No
Little Lorikeet	<i>Glossopsitta pusilla</i>	V	-	Yes	Low	Ecosystem	No
Pied Oystercatcher	<i>Haematopus longirostris</i>	E	-	No	Low	Species	No
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	V	-	Yes	Known	Species/Ecosystem	Yes
Black Bittern	<i>Ixobrychus flavicollis</i>	V	-	No	Low	Ecosystem	No
Swift Parrot	<i>Lathamus discolor</i>	E	CE	Yes	Low	Species/Ecosystem	No
Square-tailed Kite	<i>Lophoictinia isura</i>	V	-	Yes	Low	Species/Ecosystem	No
Little Bentwing-bat	<i>Miniopterus australis</i>	V	-	Yes	High	Species/Ecosystem	No
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V	-	Yes	High	Species/Ecosystem	No
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V	-	Yes	High	Ecosystem	No
Southern Myotis	<i>Myotis macropus</i>	V	-	Yes	High	Species	Yes
Barking Owl	<i>Ninox connivens</i>	V	-	No	Low	Species/Ecosystem	No

Common name	Scientific name	BC Act status*	EPBC Act status*	Identified by BAM calculator	Likelihood of occurrence	Ecosystem or species credit species	Candidate species
Powerful Owl	<i>Ninox strenua</i>	V	-	Yes	High	Species/Ecosystem	Yes
Giant Dragonfly	<i>Petalura gigantea</i>	E	-	No	Low	Species	No
Koala	<i>Phascolarctos cinereus</i>	V	V	Yes	Low	Species/Ecosystem	No
Red-crowned Toadlet	<i>Pseudophryne australis</i>	V	-	Yes	Low	Species	No
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V	Yes	Known	Species/Ecosystem	Yes
Superb Fruit-Dove	<i>Ptilinopus superbis</i>	V	V	No	Low	Ecosystem	No
Little Tern	<i>Sternula albifrons</i>	E	M	No	Low-moderate	Species/Ecosystem	No

*V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory

3.6.2.4 Threatened fauna species recorded in the subject land

Two threatened fauna species listed under the EPBC Act and/or BC Act were recorded in the subject land by WSP (2018) and Arcadis (refer to Table 3-10 and Figure 3-4).

An additional six threatened fauna species were considered highly likely to occur in the subject land, due to the presence of potential habitat and/or the species being previously recorded in (or near) the subject land (as assessed in Appendix A).

Table 3-10 Threatened fauna species recorded in the subject land

Species	BC Act status*	EPBC Act status*	Occurrence in subject land	Type of credit
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	V	V	Known to occur in the subject land. This species was observed flying over Berrys Bay construction support site (WHT7) during the survey carried out in February 2018. This species was also recorded by WSP flying over a number of locations within the subject land, during surveys carried out in 2017.	Ecosystem/species credit species
Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>)	V	-	High likelihood of occurrence in the subject land. This species is known to occur in the subject land and surrounding locality (OEH, 2019a). This species has been recorded within the surrounding assessment area in recent years, including Wollstonecraft (North Sydney Council, 2018).	Ecosystem credit species
Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>)	V	-	High likelihood of occurrence in the subject land. A winter roost for this species is located within one of the four tunnels at the Coal Loader Centre for Sustainability on the western side of Waverton peninsula, located about 50 metres north-east of Sydney Harbour north cofferdam (WHT6).	Ecosystem/species credit species
Little Bentwing Bat (<i>Miniopterus australis</i>)	V	-	High likelihood of occurrence in the subject land. This species was not recorded during targeted surveys. However, it is known to occur in the surrounding assessment area (Gonsalves and Law, 2017a; Hoyer, 2000). Balls Head Reserve is likely to comprise important foraging habitat for the species (Hoyer, 2000). This species has also been recorded at Wollstonecraft and Waverton in recent years (North Sydney Council, 2018).	Ecosystem/species credit species
White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>)	V	M	Known to occur in the subject land. This species was observed flying above Sydney Harbour near Balls Head Reserve, and above Goat Island. It has been previously recorded in the surrounding assessment area, foraging the waters of Sydney Harbour near Balls Head (OEH, 2019a). This species has been frequently observed from the southern shores of North Sydney local government area in recent years, including Balls Head Reserve, Wollstonecraft and Waverton (North Sydney Council, 2018).	Ecosystem/species credit species

Species	BC Act status*	EPBC Act status*	Occurrence in subject land	Type of credit
Powerful Owl (<i>Ninox strenua</i>)	V	-	High likelihood of occurrence in the subject land. This species was not recorded during targeted surveys. However, it is known to occur in the subject land and surrounding assessment area (OEH, 2019a). This species has been recorded frequently throughout the assessment area in recent years, including at Balls Head Reserve, Wollstonecraft and Waverton (North Sydney Council, 2018).	Ecosystem/species credit species
Southern Myotis (<i>Myotis macropus</i>)	V	-	High likelihood of occurrence in the subject land. This species was not recorded in the subject land during targeted surveys. However, it is known to occur in the surrounding assessment area. The species has been recorded previously at Berrys Bay, Badangi Reserve (Wollstonecraft) and Balls Head (Waverton) (OEH, 2019a; Gonsalves and Law, 2017b). This species has been also been at Gore Cove and Lavender Bay (North Sydney Council, 2018), just outside the assessment area.	Species credit species
Little Penguin (<i>Eudyptula minor</i>) in the Manly Point area	EP	-	High likelihood of occurrence in the subject land. This species was not recorded in the subject land during field surveys for this project. However, it has been recorded at several locations within the subject land and surrounding assessment area, including Snails Bay, Berrys Bay, Balls Head Bay, and in the main channel of Sydney Harbour (OEH, 2019a).	Species credit species

*V = Vulnerable, EP= Endangered Population, M= Migratory

3.6.2.4.1 Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox is listed as a Vulnerable species under the BC Act and EPBC Act. This species was observed flying over where the Berrys Bay construction support site (WHT7) would be located during the survey carried out in February 2018. This species was also recorded by WSP flying over a number of locations within the subject land, during surveys carried out in 2017. This species has been frequently recorded in the surrounding assessment area in recent years, including Balls Head Reserve, Waverton and Wollstonecraft (North Sydney Council, 2018).

The Grey-headed Flying-fox is generally found within 200 kilometres of the eastern coast of Australia, from Rockhampton to Melbourne. The species may be found in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps, while additional foraging is provided by urban gardens and cultivated fruit crops. The Grey-Headed Flying-fox is a highly mobile species with a nightly feeding range of 20 to 50 kilometres from a roosting camp. Diet typically comprises of a wide variety of flowering and fruiting plants (Tidemann, 1995; Churchill, 2008) with non-indigenous and exotic tree species introduced to the urban landscape providing additional foraging habitat for this species. Grey-headed Flying-foxes roost in large numbers, with up to tens of thousands of flying foxes using individual camps for mating, birth and rearing of young.

The subject land does not support a camp, and therefore does not support critical roosting habitat for the species. Two nationally important Grey-headed Flying-fox camps have been mapped near the subject land by *National Flying-fox monitoring viewer* (DoEE, 2019b):

- Flying-fox Camp I.D. 487 located within Centennial Park, around seven kilometres south-east of the subject land. It has supported up to 50,000 flying foxes in recent years
- Flying-fox Camp I.D. 529, located along Burnt Bridge Creek in Balgowlah, around nine kilometres north-east of the subject land. It has supported up to 10,000 flying foxes in recent years.

It is likely that the individuals recorded flying over the subject land were from these camps (although a number of other camps are located within the species' foraging range) and were observed flying overhead during their nightly foraging activities. The subject land provides foraging habitat for the Grey-headed Flying-fox, given the presence of preferred blossom and fruit tree species that occur within parks, road verges and private land (eg residential gardens). A number of locations within the subject land support tree species that offer a foraging resource for the species, as listed by *Ranking the feeding habitats of Grey-headed flying foxes for conservation management* (Eby and Law, 2008). These tree species are listed in Table 3-11.

Table 3-11 Grey-headed Flying-fox feed trees recorded at sites within the subject land

Tree species recorded that are in the blossom diet of Grey-headed Flying-foxes	Tree species recorded that are in the fruit diet of Grey-headed Flying-foxes
<ul style="list-style-type: none"> • <i>Corymbia gummifera</i> • <i>Eucalyptus saligna</i> • <i>Eucalyptus sideroxylon</i> • <i>Eucalyptus botryoides</i> • <i>Angophora costata</i> • <i>Melaleuca quinquenervia</i>. 	<ul style="list-style-type: none"> • <i>Elaeocarpus reticulatus</i> • <i>Ficus spp.</i> • <i>Pittosporum undulatum</i> • <i>Syzygium sp.</i>

3.6.2.4.2 Eastern Freetail-bat (*Mormopterus norfolkensis*)

The Eastern Freetail-bat is listed as a Vulnerable species under the BC Act.

This species was not recorded during targeted surveys. However, it is known to occur in the subject land and surrounding locality (OEH, 2018a). This species has been recorded within the surrounding assessment area in recent years, including Wollstonecraft (North Sydney Council, 2018).

The Eastern Freetail-bat is found east of the Great Dividing Range, from Brisbane in south-east Queensland to Sydney in NSW, where it is most commonly recorded in dry eucalypt forest and woodland and shows a preference for open spaces in woodland or forest. The species has also been recorded in swamp forests and mangrove forests. The Eastern Freetail-bat forages in openings and gaps in the forest including over larger waterways (Churchill, 2008). The diet of this species has not been studied but is most probably insectivorous (OEH, 2019d). The Eastern Freetail-bat roosts mainly in tree hollows, usually in hollow spouts of large mature trees, but will also roost under exfoliating bark or in man-made structures and buildings (OEH, 2019d; Churchill, 2008).

The subject land supports potential roosting habitat for the species due to the presence of buildings, such as those where the Berrys Bay construction support site (WHT7) would be located. These man-made habitats are described in more detail in Section 3.7.2. The subject land supports limited foraging habitat due to the absence of forested areas. However, the species may forage in well-vegetated areas such as Balls Head Reserve, near the subject land.

3.6.2.4.3 Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)

Eastern Bentwing-bat is listed as a Vulnerable species under the BC Act.

This species was identified outside of but close to the subject land; Eastern Bentwing-bats have been recorded roosting within one of the four tunnels at the Coal Loader Centre for Sustainability on the western side of the Waverton peninsula, about 50 metres north east of Sydney Harbour north cofferdam (WHT6).

The species has also been recorded previously at Waverton, Balls Head, Berrys Bay and Wollstonecraft (OEH, 2019a; Gonsalves and Law, 2017a, North Sydney Council, 2018), and is known to roost in stormwater drains elsewhere in the surrounding locality (Hoye, 2000). Eastern Bentwing-bats have been found roosting in at least six concrete box culverts throughout North Sydney local government area (L Gonsalves and B Law 2018, personal communication, 6 August), and has been found roosting with Southern Myotis underneath a jetty that is located within one kilometre of the subject land.

The Eastern Bentwing-bat is a microbat that occurs along the east and north-west coasts of Australia (OEH, 2019d) where it is found in a variety of habitats including rainforest, dry and wet sclerophyll forest, open woodland, paperbark forest and open grassland. The species hunts for moths and other flying insects above tree canopies or in open areas (OEH, 2019d).

Eastern Bentwing-bats are known to use a number of roost sites throughout the year (Churchill, 2008). Caves are the primary roosting habitat for this species. However, Eastern Bentwing-bats also use derelict mines, storm-water tunnels, buildings and other man-made structures (OEH, 2019d). The most significant of these roosts are maternity roosts and roosts used over winter for hibernation (OEH, 2019d).

Female Eastern Bentwing-bats inhabit and congregate in specific caves that provide constant high temperate and humidity to give birth and raise young (Dwyer, 2009). Maternity caves are used annually in spring and summer for the birth and rearing of young. At other times of the year, populations disperse within a territorial range of about 300 kilometres from the maternity cave (Churchill, 2008).

The subject land does not support a maternity cave. However, a roost used over winter for hibernation by the Eastern Bentwing-bats is located in one of the four tunnels at the Coal Loader Centre for Sustainability, identified in the tunnel furthest from the harbour foreshore. This roost is located about 50 metres north east of Sydney Harbour north cofferdam (WHT6).

Individuals have been observed roosting in crevices and alcoves (where coal hoppers have been removed) in the tunnel roof, with some clusters of individuals hanging from the roof itself. The number of Eastern Bentwing-bats occupying this winter roost in recent years has fluctuated, but this species generally occupies the tunnel during autumn, winter and early spring (Table 3-12). Absence of roosting bats in summer, which is the breeding/maternity season for the species, means that the tunnel is not used as a maternity roost (Gonsalves and Law, 2017a).

Table 3-12 Estimated number of Eastern Bent-wing bats occupying Coal Loader tunnel

Date of survey	Estimated colony size within Coal Loader tunnel	Source of data
5 th May 2000	400-500 individuals	Hoye (2000)
17 th May 2000	150-170 individuals	Hoye (2000)
23 rd May 2000	150-170 individuals	Hoye (2000)
25 th May 2000	0 individuals	Hoye (2000)
March 2014	50-90 individuals	Gonsalves and Law (2017a)

Date of survey	Estimated colony size within Coal Loader tunnel	Source of data
April 2014	60-150 individuals	Gonsalves and Law (2017a)
May 2014	180-200 individuals	Gonsalves and Law (2017a)
June 2014	180-200 individuals	Gonsalves and Law (2017a)
July 2014	0 individuals	Gonsalves and Law (2017a)
August 2014	280-300 individuals	Gonsalves and Law (2017a)
14 th May 2018	0 individuals	Inspection carried out by North Sydney Council
28 th May 2018	At least 28 individuals	Inspection carried out by North Sydney Council
25 th June 2018	At least 60 individuals	Inspection carried out by Arcadis ecologists and North Sydney Council
19 th July 2018	At least 130 individuals	Inspection carried out by North Sydney Council
20 th August 2018	At least 210 individuals	Inspection carried out by North Sydney Council
17 th September 2018	At least 50 individuals	Inspection carried out by North Sydney Council

Eastern Bentwing-bats that roost in this tunnel during winter may forage above vegetation that occurs within or near the subject land, road verges and private properties (eg residential gardens), and throughout larger tracts of bushland in the surrounding locality, including Balls Head Reserve.

Hoye (2000) found that Eastern Bentwing-bats often moved between roosts located in the North Sydney local government area with many individuals moving between the Coal Loader tunnel roost and a roost located in a park in Cammeray. A few individuals were identified at roosts even further away, at Middle Head, Georges Head and Henry Head at La Perouse (Hoye, 2000), suggesting that the species is capable of utilising several roosting habitats throughout the locality.

3.6.2.4.4 Little Bentwing-bat (*Miniopterus australis*)

Little Bentwing-bat is listed as a Vulnerable species under the BC Act.

This species was not recorded during targeted surveys. However, it is known to occur in the surrounding assessment area (Gonsalves and Law, 2017a; Hoye, 2000). Balls Head Reserve is likely to comprise important foraging habitat for the species (Hoye, 2000). This species has also been recorded at Wollstonecraft and Waverton in recent years (North Sydney Council, 2018).

The Little Bentwing-bat occurs along the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW, where it inhabits moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. This species is generally found in well-timbered areas, where it hunts for flying insects (predominantly beetles, moths and flies) between the shrub and canopy layer (Churchill, 2008).

The Little Bentwing-bat roosts in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day. During winter, the species enters a shallow hibernation, emerging frequently from these roosts to hunt for food. The Little Bentwing-bat moves to maternity caves in spring, often together with Eastern Bentwing-bats. Little Bentwing-

bats appear to depend on the congregation of Eastern Bentwing-bats (which are larger-bodied bats) to provide the high temperatures needed to rear their young. Males and juveniles disperse from maternity roosts in summer (OEH, 2019d; Churchill, 2008).

The subject land supports potential roosting habitat for the species, due to the presence of stormwater drains, culverts and buildings, such as those where the Berrys Bay construction support site (WHT7) would be located. These man-made habitats are described in more detail in Section 3.7.2. The subject land itself supports limited foraging habitat due to the absence of forested areas. However, the species may forage near the subject land, in well-vegetated areas such as Balls Head Reserve.

3.6.2.4.5 White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

White-bellied Sea-Eagle is listed as a Vulnerable species under the BC Act, and a Migratory species under the EPBC Act.

This species was observed flying above Sydney Harbour near Balls Head Reserve, and above Goat Island. It has been previously recorded in the surrounding assessment area, foraging the waters of Sydney Harbour near Balls Head (OEH, 2019a). This species has been frequently observed from the southern shores of North Sydney local government area in recent years, including Balls Head Reserve, Wollstonecraft and Waverton (North Sydney Council, 2018).

The White-bellied Sea-Eagle is distributed along the east coast of NSW (around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves), and along all major inland rivers, swamps, freshwater lakes and reservoirs. This species hunts above large areas of open water for fish, freshwater turtles, waterbirds, reptiles, mammals and carrion. White-bellied Sea-Eagles typically construct a large stick nest in a large emergent eucalypt, within mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. However, nests may be built in a variety of sites including bushes, mangroves, cliffs, rocky outcrops, caves, crevices, on the ground or on artificial structures (DoEE, 2019a). White-bellied Sea-Eagles may be solitary or live in pairs or small family groups consisting of a pair of adults and dependent young. Resident pairs are territorial and occupy nesting territories of hundreds of hectares.

The subject land is not known to support a White-bellied Sea Eagle nest. The closest known nesting site is located in Newington Nature Reserve, next to the Parramatta River, about 12 kilometres north-west of the subject land. A pair of White-bellied Sea eagles occupies this nest and most recently raised two chicks that fledged in October 2019 (Birdlife, 2019).

The subject land offers foraging habitat to the species, due to the presence of preferred prey species that inhabit Sydney Harbour. A very small proportion of subject land also offers potential perching habitat in the trees that occur along the harbour foreshore at Yurulbin Point construction support site (WHT4) and Berrys Bay construction support site (WHT7) locations.

3.6.2.4.6 Powerful Owl (*Ninox strenua*)

The Powerful Owl is listed as a Vulnerable species under the BC Act. This species was not recorded during targeted surveys. However, it is known to occur in the subject land and surrounding assessment area (OEH, 2019a). This species has been recorded frequently throughout the assessment area in recent years, including at Balls Head Reserve, Wollstonecraft and Waverton (North Sydney Council, 2018).

Distribution of the Powerful Owl ranges from South Australia to Rockhampton in Queensland, generally within 200 kilometres from the coast. Within NSW, the Powerful Owl is distributed throughout the length of the Great Dividing Range, which is their stronghold, and extends from the coast to the western slopes where they occur in much lower numbers.

The Powerful Owl inhabits open sclerophyll forests and woodlands dominated by Eucalypts, and frequently occurs in sheltered gullies containing old-growth trees, a dense understorey and often near permanent streams (Higgins, 1999). The Powerful Owl requires large areas of habitat but can occur in fragmented landscapes and has been recorded in exotic pine plantations and large trees in parks and gardens.

The Powerful Owl is the largest predator of nocturnal forest-dwelling animals in Australian forests. It hunts in open forests of woodlands for arboreal prey, (Higgins, 1999), such as the Greater Glider, Common Ringtail Possum, Sugar Glider, Grey-headed Flying-fox, and roosting birds such as Pied Currawong, Australian Magpie and Rainbow Lorikeet. It roosts by day in dense vegetation such as *Syncarpia glomulifera*, *Allocasuarina littoralis* (Black She-oak), *Acacia melanoxylon* (Blackwood), *Angophora floribunda* (Rough-barked Apple), *Exocarpos cupressiformis* (Cherry Ballart) and a number of eucalypt species.

A small area of vegetation within the subject land offers potential foraging habitat to the Powerful Owl. The small area of Smooth-barked Apple – Coast Banksia/Cheese Tree open forest (as described in Section 3.3.1), which occurs within an exclusion zone next to where the Berrys Bay construction support site (WHT7) would be located, is continuous with a larger tract of bushland at Balls Head Reserve. This vegetation likely supports preferred prey species such as Common Ringtail Possum and Grey-headed Flying-fox. The subject land does not support preferred nesting habitat, given the absence of hollow-bearing trees. The subject land does not support preferred roosting habitat.

3.6.2.4.7 Southern Myotis (*Myotis macropus*)

Southern Myotis is listed as a Vulnerable species under the BC Act.

This species was not recorded in the subject land during targeted surveys. However, it is known to occur in the surrounding assessment area. The species has been recorded previously at Berrys Bay, Badangi Reserve (Wollstonecraft) and Balls Head (Waverton) (OEH, 2019a; Gonsalves and Law, 2017b). This species has been also been recorded at numerous bays outside of the subject land, but within or near the assessment area (Gonsalves and Law, 2017b North Sydney Council, 2018).

The Southern Myotis is a microbat that occurs along the eastern coast of New South Wales and is rarely found more than 100 kilometres inland. This species is strongly associated with waterways including streams, pools, dams and rivers, where it forages for aquatic invertebrates and small fish.

This species generally roosts in groups of 10 to 15 individuals close to water and has been found roosting in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage (OEH, 2019a). However, roosts have also been found in culverts more than one kilometre from the nearest permanent waterbody and this species is known to fly over land to forage at isolated farm dams (Anderson et al., 2006).

The Southern Myotis is known to roost underneath a jetty that is located within one kilometre of the subject land (Gonsalves and Law, 2017b). This roost was found to be used by around 50 pregnant and lactating females as well as males in March 2015. It was also found that Balls Head Bay within west harbour was a feeding 'hot spot' for the species, and that bats roosting in the jetty in west harbour only foraged in bays in this zone and on the nearby Lane Cove River.

The subject land supports potential marginal roosting habitat for the species, due to the presence of jetties, wharves and other man-made structures along the harbour foreshore, including the large Coal Loader wharf at Waverton (near Sydney Harbour north cofferdam (WHT6)), and smaller wharves and jetties at Yurulbin Point construction support site (WHT4) and Berrys Bay construction support site (WHT7). These man-made habitats are described in more detail in Section 3.7.2. The subject land also contains potential foraging habitat, particularly sheltered bays that can provide calmer water surfaces that are more suited to the trawling foraging strategy that bats employ (Gonsalves and Law, 2017b).

3.6.2.4.8 Little Penguin in the Manly Point area (endangered population)

One threatened population is known to occur in the subject land on occasion: the population of Little Penguins in the Manly Point area (from just north of Smedley's Point to Cannae Point), which is listed as an Endangered Population under the BC Act.

This species was not recorded in the subject land during targeted surveys. However, it has been recorded at several locations within the subject land and surrounding assessment area, including

Snails Bay, Berrys Bay, Balls Head Bay, and in the main channel of Sydney Harbour (OEH, 2019a).

This population at Manly is the only known breeding population of Little Penguins on the mainland in NSW, where nesting habitat at Manly includes burrows under rocks on the foreshore, under waterfront houses and structures (such as stairs or in wood piles) and under overhanging vegetation including lantana and under coral tree roots (NPWS, 2000).

From May, male penguins start establishing or reconstructing a suitable burrow for nesting and to attract females. Egg-laying at Manly has been recorded as early as the first week of June. However, the peak breeding season is generally from July to December. After the chicks have hatched (Little Penguins usually lay a clutch of two eggs), adults alternate between remaining in the nest and foraging, until the chicks have developed enough to be left unguarded during the day, while both adults forage. The adults return to the nest to feed their chicks at night, until the chicks leave the nest after seven to nine weeks to mature at sea. It is common for the Little Penguins at Manly to produce a second clutch of eggs later in the season, after the chicks from the first clutch have fledged (NPWS, 2000).

Little Penguins forage in shallow waters throughout Sydney Harbour for small shoaling fish, cephalopods and, to a lesser extent, crustaceans (NPWS, 2000). Adult penguins may travel 14 to 20 kilometres a day when foraging. While the subject land offers foraging habitat (marine habitat) to Little Penguins, nesting habitat at Manly is located about 10 kilometres to the north east.

3.7 Fauna habitat

3.7.1 Vegetated habitats

Land use within the subject land is dominated by residential development, and to a lesser extent, commercial and industrial development. Native vegetation has also been removed for infrastructure development such as roads and rail corridors. Fauna habitat generally only persists where vegetation occurs in gardens, parks and street verges, which is often dominated by exotic plantings.

Vegetation within the subject land is typically highly modified, consisting of trees and shrubs in landscaped parks and reserves, private residential gardens and road verges. Within the subject land, native and exotic vegetation is present at the following locations (Figure 3-3):

- Within and next to Yurulbin Point construction support site (WHT4)
- Next to Berrys Bay construction support site (WHT7)
- Within and next to Cammeray Golf Course construction support site (WHT10/WFU8)
- Within and next to the Warringah Freeway Upgrade
- Jeaffreson Jackson Reserve.

With the exception of vegetation within the exclusion zone at Berrys Bay construction support site (WHT7) (which maintains connectivity to a substantial area of bushland in Balls Head Reserve), these small, isolated patches of fauna habitat do not maintain habitat connectivity with any large areas of native vegetation in the assessment area or wider locality. Much of this vegetation is subject to regular and ongoing maintenance, in that street trees are often pruned (particularly if they conflict with overhead powerlines), and grassy verges, parklands and gardens are mown.



Plate 4 Scattered trees and mown grass at Yurulbin Point construction support site (WHT4)



Plate 5 Exotic trees, shrubs and vines next to the Berrys Bay construction support site (WHT7)

Fauna species that would occur in these habitats would generally be limited to those highly mobile species which are capable of using small, isolated patches of habitat in a landscape otherwise cleared of native vegetation, and tolerant of disturbances typical of the urban environment (such as light and noise pollution). Flowering and fruiting trees and shrubs would offer foraging, nesting and roosting habitat to bats, birds and arboreal mammals, such as Grey-headed Flying-fox, Australian Magpie (*Cracticus tibicen*), Noisy Miner (*Manorina melanocephala*), Rainbow Lorikeet (*Trichoglossus moluccanus*), Grey Butcherbird (*Cracticus torquatus*), Common Brushtail Possum (*Trichosurus vulpecula*) and Common Ringtail Possum (*Pseudocheirus peregrinus*).

One potential hollow-bearing tree was identified in a *Eucalyptus saligna* in Jeaffreson Jackson Reserve (Figure 3-5). Protuberances in the trunk that often indicate the presence of hollows were observed on this tree, however these may have been caused by limb removal as observed on lower parts of the trunk. Hollow entrances, or lack thereof, were not visible from the ground. If present, hollows are likely to support common urban fauna such as Common Brushtail Possum and Sulphur-crested Cockatoo. The complexity of ground layer habitats is low. Landscaped areas and garden beds may offer marginal foraging habitat for birds, small mammals and reptiles.

3.7.2 Man-made structures and built environments

A number of built structures, including warehouses, buildings, wharves, jetties and tunnels, occur within the subject land at White Bay construction support site (WHT3), Yurulbin Point construction support site (WHT4), near Sydney Harbour north cofferdam (WHT6) and within Berrys Bay construction support site (WHT7). These structures provide potential habitat for microbats that prefer to roost in man-made structures, such as the Little Bentwing-Bat, Eastern Bentwing-Bat, Eastern Freetail-bat, Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Southern Myotis is known to roost under a concrete wharf that is located within one kilometre of the subject land (Gonsalves and Law, 2017b).

3.7.2.1 Tunnels

A roost used over winter by Eastern Bentwing-bats is located close to the subject land; roosting habitat is located within one of the four Coal Loader tunnels on the western side of Waverton peninsula, about 50 metres north-east of Sydney Harbour north cofferdam (WHT6). As described in Section 3.6.2.4.3, the number of Eastern Bentwing-bats occupying this winter roost in recent years has fluctuated, but generally occupy the tunnel during autumn, winter and early spring.

Table 3-13 Structures inspected for known microbat habitat at the Coal Loader Centre for Sustainability (near Sydney Harbour north cofferdam (WHT6))

Photo	Description of known roosting habitat
	<p>One of the four tunnels that was once part of the coal-loading operations at Waverton. The tunnel is about 175 metres long and is open at both ends, although a locked gate at both ends prevents access to and disturbance by people. Eastern Bentwing-bats are known to roost in the alcoves in the ceiling formed by the coal hoppers.</p>

3.7.2.2 Buildings

No roosting microbats were found during the diurnal inspection of the interior and exterior of all buildings and sheds at Berrys Bay construction support site (WHT7). No evidence of microbat occupation (ie guano) was identified in any buildings or sheds. No threatened microbats were recorded at this location. Anabat surveys carried out at dusk on 15 February 2018 identified just one microbat species flying near buildings: Gould’s Wattleed Bat (*Chalinolobus gouldii*). A description of each building inspected is provided in Table 3-14.

Potential microbat roosting habitat at Berrys Bay construction support site (WHT7) is generally restricted to a few small wall and ceiling cavities identified within only a few buildings. All other buildings in the site are either well-sealed and do not offer access to microbats or are too open and exposed to offer adequate protection from adverse climatic conditions. In addition, the presence of fauna species that may predate on microbats, such as rats, ringtail possums and brushtail possums (Banks and Smith, 2015; Threlfall et al., 2013), may affect the likelihood of microbats persisting in built structures at Berrys Bay.

Table 3-14 Buildings inspected for potential microbat habitat at Berrys Bay construction support site (WHT7)

Photo of exterior	Photo of interior	Description of potential roosting habitat
		<ul style="list-style-type: none"> • Several entry/exit points along corroded gutters to interior of shed • Potential roosting habitat located in wall cavities along southern wall of building, accessible from exterior of building • Remainder of shed likely too exposed to support preferred roosting habitat.
	<p>Not accessible.</p>	<ul style="list-style-type: none"> • No visible entry/exit points for microbats • Building well sealed, no gaps or crevices evident • No potential roosting habitat visible.

Photo of exterior	Photo of interior	Description of potential roosting habitat
		<ul style="list-style-type: none"> • Entry/exit points via doorway and broken windows, gaps in roller door • Potential roosting habitat in small wall and ceiling cavities, among ceiling support beams.
		<ul style="list-style-type: none"> • Exit/entry points provided via broken windows, corroded guttering, gaps and holes in the roof and walls • Interior of warehouse-type building likely too exposed to support preferred roosting habitat • Frequent use by possums evident due to the abundance of scat.
	<p>Not accessible</p>	<ul style="list-style-type: none"> • Entry/exit point through broken window • Potential for bats to roost beneath shingles on exterior of building when weather favourable (not completely protected from rain and wind) • Interior unable to be inspected, however ceiling appears well-sealed and unlikely to offer roosting habitat.
		<ul style="list-style-type: none"> • Entry/exit points above toilet stall doors • Interior of toilet stalls exposed to weather (cold temperatures and wind), reducing suitability of roosting habitat • Limited roosting opportunities below exposed corrugated roof.

3.7.2.3 Jetties and wharves

Jetties and wharves occurring within the subject land were assessed for their potential to provide roosting habitat. Structures that have roosting habitat potential are summarised in Table 3-15. The descriptions provided are based on observations made by Arcadis ecologists from the foreshore. No close inspections of these structures were able to be made.

Table 3-15 Jetties and wharves located in the subject land that were inspected for potential microbat roosting habitat

Location	Photo	Description of potential roosting habitat
White Bay construction support site (WHT3)		A solid sea wall that does not offer potential microbat habitat.
Yurulbin Point construction support site (WHT4)		A timber structure that offers limited and marginal potential roosting habitat. Gaps in the timber exposes potential roosting habitat to wind and rain. Microbats generally prefer roost sites that are protected from adverse weather conditions.
Coal Loader Wharf, near Sydney Harbour north cofferdam (WHT6)		A timber structure that offers limited and marginal potential roosting habitat. Gaps in the timber mean that potential roosting habitat is exposed to wind and rain. Microbats generally prefer roost sites that are protected from adverse weather conditions.
Berrys Bay construction support site (WHT7)		Two dilapidated timber jetties that offer limited and marginal potential roosting habitat. Gaps in the timber mean that potential roosting habitat is exposed to wind and rain. Microbats generally prefer roost sites that are protected from adverse weather conditions.

3.7.3 Freshwater habitats

One waterway occurs within the subject land: Whites Creek. The lower reach of Whites Creek, a highly modified waterway, is located near Rozelle Rail Yards construction support site (WHT1).

The catchments of three other waterways fall within the subject land: Willoughby Creek, Flat Rock Creek and Quarry Creek. These waterways are considered in this BDAR as they are located downstream of the project and may be indirectly impacted by the project (refer to Section 5 for further details of potential indirect impacts on freshwater habitats).

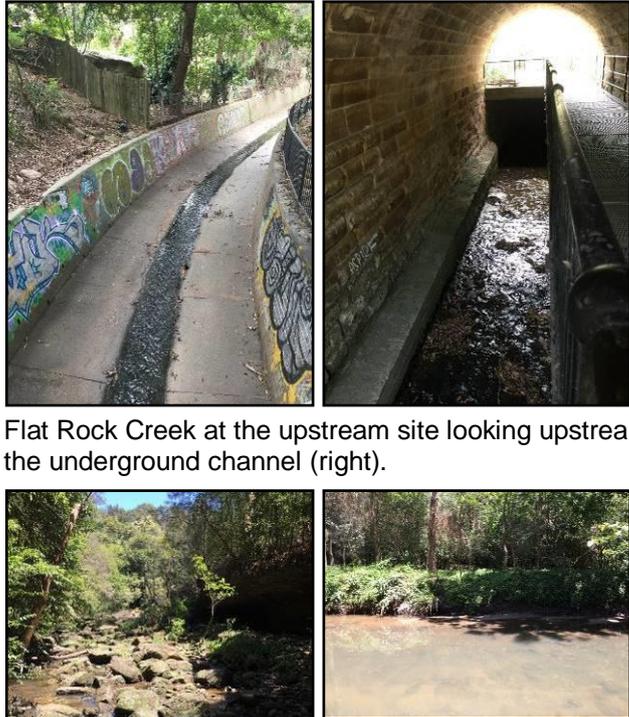
These waterways and the freshwater habitat features they support are summarised in Table 3-16. A detailed description of each waterway is provided in Western Harbour Tunnel and Warringah Freeway Upgrade Project Freshwater Ecology Impact Assessment (Cardno, 2020) (Appendix D).

Table 3-16 Waterways within or downstream of the project

Feature	Description
Whites Creek	
Description	Located near Rozelle Rail Yards construction support site (WHT1), in the southern extent of the subject land. Flows in a north-easterly direction from Parramatta Road to The Crescent at Annandale, before discharging into Rozelle Bay. This waterway receives stormwater from the surrounding urban catchment. Also known as Whites Creek Stormwater Channel No.95 (Sydney Water 2018). The surrounding catchment is characterised by residential development, commercial and industrial development, parkland and a network of local and arterial roads.
Stream order	First order waterway.
Key Fish Habitat Type and Class	Not applicable. Sections of a stream that have been concrete-lined are not considered key fish habitat (DPI, 2013).
Sensitive receiving environment	No.
Geomorphology	<ul style="list-style-type: none"> Concrete-lined channel Vertical concrete slabs up the banks.
General water quality	<ul style="list-style-type: none"> Receives stormwater from the surrounding urban catchment Estuarine, due to an influx of saltwater from Rozelle Bay Periodically experiences microbiological contamination Occasionally low dissolved oxygen and elevated pH and turbidity Elevated nutrient concentrations Elevated heavy metal concentrations.
Condition of riparian vegetation	Low. Riparian vegetation is highly modified and consists of planted native trees and shrubs within landscaped areas (eg within Buruwan Park, next to The Crescent). In other areas, weeds are common.
Instream habitat	No instream fish habitat is present, due to concrete channel structure. No logs, aquatic vegetation, emergent vegetation or rocks are present.

Feature	Description
Photo	 <p data-bbox="461 443 1374 472">Whites Creek at the upstream site (1a) (left) and downstream site (1b) (right).</p>
Willoughby Creek	
Description	<p data-bbox="461 573 1382 815">Located downstream and to the north-east of Cammeray Golf Course construction support site (WHT10/WFU8), outside of the subject land. Flows in a general easterly direction from Cammeray Golf Course to Primrose Park, before discharging into Willoughby Bay at Cammeray (Middle Harbour). Parts of the project would be located within the catchment. The catchment is characterised by residential development, parkland and a network of local roads. Willoughby Creek receives stormwater from the greater residential area of Cremorne (North Sydney Council, 2003).</p>
Stream order	First order waterway.
Key Fish Habitat Type and Class	<ul data-bbox="461 909 1126 972" style="list-style-type: none"> • Type 3 – minimally sensitive Key Fish Habitat • Class 3 – minimal Key Fish Habitat for fish passage.
Sensitive receiving environment	No.
Geomorphology	<ul data-bbox="461 1102 1358 1218" style="list-style-type: none"> • Entrenched bedrock in the upstream reaches of the survey site that has been modified to form a stormwater channel • Concrete-lined channel around 10 metres downstream of the survey point.
General water quality	<ul data-bbox="461 1252 1094 1379" style="list-style-type: none"> • Freshwater • Periodically elevated heavy metal concentrations. • Elevated nitrogen concentrations • Low dissolved oxygen.
Condition of riparian vegetation	<p data-bbox="461 1415 1369 1655">Moderate. Commonly occurring native tree species within remnant riparian vegetation include <i>Callicoma serratifolia</i> (Black Wattle), <i>Ceratopetalum apetalum</i> (Coachwood), <i>Elaeocarpus reticulatus</i> and <i>Glochidion ferdinandi</i>. Localised infestations of <i>Ligustrum lucidum</i> (Large Leaf Privet) and <i>Lantana camara</i> (Lantana) occur within riparian vegetation (North Sydney Council, 2003). The riparian corridor is wider on the northern bank (around 70 metres wide), and narrower on the southern bank where it is next to grass playing fields within Primrose Park.</p>
Instream habitat	<p data-bbox="461 1691 1358 1776">No instream (aquatic or emergent) vegetation or woody debris. Some rocky features are present. The waterway is substantially shaded by adjacent riparian vegetation.</p>

Feature	Description
Photo	 <p data-bbox="459 618 1235 651">Willoughby Creek looking downstream (left) and upstream (right).</p>
Flat Rock Creek	
Description	<p data-bbox="459 748 1385 987">Located downstream and to the east of the northern extent of the subject land for the project. Flows in a south-east direction from Artarmon towards Cammeray where it enters Middle Harbour. The natural drainage characteristics of the Flat Rock Creek catchment have been altered by residential, commercial and industrial development. The creek is predominantly a concrete-lined (open and closed) stormwater channel. The catchment is characterised by residential development, recreational areas and a network of local and arterial roads.</p>
Stream order	First order waterway.
Key Fish Habitat Type and Class	<ul data-bbox="459 1084 1385 1234" style="list-style-type: none"> • Not at upper reaches (Artarmon) • Lower reaches (where creek is naturalised) are classified as Type 1 – highly sensitive Key Fish Habitat and variably as Class 1 – major Key Fish Habitat for fish passage and Class 2 – moderate Key Fish Habitat for fish passage.
Sensitive receiving environment	<ul data-bbox="459 1272 1262 1357" style="list-style-type: none"> • Not at upper reaches in Artarmon • Lower reaches in Willoughby are considered sensitive receiving environments.
Geomorphology	<p data-bbox="459 1397 1374 1606">Variable. At Artarmon, Flat Rock Creek occurs as an artificially reconstructed concrete lined waterway which flows under the Gore Hill Freeway in Artarmon. In Willoughby, Flat Rock Creek occurs as a natural ephemeral creek consisting of small standing pools and riffles varying in width (less than one to 10 metres) and depth (0 to greater than 0.5 metres). The substrate predominantly consists of Hawkesbury Sandstone bedrock and boulders, mud, detritus and logs.</p>
General water quality	<ul data-bbox="459 1644 1350 1794" style="list-style-type: none"> • Freshwater at upper reaches • Estuarine at lower reaches, due to influx of saltwater of Middle Harbour • Elevated heavy metal concentrations • Elevated nutrient concentrations • Microbiological contamination evident.

Feature	Description
Condition of riparian vegetation	At Artarmon, riparian vegetation consists of mixed native plantings in the canopy shrub and ground layers, characteristic of locally occurring native riparian communities. At Willoughby, riparian vegetation occurs along the majority of Flat Rock Creek and varies in width (0 to greater than 50 metres) and condition. Vegetation consists predominantly of PCT 1292/ME035 Water Gum – Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion; native plantings and infestations of weeds and exotics in areas which are significantly disturbed.
Instream habitat	Absent from Artarmon, where Flat Rock Creek consists of an open concrete channel. In Willoughby, large snags and dense in-stream, emergent vegetation is present in some areas.
Photo	 <p data-bbox="459 1014 1353 1077">Flat Rock Creek at the upstream site looking upstream (5a) (left) and along the underground channel (right).</p> <p data-bbox="459 1328 1345 1391">Flat Rock Creek at the downstream site looking upstream (5b) (left) and at the estuarine site (5c) looking at the right bank (right).</p>
Quarry Creek	
Description	Located downstream and to the east of the northern extent of the subject land. Flows from the southern end of Quarry Street, Naremburn, in a general north-easterly direction until it joins with Flat Rock Creek (around 250 metres downstream). Quarry Creek becomes estuarine near the Flat Rock Creek confluence.
Stream order	First order waterway.
Key Fish Habitat Type and Class	<ul style="list-style-type: none"> • Type 1 – highly sensitive Key Fish Habitat • Class 2 – moderate Key Fish Habitat for fish passage.
Sensitive receiving environment	Yes.

Feature	Description
Geomorphology	<ul style="list-style-type: none"> • Channel cut into a steep gorge • Transitions from an ephemeral waterway to low/moderate flow bedrock channel of riffles and runs flowing into an estuarine reach • Silty clay substrate along the estuarine reach.
General water quality	<ul style="list-style-type: none"> • Freshwater and estuarine • Elevated heavy metal concentrations • Elevated nutrient concentrations • Microbiological contamination evident.
Condition of riparian vegetation	Dense exotic riparian vegetation.
Instream habitat	Upper reaches support bedrock steps, rocky riffles and runs with low to moderate flow during dry conditions.
Photo	 <p>Quarry Creek looking downstream (4b).</p>

3.7.4 Marine and intertidal habitats

The subject land encompasses a portion of Sydney Harbour and its foreshores, between the confluence of the Parramatta and Lane Cove rivers to the west and the Harbour Bridge to the east. A number of shallow bays that fringe the main channel of Sydney Harbour fall within the subject land and surrounding assessment area, including Rozelle Bay, White Bay, Snails Bay, Balls Head Bay and Berrys Bay.

Sydney Harbour is a drowned river valley that is characterised by steep sided banks carved into Sydney sandstone. Sydney Harbour supports five broad marine habitats (Sydney Institute of Marine Science, 2014, Johnston, et.al. 2015):

- Intertidal rocky shores
- Shallow soft sediments, including seagrass, saltmarsh, mangroves and intertidal sandflats and mudflats
- Subtidal rocky reefs
- Deep soft sediments
- Open water.

Given the proximity of Sydney Harbour to urban, commercial and industrial development, many of these habitats have been extensively modified and disturbed by reclamation and the construction of artificial structures such as seawalls and marinas. More than 50 per cent of the natural foreshore of the harbour has been replaced with seawalls (Hedge et al., 2014). In addition, the condition of these habitats has been degraded by past and current development activities, including:

- Coastal development involving land reclamation, especially of intertidal areas
- Pollution of harbour waters and sediments by heavy metals, petroleum hydrocarbons and other chemical contamination, litter and microplastics
- A reduction in water quality resulting from the discharge of sediment and contaminant-laden stormwater runoff from urban catchments

- Dredging of channels for shipping.

The range of marine and intertidal habitats identified in the subject land and the resources they offer to marine mammals, reptiles and fish species are described and mapped in Technical working paper: Marine ecology (Cardno, 2020). Some of these habitats offer resources to wandering seabirds, shorebirds, Little Penguin and White-bellied Sea-Eagle, and these are summarised below.

3.7.4.1 Intertidal sand and mudflats

Intertidal sandflats and mudflats occur where alluvial and marine sediment depositions accumulate, typically in shallow bays. Within the subject land and surrounding assessment area, intertidal sand and mudflats were identified below rock and sandstone retaining walls at:

- The western and south-western shore of Rozelle Bay (next to Federal Park), near Rozelle Rail Yards construction support site (WHT1) (Plate 6). Mudflats along the western shore of Rozelle Bay (next to Federal Park) support regenerating mangroves
- A small foreshore area at the Yurulbin Point construction support site (WHT4) (Plate 7)
- The western shore of Snails Bay (next to Birchgrove Park)
- The southern shore of Berrys Bay, near Berrys Bay construction support site (WHT7).

These small areas of sand and mudflats within the subject land provide marginal foraging habitat to threatened shorebird species, where worms, bivalves, crustaceans and other invertebrates occur within soft substrate tidal areas that are exposed during low tide. However, no threatened shorebird species (identified during database searches) were determined to have a high likelihood of occurrence in the subject land, due to the absence of many important habitat features for these species. Sand and mudflats do not offer nesting or roosting habitat, as they are inundated at high tide.



Plate 6 Mudflats at Rozelle Bay, at Whites Creek discharge point and near Rozelle Rail Yards construction support site (WHT1)



Plate 7 Sand flats at Yurulbin Point construction support site (WHT4)

3.7.4.2 Intertidal rocky shores

Rocky intertidal shores occur between the low and high water tidemarks. Within the subject land, intertidal rocky shores typically consist of artificial seawalls (Plate 8 and 9) and small areas of natural, sandstone rocky shores. Intertidal rocky shores occur along most of the bays within the assessment area, including Rozelle Bay, White Bay, Snails Bay, Balls Head Bay and Berrys Bay.

Vertical walls and intertidal rocky areas in the subject land support a high abundance of Sydney Rock Oysters (*Saccostrea glomerata*), which comprise limited foraging resources to threatened shorebirds. Vertical walls and intertidal rocky areas within the subject land do not offer nesting or

roosting opportunities to threatened shorebird species. No threatened shorebird species identified during database searches were determined to have a high likelihood of occurrence on intertidal rocky shores within the subject land.



Plate 8 Sandstone retaining wall at Yurulbin Point construction support site (WHT4)



Plate 9 Concrete retaining wall at White Bay, near the White Bay construction support site (WHT3)

3.7.4.3 Open water

Open water habitat within Sydney Harbour supports a diversity of marine fauna species, including plankton, invertebrates, fish, sharks, turtles and occasionally, mammals such as seals and whales. These species and how they use open water habitat within the subject land are described in Technical working paper: Marine ecology (Cardno, 2020), which is included in Appendix T of the Western Harbour Tunnel and Warringah Freeway Upgrade environmental impact statement.

Open water habitat provides foraging habitat for a number of threatened bird species that forage for fish and other marine prey species. As described in Section 3.6, the White-bellied Sea-Eagle has been recorded near Balls Head within the subject land (OEH, 2019a). This species has also been observed above Goat Island (outside of, but near the assessment area), where the species may forage for fish, turtles and sea snakes.

As described in Section 3.6.2.4.8, Little Penguins have been recorded at several locations within the subject land and surrounding assessment area, including Snails Bay, Berrys Bay, Balls Head Bay, and in the main channel of Sydney Harbour (OEH, 2019a), where the species forages in shallow waters for small shoaling fish, cephalopods and, to a lesser extent, crustaceans (NPWS, 2000).

Open water within Sydney Harbour (Plate 10, Plate 11) does not support preferred habitat for wandering seabirds such as albatrosses and petrels. No wandering seabird species that were identified during database searches were determined to have a high likelihood of occurrence in the subject land.



Plate 10 Looking north to Balls Head, Waverton from Yurulbin Point, Birchgrove



Plate 11 Looking east to Goat Island from Yurulbin Point, Birchgrove

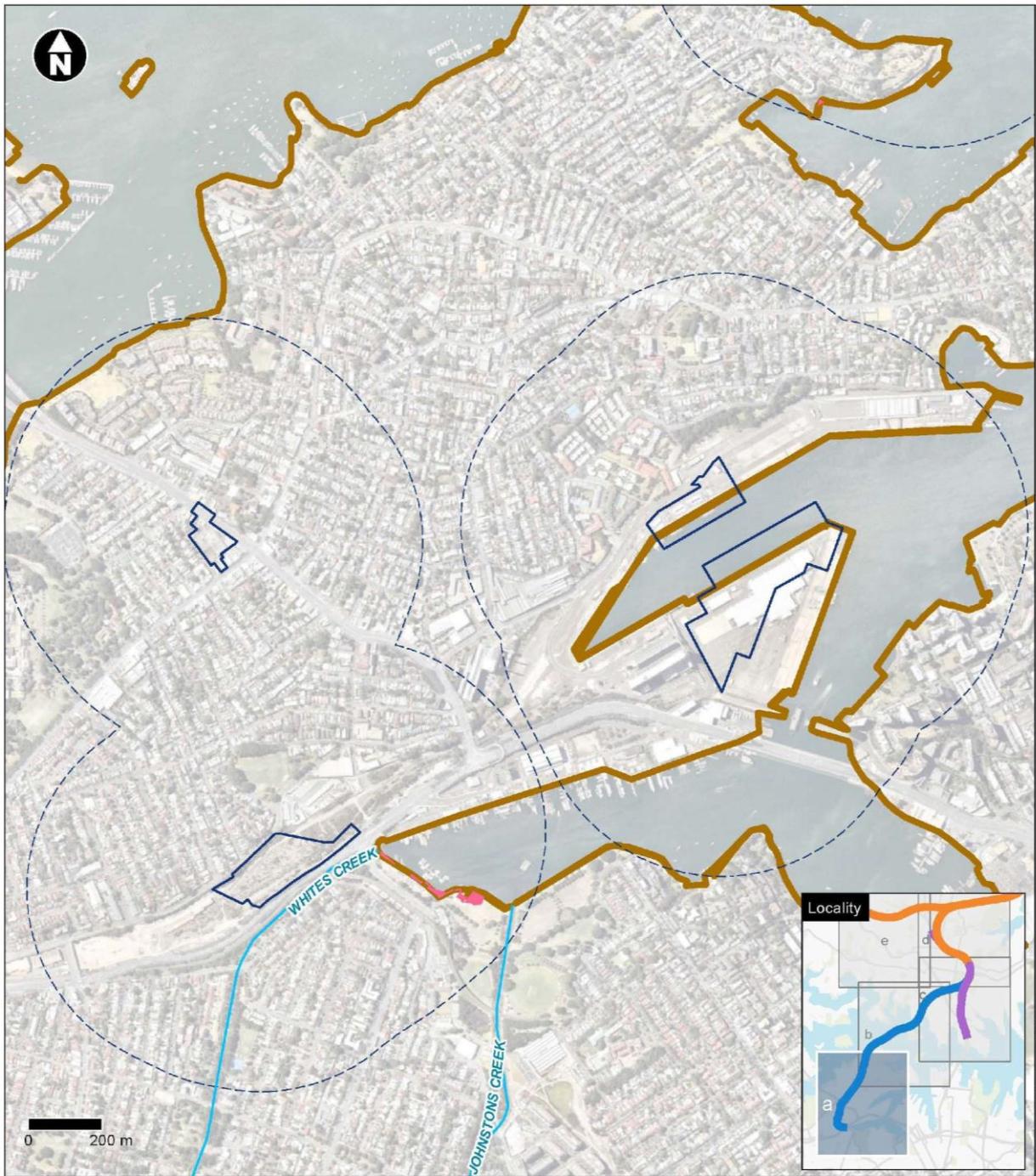


Figure 3-5 Distribution of fauna habitats within the subject land (map a)

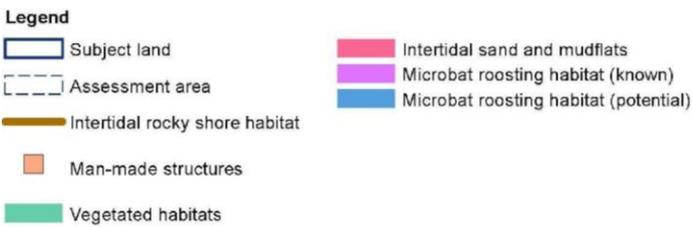
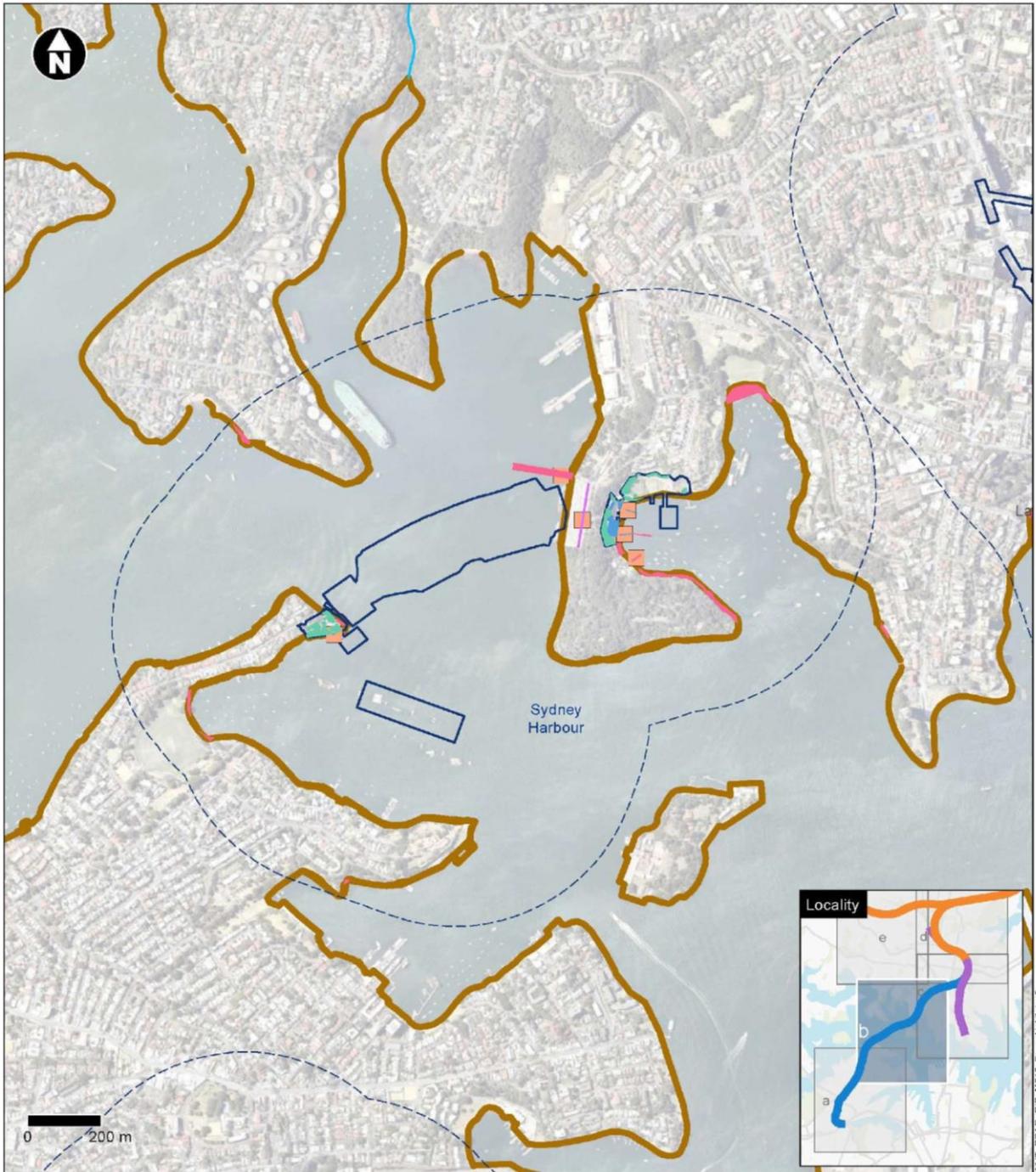
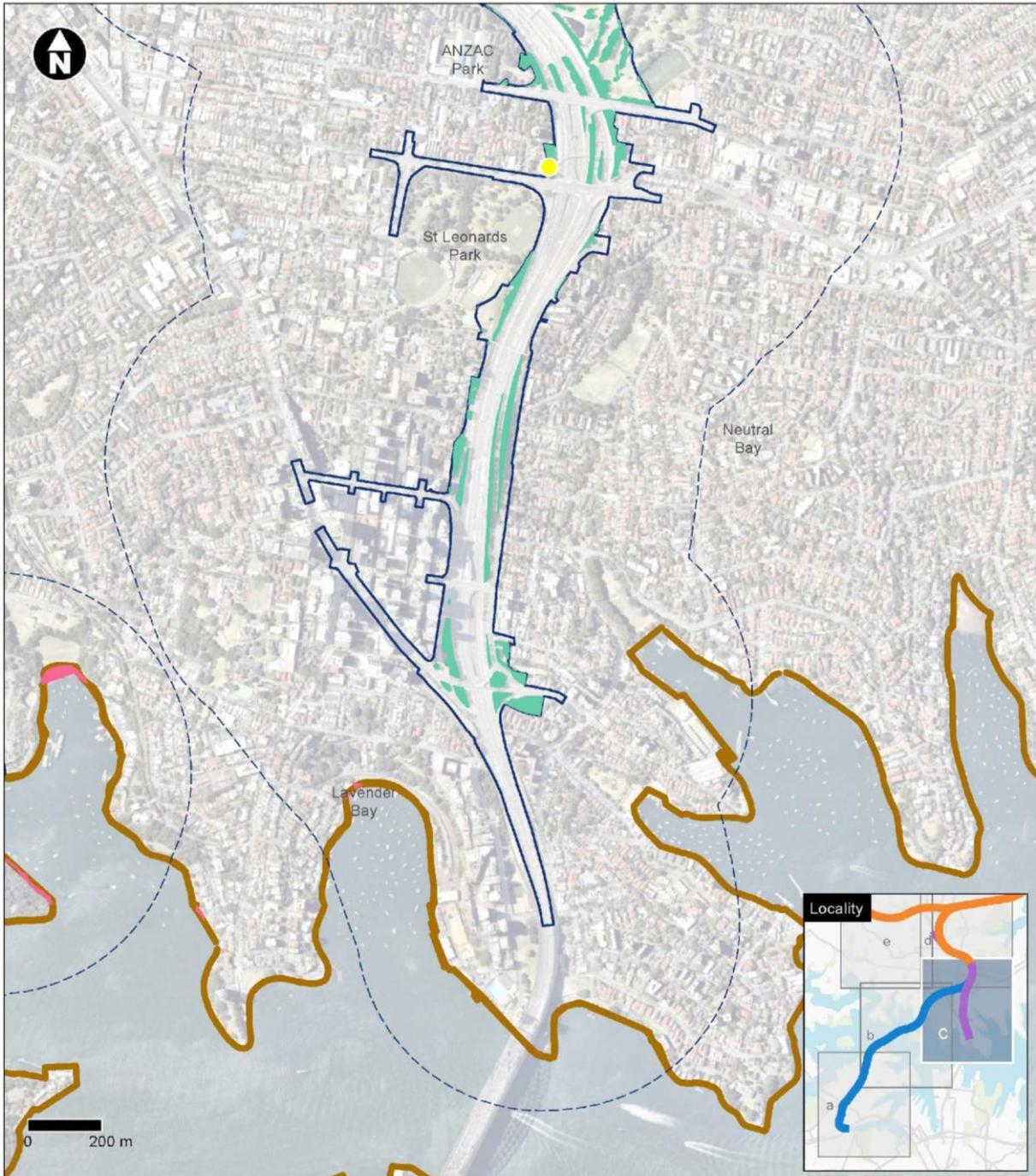


Figure 3-5 Distribution of fauna habitats within the subject land (map b)



Legend

- Subject land
- Assessment area
- Intertidal rocky shore habitat
- Potential hollow - bearing tree
- Vegetated habitats
- Intertidal sand and mudflats

Figure 3-5 Distribution of fauna habitats within the subject land (map c)

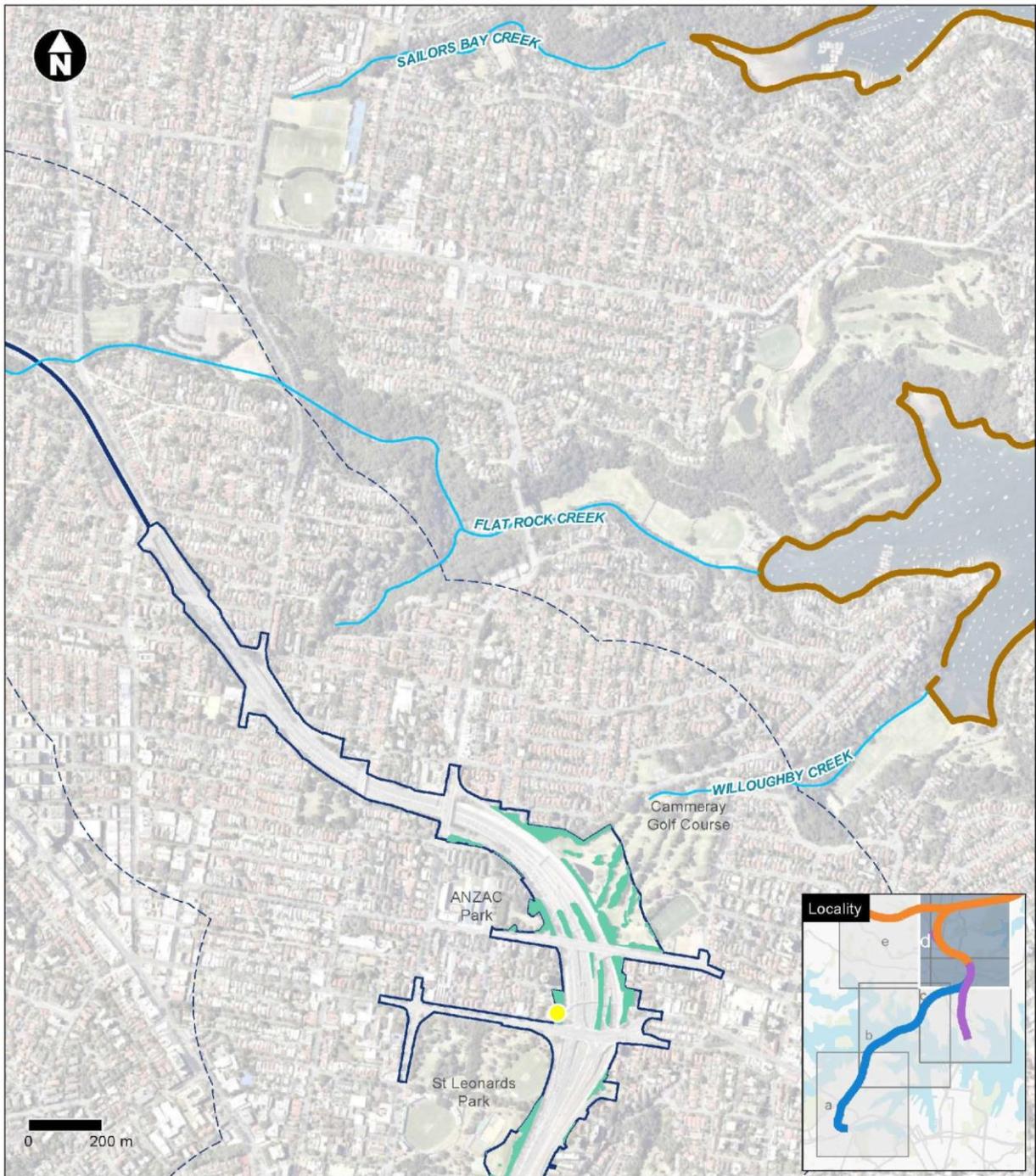
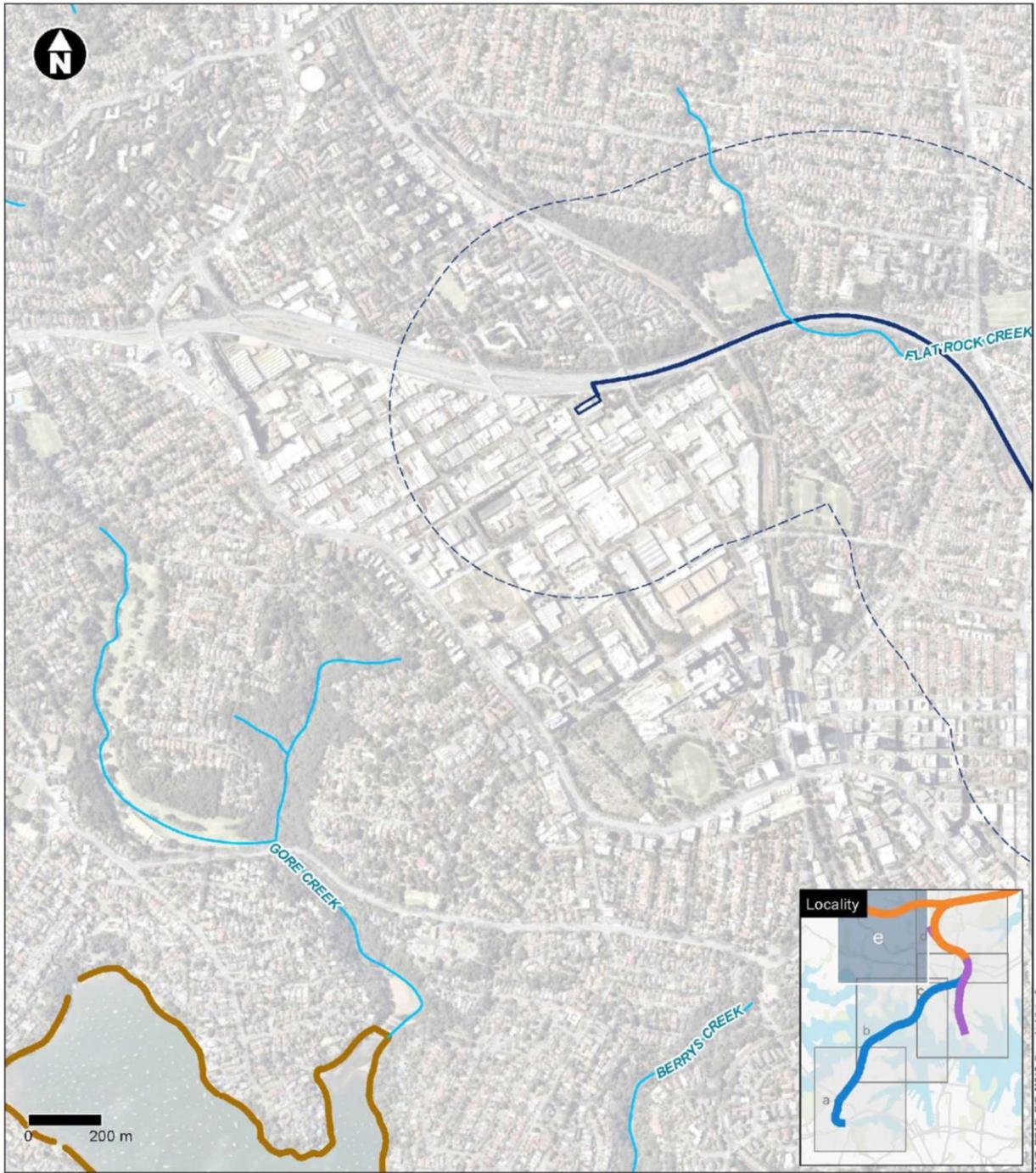


Figure 3-5 Distribution of fauna habitats within the subject land (map d)



Legend

- Subject land
- Assessment area
- Intertidal rocky shore habitat

Figure 3-5 Distribution of fauna habitats within the subject land (map e)

3.8 Groundwater dependent ecosystems

A search of the National Atlas of Groundwater Dependent Ecosystems (BOM, 2019) did not identify any groundwater dependent ecosystems within the subject land (Figure 3-6). The northern extent of the subject land, near the Warringah Freeway, is upstream of mapped groundwater dependent ecosystems associated with Flat Rock Creek (Table 3-17). Groundwater dependent ecosystems at this location may rely on subsurface presence of groundwater.

Table 3-17 Groundwater Dependent Ecosystems mapped by BOM (2019) in the locality of the subject land

Location of mapped Groundwater Dependent Ecosystems	Distance from subject land	Ecosystems mapped
Upper reaches of Flat Rock Creek at Munro Park – moderate to high potential for groundwater interaction	Around 300 metres north east of the subject land	<ul style="list-style-type: none">• Coastal Sandstone Gully Forest• Sandstone Riparian Scrub• Coastal Sand Forest.

Appendix 4 of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background Document* (NSW Office of Water 2011) identifies high priority groundwater dependent ecosystems in the Greater Metropolitan Region. None of the high priority groundwater dependent ecosystems listed are located in the subject land. The closest high priority groundwater dependent ecosystem to the subject land is Coastal Saltmarsh; a few small linear patches of this community are mapped by OEH (2016) in Jubilee Park, Glebe, around 540 metres south east of the southern extent of the subject land (Figure 3-2).

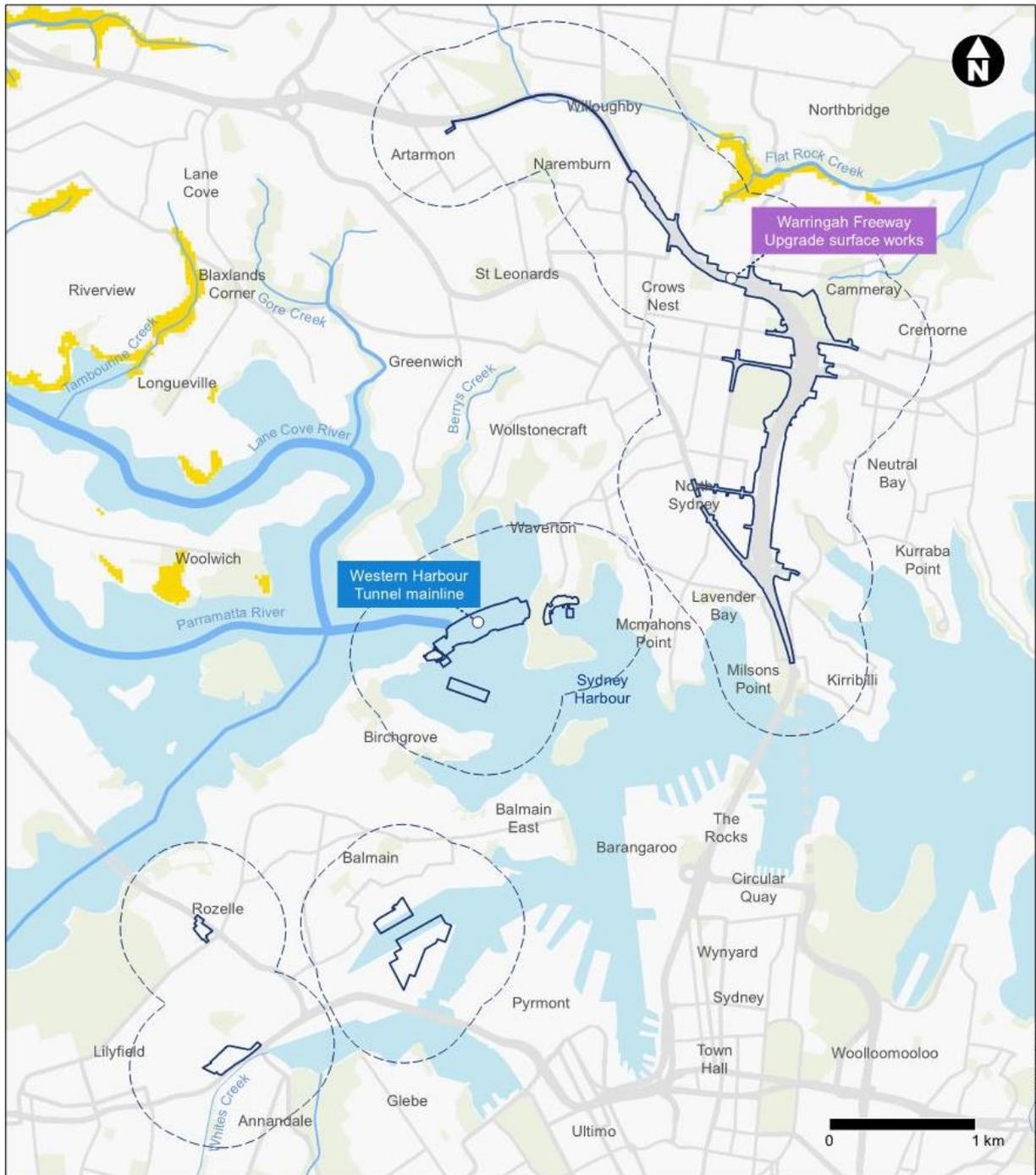


Figure 3-6 Distribution of groundwater dependent ecosystems (BOM, 2018)

3.9 Matters of National Environmental Significance

The Secretary's environmental assessment requirements require that MNES listed under the EPBC Act are considered by this BDAR.

A search of the EPBC Protected Matters Search Tool was completed for an area within 10 kilometres of the subject land. The results of this search are provided in Appendix B of this report and discussed below.

3.9.1 Wetlands of international importance

A search of the EPBC Protected Matters Search Tool found no wetlands of international importance within 10 kilometres of the subject land. The closest wetland of international importance is Towra Point nature reserve, located over 17 kilometres south of the subject land on the southern shores of Botany Bay, on the Kurnell Peninsula.

3.9.2 Terrestrial threatened species and communities

A search of the EPBC Protected Matters Search Tool found 12 TECs, 28 threatened flora species, 36 threatened bird species, three threatened frog species, eight threatened terrestrial mammal species, one threatened snail and one threatened terrestrial reptile species listed under the EPBC Act that are known or likely to occur within 10 kilometres of the subject land. Appendix A assesses the likelihood of these TECs and threatened species to occur in the subject land.

Four threatened flora species listed under the EPBC Act were recorded in the subject land during field surveys: *Acacia terminalis* subsp. *terminalis*, *Eucalyptus nicholii*, *Eucalyptus scoparia* and *Syzygium paniculatum*.

Acacia terminalis subsp. *terminalis* is listed as Endangered under the EPBC Act. One individual of the species was recorded in disturbed landscaped areas adjoining the Warringah Freeway in Jeaffreson Jackson Reserve, Cammeray. A detailed description of this species and its habitat in the subject land is provided in Section 3.6.1.3.1.

The individuals of *Eucalyptus nicholii*, *Eucalyptus scoparia* and *Syzygium paniculatum* recorded in the subject land are outside their known geographic range and/or known habitat and occur as individual trees in landscaped areas adjoining the Warringah Freeway. It is assumed that these trees have been planted, and do not naturally occur within the subject land. The planted individuals to be impacted by the project (being eucalyptus species only) are not considered to be of conservation significance and are not assessed further.

One threatened fauna species listed under the EPBC Act was recorded in the subject land during field surveys: Grey-headed Flying-fox. The Grey-headed Flying-fox is listed as Vulnerable under the EPBC Act. This species was observed flying over Berrys Bay construction support site (WHT7) during the survey carried out by Arcadis in February 2018. This species was also recorded by WSP flying over a number of locations within the subject land during surveys carried out in 2017. A detailed description of this species and its habitat in the subject land is provided in Section 3.6.2.4.1.

No other MNES were recorded or considered highly likely to occur in the subject land.

3.9.3 Migratory birds

A search of the EPBC Protected Matters Search Tool found 39 migratory bird species listed under the EPBC Act that are known or are likely to occur within 10 kilometres of the subject land (Appendix B). The likelihood of these migratory species to occur is assessed in Appendix A. One migratory bird species was recorded in the subject land: White-bellied Sea Eagle. This species was observed flying near Balls Head and Goat Island. A detailed description of this species and its habitat in the subject land is provided in Section 3.6.2.4.5.

Intertidal sand and mud flats within the subject land, as described in Section 3.7.4, do not comprise preferred foraging habitat for migratory shorebirds or waders. The marine waters of Sydney

Harbour, as described in Section 3.7.4, do not comprise preferred foraging habitat for wandering seabirds such as albatrosses or petrels.

Other migratory marine species listed under the EPBC Act are assessed in Technical working paper: Marine ecology (Cardno, 2020).

3.9.4 Marine species

The likelihood of threatened marine species listed under the EPBC Act to occur in the subject land is assessed in Technical working paper: Marine ecology (Cardno, 2020).

4 Avoid and minimise impacts

Chapter 4 (Project development and alternatives) of the environmental impact statement describes the alternatives that were considered as part of the project development process and explains the selection of the preferred corridor and design.

Four corridor alternatives were considered for a new motorway connection between Rozelle and the northern side of Sydney Harbour. The four corridors were evaluated to identify the most technically, socially and environmentally acceptable alternative with the most efficient transport connections. Environmental evaluation criteria were included to minimise environmental impact and minimise long-term loss of public open space and recreational areas.

The principles in Section 8.1 of the BAM (OEH, 2017a) have been considered to avoid and minimise impacts on native vegetation and habitat, where possible. The project development process is provided in Table 4-1.

Table 4-1 Project consistency with the principles of the BAM to avoid and minimise impacts on biodiversity

Principles	Project consistency
Corridor selection	
Locating the project in areas where there are no biodiversity values.	The project is located in a highly urbanised locality with low terrestrial biodiversity values.
Locating the project in areas where the native vegetation or threatened species habitat is in the poorest condition (ie areas that have a lower vegetation integrity score).	There is no native vegetation in the subject land that would be directly impacted. Areas of vegetation that would be impacted by the project generally consist of planted trees in road verges, parks and private residential gardens that are currently subject to edge effects and fragmentation.
Locating the project in areas that avoid habitat for species that have a high biodiversity risk weighting or native vegetation that is a TEC.	There are two threatened fauna species with a high biodiversity risk weighting that are considered to have a high likelihood of occurrence in the subject land: Eastern Bentwing-bat and Little Bentwing-bat. No breeding habitat for Eastern Bentwing-bat or Little Bentwing-bat was identified in the subject land during targeted surveys, and the foraging habitat that would be impacted does not comprise a significant proportion of foraging habitat for this species in the surrounding locality or wider bioregion. There are no TECs within the subject land.
Locating the project such that connectivity enabling movement of species and genetic material between areas of adjacent or nearby habitat is maintained.	Small, isolated patches of fauna habitat within the subject land do not maintain habitat connectivity with any large areas of native vegetation in the wider locality. The project would not further increase fragmentation of different areas of habitat of threatened species that would adversely affect the movement of those species across their range. Most native fauna species, including threatened species, in the locality of the subject land are mobile bird or bat species, and the existing level of connectivity for these species would not be changed by the project.

Principles	Project consistency
Consideration of alternatives	
An analysis of alternative modes or technologies that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed mode or technology.	The majority of the project avoids surface impacts to terrestrial biodiversity values by tunnelling. Design and construction works have been developed to minimise direct impacts to seagrass and other areas of marine habitat value.
An analysis of alternative routes that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed route.	<p>The preferred corridor was found to have fewer environmental impacts than some other corridors considered. The preferred corridor minimises waterway crossings, and avoids construction works on Goat Island, which is part of the Sydney Harbour National Park. Environmental investigations, and community and stakeholder feedback were used to inform the identification of appropriate construction support sites within the preferred corridor. The primary driver for the location of these sites was the objective of minimising environmental and community impacts, while being suitably located to facilitate the construction activities of the project. Wherever possible, construction support sites have been located to minimise the overall property acquisition requirements, as well as impacts on heritage items and ecologically sensitive areas. Key factors applied to identification of potential construction support sites included:</p> <ul style="list-style-type: none"> • Locating the construction support sites as close as possible to project construction areas • Avoiding sensitive environmental and community locations where possible • Maximising opportunities for direct access to arterial roads or water transport opportunities for construction traffic, and avoiding the need to use local residential streets if possible • Minimising property disturbance and acquisition requirements, particularly in residential areas.
An analysis of alternative locations that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed location.	
An analysis of alternative sites within a property on which the project is proposed that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed site.	
Design refinement	
Reducing the clearing footprint of the project.	<p>The design of the project and the selection of the preferred construction methodology within the preferred corridor has been influenced by a number of environmental factors, including biodiversity. Where feasible, the design of the project within the preferred corridor has been refined to avoid or minimise impacts on biodiversity. Specific design and construction responses to avoid and minimise adverse impacts on biodiversity include:</p> <ul style="list-style-type: none"> • Avoidance of direct impacts to native vegetation and threatened species habitat by locating construction support sites so that vegetation removal is avoided and/or minimised. The only area of native PCT identified in the subject land has been protected by an exclusion zone within the construction support site layout and would not be removed from the subject land • Avoidance of direct impacts to seagrass and other areas of marine habitat value • Development of a customised approach to dredging across Sydney Harbour specifically to minimise disturbance of marine sediment (including contaminated
Locating ancillary facilities in areas where there are no biodiversity values.	
Locating ancillary facilities in areas where the native vegetation or threatened species habitat is in the poorest condition (ie areas that have a lower vegetation integrity score).	
Locating ancillary facilities in areas that avoid habitat for species and vegetation in high threat status categories (eg an EEC or CEEC).	

Principles	Project consistency
	sediment) and subsequent impacts to marine ecology <ul style="list-style-type: none"> • Inclusion of silt curtains during dredging and use of a clamshell dredge to minimise potential impacts to marine ecology, by minimising the mobilisation of sediments and reducing turbidity of marine waters • Design of the wastewater treatment plants to avoid adverse impacts to water quality in the harbour.
Providing structures to allow species and genetic material to move across barriers or hostile gaps.	The project is located within a highly urbanised landscape, which currently contains numerous barriers and hostile gaps for species movement, including the Warringah Freeway. Most native fauna species, including threatened species, in the locality of the subject land are mobile bird or bat species, and the existing level of connectivity for these species would not be changed by the project.
Making provision for the demarcation, ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat on the development site*.	Refer to Section 5.7 for a description of measures to protect and rehabilitate vegetation and habitat in the subject land.

* note – the term ‘development site’ is a term used by the BAM, which for the purposes of this assessment, is analogous with the terms ‘subject land’ and ‘development footprint’

Section 8.2 of the BAM (OEH, 2017a) identifies principles for avoiding and minimising prescribed biodiversity impacts. Prescribed biodiversity impacts are discussed in Section 5.4 of this BDAR. Prescribed biodiversity impacts that are relevant to the project include:

- Impacts of development on the habitat of threatened species or ecological communities associated with human made structures
- Impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation
- Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities.

The principles for avoiding and minimising prescribed biodiversity impacts are considered in Table 4-2.

Table 4-2 Project consistency with the principles of the BAM to avoid and minimise prescribed biodiversity impacts

Principles	Project consistency
Project location	
Locating the envelope of surface works to avoid direct impacts on the habitat features identified as subject to prescribed biodiversity impacts.	The project is located in a highly urbanised locality, largely devoid of vegetation, including non-native vegetation. Surface works are largely contained to the road corridor, avoiding man-made structures that provide fauna habitat.

Principles	Project consistency
<p>Locating the envelope of sub-surface works, both in the horizontal and vertical plane, to avoid and minimise operations beneath the habitat features identified as subject to prescribed biodiversity impacts eg locating longwall panels away from geological features of significance or water dependent plant communities and their supporting aquifers.</p>	<p>Tunnelling has avoided impacts to groundwater dependent ecosystems.</p>
<p>Locating the project to avoid severing or interfering with corridors connecting different areas of habitat, migratory flight paths to important habitat or local movement pathways.</p>	<p>Small, isolated patches of fauna habitat within the subject land do not maintain habitat connectivity with any large areas of native vegetation in the wider locality. It would not sever habitat corridors or interfere with fauna movements.</p>
<p>Optimising project layout to minimise interactions with threatened species and ecological communities, eg designing turbine layout to allow buffers around features that attract and support aerial species, such as forest edges, riparian corridors and wetlands, ridgetops and gullies.</p>	<p>Impact to sensitive areas have been minimised by optimising the location and layout of temporary construction support sites and permanent tunnel support facilities.</p>
<p>Locating the project to avoid direct impacts on water bodies.</p>	<p>Alternative crossing methodologies for Sydney Harbour were explored during design development. As summarised in Chapter 4 (Project development and alternatives) of the environmental impact statement, the preferred methodology of the immersed tube tunnel was selected as it provides a shallow alignment and enables better grades and journey experience (eg safety and long-term emissions). The construction methodology for the immersed tube tunnel construction has been selected to minimise impacts on waterbodies (refer to Chapter 5 of the Environmental Impact Statement).</p>
<p>An analysis of alternative modes or technologies that would avoid or minimise prescribed biodiversity impacts and justification for selecting the proposed mode or technology.</p>	<p>The majority of the project avoids surface impacts to terrestrial biodiversity values by tunnelling. Design and construction works have been developed to avoid direct impacts to seagrass and other areas of marine habitat value in Sydney Harbour.</p>
<p>An analysis of alternative routes that would avoid or minimise prescribed biodiversity impacts and justification for selecting the proposed route.</p>	<p>The preferred corridor was found to have fewer environmental impacts than some other corridors considered. The preferred corridor minimises waterway crossings, reducing potential water quality impacts.</p>
<p>An analysis of alternative locations that would avoid or minimise prescribed biodiversity impacts and justification for selecting the proposed location.</p>	<p>Wherever possible, construction support sites have been located to minimise the overall property acquisition requirements, which would minimise impacts to man-made structures and non-native vegetation that provide fauna habitat.</p>
<p>An analysis of alternative sites within a property on which the project is proposed that would avoid or minimise prescribed biodiversity impacts and justification for selecting the proposed site.</p>	

Principles	Project consistency
<p>Justifications for project location decisions should identify any other site constraints that the proponent has considered in determining the location and design of the project, eg bushfire protection requirements including clearing for asset protection zones, flood planning levels, servicing constraints.</p>	<p>Site constraints have been minimised by optimising the location and layout of temporary construction support sites and permanent tunnel support facilities.</p>
Project design	
<p>Engineering solutions, eg proven techniques to minimise fracturing of bedrock underlying features of geological significance, water dependent communities and their supporting aquifers, proven engineering solutions to restore connectivity and favoured movement pathways.</p>	<p>Impacts to groundwater-dependent ecosystems and connectivity are not anticipated.</p>
<p>Design of project elements to minimise interactions with threatened and protected species and ecological communities, eg designing turbines to dissuade perching and minimise the diameter of the rotor swept area, designing fencing to prevent animal entry to transport corridors.</p>	<p>Construction of the Sydney Harbour crossing, between Birchgrove and Waverton, would involve the installation of immersed tube tunnels that would sit within a gravel-lined, dredged tunnel trench. Construction of the tubes would largely be contained within cofferdams to minimise interactions with any threatened and protected fauna species inhabiting Sydney Harbour.</p>
<p>Design of the project to maintain environmental processes critical to the formation and persistence of habitat features not associated with native vegetation.</p>	<p>The project is not expected to adversely impact environmental processes critical to the formation and persistence of habitat features not associated with native vegetation, due to an absence of karst, caves, crevices, cliffs or other features of geological significance.</p>
<p>Design of the project to maintain hydrological processes that sustain threatened species and TECs.</p>	<p>Impacts to groundwater dependent ecosystems and connectivity are not anticipated.</p>
<p>Design of the project to avoid and minimise downstream impacts on rivers, wetlands and estuaries by control of the quality of water released from the site.</p>	<p>Water treatment devices, such as construction sediment basins, would be located where they collect a high proportion of sediment-laden runoff from disturbed areas of the construction; treated wastewater would be discharged to Willoughby Creek and into Rozelle Bay. Discharges from the wastewater treatment plants during construction and operation would be designed to improve or maintain water quality in the receiving environment.</p>

5 Impact assessment

For the purpose of this assessment, it is assumed that all biodiversity values occurring within the subject land would be removed, due to the construction and operation of temporary and permanent features of the project. The term 'subject land' is analogous with the term 'construction footprint' that is used in the environmental impact statement, and with the term 'development footprint' that is prescribed by the BAM.

Native vegetation occurring within the exclusion zone at the Berrys Bay construction support site (WHT7) and planted native vegetation occurring within the exclusion zone at the Cammeray Golf Course construction support site (WHT10 and WFU8) is within the subject land but would not be removed.

Refer to Sections 1.2 and 1.3 for a description of the key features of the project. Further detail is provided in Chapter 5 (Project description) and Chapter 6 (Construction work) of the environmental impact statement.

5.1 Direct impacts on native vegetation and habitat

5.1.1 Removal of native vegetation

A small area of native vegetation, meeting the definition of PCT 1778 (Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney) occurs in an exclusion zone in the south-western corner of the Berrys Bay construction support site (WHT7). This area of vegetation would be avoided and would not be directly impacted by the project.

No other PCTs occur within the subject land, and as such, no PCTs would be removed for the project.

5.1.2 Removal of threatened flora species

Construction of the project would have direct impacts on three threatened flora species listed under the BC Act and EPBC Act. Table 5-1 summarises the impacts to these species.

Species credits are required to offset the impacts to the single individual of *Acacia terminalis* subsp. *terminalis* recorded in the subject land. The credit requirements are provided in Section 7.1.2. No other threatened plant species listed under the BC Act and/or EPBC Act are anticipated to be directly impacted by the project.

Table 5-1 Summary of impacts on threatened flora species

Threatened species	BC Act Status*	EPBC Act Status*	Number individuals to be removed	Offsets required?
<i>Acacia terminalis</i> subsp. <i>terminalis</i> (Sunshine Wattle)	E	E	1	Yes. Although the individual of this species identified within the subject land is located in landscaped roadside vegetation, it is located within the known range of the species and is therefore assumed to be of wild provenance.

Threatened species	BC Act Status*	EPBC Act Status*	Number individuals to be removed	Offsets required?
<i>Eucalyptus nicholii</i> (Narrow-leaved Black Peppermint)	V	V	Up to 7**	No. This species is endemic to the New England Tablelands bioregion of NSW and does not naturally occur in the locality of the subject land. The planted individuals to be impacted by the project are not considered to be of conservation significance and are not assessed further under the BAM.
<i>Eucalyptus scoparia</i> (Wallangarra White Gum)	E	V	Up to 2**	No. This species is endemic to the New England Tablelands bioregion of NSW and does not naturally occur in the locality of the subject land. The planted individuals to be impacted by the project are not considered to be of conservation significance and are not assessed further under the BAM.

*V=Vulnerable, E=Endangered

**Many of these individuals are on the boundary of the subject land. Therefore, the precise number of individuals to be impacted would be confirmed during further design development.

5.1.3 Removal of threatened fauna species habitat

Around 7.29 hectares of vegetation would be removed for the project. This vegetation consists of:

- 2.99 hectares of native plantings
- 2.84 hectares of native plantings within the vegetated medians of Warringah Freeway
- 1.11 hectares of urban exotic/native plantings
- 0.35 hectares of exotic plantings.

Vegetation that would be removed is primarily located within the Warringah Freeway road reserve and Cammeray Golf Course construction support site (WHT10/WFU8). Additionally, a small area of planted vegetation would be removed from Yurulbin Point construction support site (WHT4). This vegetation occurs as planted native and exotic horticultural specimens or isolated remnant trees within otherwise planted areas.

None of this vegetation conforms to a PCT and therefore no impacts to ecosystem credit species are anticipated and offsets are not required.

The removal of flowering and fruiting trees, shrubs and ground layer vegetation from the subject land would result in the negligible loss of potential foraging and sheltering habitat to a number of threatened fauna species known or considered likely to occur in the subject land. The extent of terrestrial fauna habitat to be removed does not comprise a substantial portion of foraging habitat available in the wider locality.

The removal of a potential hollow-bearing tree in Jeaffreson Jackson Reserve would result in the loss of nesting, roosting and/or sheltering habitat for locally occurring hollow-dependent fauna species, such as the Common Brushtail Possum and Sulphur-crested Cockatoo. Its removal is unlikely to impact any threatened fauna species.

The limited extent of terrestrial fauna habitat within the subject land generally occurs as small, isolated patches of fauna habitat that do not maintain habitat connectivity with any large areas of native vegetation in the assessment area or wider locality. Much of this vegetation is subject to regular and ongoing disturbance and maintenance: street trees are often pruned (particularly if

they conflict with overhead powerlines), and grassy verges and gardens are mown. The removal of a small area of vegetation from the subject land would not substantially contribute to an increase in habitat fragmentation across the subject land.

No threatened species credit fauna species were recorded in the subject land during targeted seasonal surveys. Although fauna species which are listed as both species credit and ecosystem credit species were recorded (Grey-headed Flying-fox and White-bellied Sea-Eagle), no suitable breeding habitat for these species to which species credits would apply was recorded in the subject land.

5.1.4 Fauna injury and mortality

Terrestrial fauna injury or mortality may occur during vegetation clearing activities (particularly during the felling of trees) or may result from collisions with work vehicles or plant, or accidental entrapment in plant, trenches or other works. Threatened fauna species with a high likelihood or known occurrence in the subject land could be subject to injury or mortality.

However, the majority of fauna recorded within the subject land, including any potential threatened species, are highly mobile birds and mammals and these species are likely to be able to move away from vegetation clearing and other construction activities quite readily. Fauna species susceptible to injury or mortality include less mobile, non-threatened species such as amphibians, reptiles, invertebrates and juvenile/nesting birds/mammals.

Marine fauna injury or mortality may occur during construction of the mainline tunnels crossing Sydney Harbour, or may result from collisions with watercraft or barges carrying out construction within Sydney Harbour. This could include the threatened Little Penguin, however this species typically forages in shallow waters at the shoreline, which the project largely avoids. Sydney Harbour is subject to high levels of water traffic and the species may be adapted to avoiding water vessels.

Measures to avoid fauna injury and mortality are described in Section 5.7.

5.2 Indirect impacts on native vegetation and habitat

Indirect impacts occur when the project or activities relating to the construction or operation of the project affect native vegetation, TECs and threatened species habitat beyond the subject land. Impacts may also result from changes to land-use patterns, such as an increase in vehicular access and human activity on native vegetation, TECs and threatened species habitat.

Section 9.1.4.2 of the BAM identifies the types of indirect impacts on native vegetation and habitat beyond the subject land that must be considered. The relevance of these types of impacts to the project are provided in Table 5-2. Matters that have been determined to be relevant are considered further in this section.

Table 5-2 Indirect impacts on native vegetation and habitat specified by the BAM

Indirect impact	Relevance to the project
Inadvertent impacts on adjacent habitat or vegetation	The only area of adjacent native vegetation is located in an exclusion zone next to the Berrys Bay construction support site (WHT7). Inadvertent impacts to this vegetation are considered relevant and have been considered further in this section.
Reduced viability of adjacent habitat due to edge effects	Not relevant. No new edges would be created as no native vegetation would be cleared for the project.
Reduced viability of adjacent habitat due to noise, dust or light spill	Noise, vibration, dust and light spill could affect fauna inhabiting vegetation in nearby terrestrial habitats. This impact has been considered further in this section.

Indirect impact	Relevance to the project
Transport of weeds and pathogens from the site to adjacent vegetation	An increase in movements of people and machinery may facilitate the introduction or spread of weeds. This impact has been considered further in this section.
Increased risk of starvation, exposure and loss of shade or shelter	Not relevant. Fauna species using modified habitats within the subject land are highly mobile bird and mammal species and are likely to be able to move away from vegetation clearing and other construction activities quite readily.
Loss of breeding habitats	Not relevant. Breeding habitat within the subject land is limited to nesting habitat for common bird species in urban trees. There is no preferred nesting or roosting (ie breeding) habitat in the subject land for any threatened species known or considered likely to occur. Marginal potential roosting habitat offered by wharves and jetties in the subject land do not comprise preferred breeding habitat for locally occurring threatened microbat species.
Trampling of threatened flora species	Not relevant. Although one threatened flora species, <i>Acacia terminalis</i> subsp. <i>terminalis</i> , was recorded within the subject land, it is assumed that this individual would be removed. Another three planted non-local threatened tree species have been recorded within or adjacent to the subject land. No additional threatened flora species have been identified, nor are considered likely to occur in areas immediately adjacent to the subject land.
Inhibition of nitrogen fixation and increased soil salinity	Not relevant. The project would not inhibit nitrogen fixation in adjacent vegetation communities and the risk of increased soil salinity as a result of the project is low to negligible.
Fertiliser drift	Not relevant. The project would not include use of fertiliser.
Rubbish dumping	Not relevant. The project is located within a highly urbanised area and would not increase the existing likelihood of rubbish dumping.
Wood collection	Not relevant. The project is located within a highly urbanised area and would not increase the existing likelihood of wood collection.
Bush rock removal and disturbance	Low but not considered to be relevant, due to the absence of threatened species from the subject land that would be associated with bushrock. There are some areas of sandstone benching and outcropping at Yurulbin Point construction support site (WHT4) that may be disturbed by the project.
Increase in predatory species populations	Not relevant. Predatory species in the locality of the project are most likely to be domesticated pets, and the project would not result in increases to these populations.
Increase in pest animal populations	Low but not considered to be relevant. The subject land is in a highly urbanised area, and the project is unlikely to increase the population of any pest animals.
Increased risk of fire	Not relevant.
Disturbance to specialist breeding and foraging habitat, eg beach nesting for shorebirds	Not relevant. No areas of specialist breeding and foraging habitat have been identified within the subject land.

5.2.1 Inadvertent impacts on adjacent habitat or vegetation

Native vegetation in Balls Head Reserve is next to the Berrys Bay construction support site (WHT7) at Waverton. PCT 1778 (Smooth-barked Apple – Coast Banksia/Cheese Tree open forest on sandstone slopes on the foreshores of the drowned river valleys of Sydney) is located on elevated rocky slopes, above buildings that would be used as site offices.

Indirect impacts to this vegetation could include the introduction and spread of weeds, soil disturbance, rubbish dumping and trampling, though impacts are likely to be minor and contained to the edge of subject land. The native vegetation on the lower slope in this location is currently highly degraded, with exotic shrubs, small trees and grass species dominant, and it is unlikely that the use of buildings next to this vegetation as offices would further modify this already degraded vegetation.

5.2.2 Reduced viability of adjacent habitat due to noise, dust or light spill

Construction activities would result in localised and temporary noise and vibration impacts, however as construction areas occur in highly urbanised areas that are subject to ambient noise, this increase in noise and vibration is not expected to have a significant impact and native fauna.

Site offices at Berrys Bay construction support site (WHT7) that are located near native vegetation would be established in existing buildings, which would minimise impacts during site establishment.

Construction activities that occur at Sydney Harbour north cofferdam (WHT6) and Berrys Bay construction support site (WHT7) may indirectly affect threatened fauna species that have been previously recorded in Balls Head Reserve and/or the Coal Loader tunnel (Waverton), including:

- White-bellied Sea-Eagle
- Eastern Bentwing-bat
- Little Bentwing-bat
- Grey-headed Flying-fox
- Powerful Owl
- Eastern Freetail-bat
- Southern Myotis.

Buildings, wharves, jetties, tunnels and other built structures that provide fauna habitat in the subject land, within or near White Bay construction support site (WHT3), Yurulbin Point construction support site (WHT4), Sydney Harbour south cofferdam (WHT5) and Berrys Bay construction support site (WHT7) could be indirectly impacted by nearby construction activities. Indirect impacts could include noise, light spill and dust near roosting/nesting fauna, including microbats. These indirect impacts would occur throughout the duration of construction in these areas.

Indirect impacts would last for the duration of the construction in this area. Most of the remainder of the subject land is located next to urban/developed land with minimal vegetation where indirect impacts to native vegetation are not anticipated.

5.2.3 Transport of weeds and pathogens from the site to adjacent vegetation

An increase in the movement of people, vehicles, machinery, vegetation waste and soil during and following construction activities may facilitate the introduction or spread of exotic grasses and other weeds that currently occur. Disturbed areas, such as those in which earthworks are to be carried out, would be particularly susceptible to weed establishment. The subject land is highly urbanised, with little to no native vegetation, reducing the threat of weeds to biodiversity. Even so, environmental management measures would be required to minimise the risk of introduction and spread of weeds.

The project has the potential to increase the spread of pathogens that threaten native biodiversity values, such as the soil-borne pathogen *Phytophthora cinnamomi* (Phytophthora). Phytophthora

infects roots and is associated with damage and death to native plants. It may be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of *Phytophthora* may also be dispersed by vehicles (eg cars and earth moving equipment), animals, walkers and movement of soil. It is listed as a Key Threatening Process (defined as a process which threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community) under the BC Act. There may be an increased risk of dispersal of *Phytophthora* as a result of the construction activities that involve soil disturbance.

5.3 Serious and irreversible impacts

The OEH (2017b) *Guidance to assist a decision-maker to determine a serious and irreversible impact* identifies threatened species and ecological communities most at risk of serious and irreversible impacts.

None of the species or ecological communities identified within the guidance document (OEH, 2017b) are known to occur within the subject land. However, two threatened species at risk of a serious and irreversible impact are considered to have a high likelihood of occurrence in the subject land: Eastern Bentwing-bat (*Miniopterus schreibersii* var. *oceanensis*) and Little Bentwing-bat (*Miniopterus australis*).

However, OEH (2017b) specifies that, for these two species, only breeding habitat is subject to assessment to determine serious and irreversible impacts.

Breeding habitat for Eastern Bentwing-bat consists of maternity caves that females migrate to in summer. Only three maternity caves are known in NSW and no such caves are located in the subject land. Similarly, Little Bentwing-bats form maternity colonies in summer, often formed in association with Eastern Bentwing-bats (OEH, 2019d). Only five maternity colonies are known in Australia, and these are not within the subject land.

As the subject land does not support breeding habitat for Eastern Bentwing-bat and Little Bentwing-bat there is no further assessment of serious and irreversible impacts to these species.

5.4 Prescribed biodiversity impacts

Clause 6.1 of the NSW *Biodiversity Conservation Regulation 2017* identifies actions that are prescribed as impacts to be assessed under the Biodiversity Offsets Scheme. Prescribed biodiversity impacts must be assessed in accordance with Section 9.2 of the BAM.

The prescribed biodiversity impacts in the BAM and their relevance to the project are listed in Table 5-3.

Table 5-3 Prescribed biodiversity impacts specified by the BAM

Prescribed biodiversity impact (BAM)	Relevance to current project
Impacts of development on the habitat of threatened species or ecological communities associated with karst, caves, crevices, cliffs and other features of geological significance	Not relevant – no karst, caves, crevices, cliffs or other features of geological significance in or adjoining the subject land.
Impacts of development on the habitat of threatened species or ecological communities associated with rocks	Not relevant – Scattered rocks and slabs occur in Yurulbin Point construction support site (WHT4) and next to Berrys Bay construction support site (WHT7). This small extent of rocky habitat does not support preferred habitat for threatened species or ecological communities associated with rocks.
Impacts of development on the habitat of threatened species or ecological communities associated with human made structures	Relevant – human made structures occur within and next to the subject land. Human-made structures such as tunnels, wharves, jetties and buildings offer potential roosting habitat to locally occurring threatened microbat species. Direct and indirect impacts of the project may adversely affect threatened fauna species that could utilise these human-made structures. Refer to Section 5.4.1 for further details.
Impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation	Relevant – non-native vegetation occurs within and next to the subject land as described in Section 3.7.1. Trees and shrubs associated with non-native vegetation offers foraging habitat to locally occurring threatened birds, arboreal mammals and Grey-headed Flying-fox. The removal of non-native vegetation from the subject land may have direct and indirect impacts on these threatened species. Refer to Section 5.4.2 for further details.
Impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range	Not relevant – with the exception of vegetation within the exclusion zone at Berrys Bay construction support site (WHT7), that maintains connectivity to a substantial area of bushland in Balls Head Reserve, small, isolated patches of fauna habitat within the subject land do not maintain habitat connectivity with any large areas of native vegetation in the assessment area or wider locality. The project would not further increase fragmentation of different areas of habitat of threatened species that would adversely affect the movement of those species across their range.
Impacts of the development on movement of threatened species that maintains their lifecycle	Not relevant – the project would not result in the loss of fauna habitat features and fauna habitat connectivity that would adversely affect the migration, dispersal and daily movement of fauna species.
Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and TECs	Relevant – turbidity and sedimentation of open water within Sydney Harbour and its bays would likely arise from dredging and piling activities, particularly for construction of the Sydney Harbour crossing. Unmanaged construction activities near watercourses could increase levels of turbidity and sediment deposition, decrease dissolved oxygen, and change pH levels in receiving environments. Refer to Section 5.4.3 for further details.
Impacts of wind turbine strikes on protected animals	Not relevant – no wind turbines are proposed as part of the project.

Prescribed biodiversity impact (BAM)	Relevance to current project
Impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC	Not relevant – while the project is for a major road upgrade, the project is located almost entirely underground. All above-ground components of the project are located in urbanised areas and within existing road corridors from which native vegetation and intact fauna habitat is absent. No threatened species of animals that would typically be at risk of fauna strike (ie terrestrial and slow-moving fauna species) have been recorded in the subject land.

5.4.1 Impacts of development on the habitat of threatened species or ecological communities associated with human made structures

Construction of the project may impact upon roosting habitat for threatened microbats that are known or considered likely to roost in human-made structures within and near the subject land, including tunnels, wharves, jetties and buildings. Measures to minimise and mitigate potential construction impacts on human-made structures that are known to be or may be used for roosting habitat are outlined in Section 6, and adaptive management strategies would be further developed in consultation with the relevant divisions of the Department of Planning, Industry and Environment (Environment, Energy and Science, and Regions, Industry, Agriculture and Resources) before the start of construction of the project.

5.4.1.1 Impacts on Coal Loader tunnel

As described in Section 3.7.2, a winter roost for Eastern Bentwing-bats is located within one of the Coal Loader tunnels located at the Coal Loader Centre for Sustainability and on the western side of Waverton peninsula. This tunnel is located outside of the subject land, but close to Sydney Harbour north cofferdam (WHT6). The project would not directly impact the Coal Loader tunnel; retention of the Coal Loader tunnel in its existing condition means that the project would not result in the loss of winter roosting habitat for Eastern Bentwing-bats.

The number of Eastern Bentwing-bats occupying this winter roost in recent years has fluctuated (as outlined in Table 3-12), but the species generally occupies the tunnel during autumn, winter and early spring.

The mainline tunnels would pass directly beneath the Coal Loader tunnels at a depth of around 27 metres. The majority of the tunnel excavation would be carried out using a number of roadheaders supported from multiple sites. Tunnel lining would be installed progressively following tunnel excavation, comprising of cement grouted rock anchors or rock bolts covered with plastic sheeting, and a shotcrete layer to prevent corrosion. The temporary Sydney Harbour north cofferdam (WHT6) is also located near the Coal Loader, and construction of this cofferdam would require piling and underwater excavation of rock.

Construction activities in the vicinity of the Coal Loader that are considered to be the highest potential noise construction activities are:

- Excavation of the mainline tunnels by roadheaders. Ground borne noise and vibration levels would be highest when the roadheader is directly below the Coal Loader tunnels and would decrease as the roadheader moves away further along the tunnel
- The installation and removal of cofferdams, in particular the piling that is required for the installation of the Sydney Harbour north cofferdam (WHT6) located next to the Coal Loader
- Rock hammering required for benching within the mainline tunnels.

Other activities in the vicinity of the Coal Loader, such as dredging and tube tunnel immersion, have the potential for noise impacts, though are not considered to be high noise activities (see Table 5-4).

The duration of high noise activities is about 18-24 months, noting that the frequency of high noise activities would vary throughout this period. Other activities that could be audible from the Coal

Loader tunnel, but are not likely to be high noise activities, would occur over a 27 month period. Certain activities would be carried out during standard construction hours (eg cofferdam excavation) with respite periods for high noise activities (eg piling) as discussed in Technical working paper: Noise and vibration (Renzo Tonin and Associates, 2020).

Airborne and ground-borne noise predictions due to construction activity in the vicinity of the Coal Loader tunnels is documented in Technical working paper: Noise and vibration (Renzo Tonin and Associates, 2020) (refer to Appendix G of the environmental impact statement). Based on the results in this technical working paper, Renzo Tonin and Associates provided predicted noise levels as summarised in Sections 5.4.1.1.1 and 5.4.1.1.2. For reference, the perception of various sound levels for both air and ground borne noise can be found at www.yourhome.gov.au/housing/noise-control.

It is expected that, during further design development, the predicted noise impacts would be reviewed based on the final construction methods and equipment.

5.4.1.1.1 Predicted airborne noise

The predicted airborne noise levels during the most noise-intensive construction activities, during both standard construction hours and outside of standard construction hours, are shown in Table 5-4. Predicted noise levels range from 38dB(A) to 64dB(A). Ambient noise levels about 150 metres from the Coal Loader range from 45dB(A) at night to 51 dB(A) in the evening.

Table 5-4 Predicted airborne noise levels during construction

Stage	Representative activity	Predicted noise levels at the Coal Loader tunnel, $L_{Aeq\ 15\ minute}$ dB(A)		Predicted noise levels at the Coal Loader tunnel, with potential reverberant building up (+6dB(A))	
		Standard construction hours	Outside standard construction hours	Standard construction hours	Outside standard construction hours
Installation of temporary cofferdam structure	Installation of the Sydney Harbour north cofferdam (WHT6)	58	-	64	-
	Dewater cofferdams	-	-	-	-
Excavation of rock within cofferdam and trench	Excavate cofferdams	54	-	60	-
Construction of interface structure	Cast transition structures	38	-	44	-
Removal of cofferdam structure and site rehabilitation	Remove cofferdams	-	-	-	-

Stage	Representative activity	Predicted noise levels at the Coal Loader tunnel, $L_{Aeq\ 15\ minute}$ dB(A)		Predicted noise levels at the Coal Loader tunnel, with potential reverberant building up (+6dB(A))	
		Standard construction hours	Outside standard construction hours	Standard construction hours	Outside standard construction hours
Dredging and gravel placement	Prepare foundations	40	36	46	42
Tunnel element immersion	Immerse elements	38	38	44	44

5.4.1.1.2 Predicted ground-borne noise

The vibration of walls, ceilings, floors and other structures (associated with construction activities) may radiate audible sound, which is known as ground-borne noise. The Coal Loader tunnel floor is around nine metres above sea level, and the road tunnel crown at the location of the Coal Loader tunnel would be about 19 metres below sea level. The following reasonable worst-case levels of ground-borne noise have been predicted for the Coal Loader tunnel that supports Eastern Bentwing-bat roosting habitat:

- The use of rock hammer equipment for the purpose of benching activities may result in ground-borne noise levels up to 54dB(A), which could build up to 60dB(A) if the Coal Loader tunnel is reverberant
- The use of roadheaders for rock-drilling tunnelling activities could result in ground-borne noise levels up to 38dB(A), which could build up to 44dB(A) if the tunnel is reverberant
- The use of a rockhammer during the excavation of the Sydney Harbour north cofferdam (WHT6), which is about 55 metres from the Coal Loader tunnel, could result in ground-borne noise levels up to 44dB(A). If the Coal Loader tunnel is reverberant, this could increase to 50dB(A).

High levels or extended periods of airborne and/or ground-borne noise in the Coal Loader tunnel may create unfavourable roosting conditions for the Eastern Bentwing-bat between autumn and early spring (ie when the Coal Loader tunnel is occupied by the species).

It is not clearly understood how the species may respond to sudden or continuous construction related noise, the level of which would vary depending on the type of construction activity and the proximity of the construction activity to the Coal Loader tunnel (refer to Table 5-4). Possible responses of Eastern Bentwing-bats to construction-related noise include:

- Individuals roosting in the Coal Loader tunnel between autumn and early spring seek alternative roosting habitat due to sudden noise (ie the start of piling or tunnelling near the Coal Loader tunnel). Although the species is highly mobile and is known to move between several roost sites in the surrounding locality, particularly following disturbance (Hoye, 2000), it is not known if alternative roost sites could support the large number of bats that currently occupy the Coal Loader tunnel during winter. Having to seek alternative roosting habitat in the colder weeks of winter could reduce the resilience of some individuals, as their fat reserves are generally at their lowest and bat activity may be constrained by limited energy availability. However, during consultation with the former DPI (now the Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources) it was discussed that Eastern Bentwing-bats occupying the Coal Loader tunnel appear to rarely enter full torpor, and regularly forage throughout winter (L Gonsalves and B Law 2018, personal communication, 6 August)

- Individuals appear to tolerate airborne and/or ground-borne noise in the Coal Loader tunnel and continue to occupy the roost between autumn and early spring. It is not known whether ongoing disturbance could reduce the resilience of some individuals.

Consequences of these impacts for the local and bioregional persistence of the Eastern Bentwing-bats are uncertain. Given the uncertainty around the impact of construction-related noise on the roosting behaviour of Eastern Bentwing-bats, the species activity at the Coal Loader tunnel would be monitored and environmental management measures to minimise impacts on the species would be developed in response to any observable impacts.

Upon completion of construction and during operation, the project is not expected to cause noise related impacts on the Coal Loader tunnel, and Eastern Bentwing-bats could continue to roost undisturbed in the Coal Loader tunnel.

5.4.1.2 Impacts on wharves, jetties and buildings

As described in Section 3.7.2, timber jetties and wharves located at White Bay construction support site (WHT3), Yurulbin Point construction support site (WHT4), Sydney Harbour south cofferdam (WHT5) and Berrys Bay construction support site (WHT7) may offer limited and marginal potential roosting habitat to microbats. With the exception of structures at Yurulbin Park and at Berrys Bay, no jetties and wharves would be removed for the project. It was determined that the structures at Yurulbin Park and at Berrys Bay offer limited and marginal potential roosting habitat (refer to Table 3-15), and therefore the removal of the structures is unlikely to adversely impact locally recorded microbats. A pre-demolition survey of structures to be removed would be carried out to identify the presence of any microbats, and if present, exclusions measures will be implemented. This environmental management measure is detailed in Section 6.

The buildings located at Berrys Bay are unlikely to support preferred microbat roosting habitat of locally occurring threatened species. The existing buildings would not be removed for the project; rather, they would be retained for use as workshops and storage areas. The marginal roosting habitat offered by these buildings would be subject to construction-related noise, resulting from the 24-hour operation of the construction support site at Berry Bay (WHT7), and this ongoing disturbance may lead individuals to seek alternative roosting habitat in the surrounding locality.

Therefore, impacts on potential microbat habitat associated with wharves, jetties and buildings within the subject land are expected to be minor, and adverse impacts on threatened microbats that may occupy these roosts on occasion are unlikely.

5.4.2 Impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation

Non-native vegetation to be removed from the subject land comprises three categories of vegetation not consistent with the definition of any PCTs that occur within the subject land:

- Native plantings
- Urban exotic/native plantings
- Exotic plantings.

Non-native vegetation is characterised by highly modified and/or landscaped vegetation in gardens, parks and road verges within the subject land. The extent of this non-native vegetation is shown in Figure 3-3. These areas generally contain planted native and exotic horticultural specimens or isolated remnant trees within otherwise planted areas.

Commonly occurring species within patches of non-native vegetation include *Casuarina glauca* (Swamp Oak), *Grevillea* species, *Callistemon* species, *Murraya paniculata* (Murraya), *Eucalyptus microcorys* (Tallowwood), *Nerium oleander*, *Acacia podalyriifolia* (Queensland Silver Wattle), *Lophostemon confertus*, *Cenchrus clandestinus*, *Ehrharta erecta*, *Axonopus fissifolius* (Narrow-leaved Carpet Grass), *Plantago lanceolata* (Lamb's Tongues), *Hypochaeris radicata* (Catsear), *Trifolium* spp.

This vegetation offers potential foraging resources to some threatened species known or considered highly likely to occur in the subject land, as listed in Table 5-5. Non-native vegetation does not offer preferred nesting or roosting (ie breeding) habitat to any threatened species known or considered likely to occur in the subject land.

Table 5-5 Potential impacts on threatened species associated with non-native vegetation

Species	Nature, extent and duration of short and long-term impacts due to non-native vegetation removal	Importance within the bioregion of the habitat to these species or ecological communities	Consequences of the impacts for the local and bioregional persistence of the species
Powerful Owl (<i>Ninox strenua</i>)	Loss of habitat of preferred prey species (e.g. Common ringtail possum) offered by non-native vegetation in the subject land. This potential foraging habitat vegetation consists of very small areas of mostly planted exotic and native trees from road verges and parks.	Low. Potential foraging habitat to be removed consists of very small areas of mostly planted exotic and native trees. The area of habitat to be removed is negligible at a bioregional scale. Similar foraging habitat is readily available throughout the surrounding locality and wider bioregion.	Negligible. Potential foraging habitat to be removed does not comprise a significant proportion of foraging habitat available to this species in the surrounding locality or wider bioregion. The loss of a small area of potential foraging habitat is not expected to adversely impact the persistence of this species at a local nor bioregional scale.
Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>)	Loss of potential foraging habitat offered by non-native vegetation from the subject land. This vegetation consists of very small areas of mostly planted exotic and native trees from road verges and parks.	Low. Potential foraging habitat to be removed consists of very small areas of mostly planted exotic and native trees. The area of habitat to be removed is negligible at a bioregional scale. Similar foraging habitat is readily available throughout the surrounding locality and wider bioregion.	Negligible. Potential foraging habitat to be removed does not comprise a significant proportion of foraging habitat available to this species in the surrounding locality or wider bioregion. The loss of a small area of potential foraging habitat is not expected to adversely impact the persistence of this species at a local nor bioregional scale.
Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>)	Loss of potential foraging habitat offered by non-native vegetation in the subject land. This vegetation consists of very small areas of mostly planted exotic and native trees from road verges and parks.	Low. Potential foraging habitat to be removed consists of very small areas of mostly planted exotic and native trees. The area of habitat to be removed is negligible at a bioregional scale. Similar foraging habitat is readily available throughout the	Negligible. Potential foraging habitat to be removed does not comprise a significant proportion of foraging habitat available to this species in the surrounding locality or wider bioregion. The loss of a small

Species	Nature, extent and duration of short and long-term impacts due to non-native vegetation removal	Importance within the bioregion of the habitat to these species or ecological communities	Consequences of the impacts for the local and bioregional persistence of the species
		surrounding locality and wider bioregion.	area of potential foraging habitat is not expected to adversely impact the persistence of this species at a local nor bioregional scale.
Little Bentwing-bat (<i>Miniopterus australis</i>)	Loss of potential foraging habitat offered by non-native vegetation in the subject land. This vegetation consists of very small areas of mostly planted exotic and native trees from road verges and parks.	Low. Potential foraging habitat to be removed consists of very small areas of mostly planted exotic and native trees. The area of habitat to be removed is negligible at a bioregional scale. Similar foraging habitat is readily available throughout the surrounding locality and wider bioregion.	Negligible. Potential foraging habitat to be removed does not comprise a significant proportion of foraging habitat available to this species in the surrounding locality or wider bioregion. The loss of a small area of potential foraging habitat is not expected to adversely impact the persistence of this species at a local nor bioregional scale.
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	Loss of potential foraging habitat offered by non-native vegetation in the subject land. This vegetation consists of very small areas of mostly planted exotic and native trees from road verges and parks. No breeding habitat for this species would be removed, as a camp is not located in the subject land.	Low. Potential foraging habitat to be removed consists of very small areas of mostly planted exotic and native trees. The area of habitat to be removed is negligible at a bioregional scale. Similar foraging habitat is readily available throughout the surrounding locality and wider bioregion.	Negligible. Potential foraging habitat to be removed does not comprise a significant proportion of foraging habitat available to this species in the surrounding locality or wider bioregion. The loss of a small area of potential foraging habitat is not expected to adversely impact the persistence of this species at a local nor bioregional scale.

5.4.3 Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities

5.4.3.1 Marine and intertidal habitats

Construction of the Sydney Harbour crossing, between Birchgrove and Waverton, would involve the installation of immersed tube tunnels that would sit within a gravel-lined, dredged tunnel trench. The installation of two temporary cofferdams at Sydney Harbour south (WHT5) and Sydney Harbour north (WHT6) would involve dredging of the sea floor, piling and rock excavation.

These construction activities have the potential to generate silt, disturb and mobilise contaminated sediment and increase the turbidity of waters within and near the subject land.

These construction activities have the potential to result in a decrease in water quality and degradation of marine and intertidal habitats, which may adversely impact foraging habitat for threatened species that may use the habitats, including the Little Penguin and White-bellied Sea-Eagle.

In order to minimise the impact on the surrounding marine environment, the selected methodology for the project has considered dredging methods and controls to limit the potential for turbidity impacts and mobilisation of sediment. This includes:

- Use of a closed environmental clamshell (a closed bucket) to dredge the top layer of bed of the harbour, which is used to avoid the spread of material into the water column
- Use of 'hopper' barges positioned next to the dredge with no overflow allowed
- Installation of silt curtains during dredging including:
 - A silt curtain secured to the dredge barge on a fixed or floating boom two to three metres deep
 - An additional shallow silt curtain adjacent to ecologically sensitive areas to provide additional protection.

Impacts on marine species and the marine environment within the subject land are assessed in further detail within Technical working paper: Marine ecology (Cardno, 2020). This section considers potential impacts of the project on threatened birds that may use marine habitats, including the Little Penguin and White-bellied Sea-Eagle.

5.4.3.1.1 *Little Penguin*

As described in Section 3.6.2.4.8, Little Penguins have been recorded at several locations within the subject land and wider assessment area, including Snails Bay, Berrys Bay, Balls Head Bay, and in the main channel of Sydney Harbour (OEH, 2019a), where the species forages in shallow waters for small shoaling fish, cephalopods and, to a lesser extent, crustaceans (NPWS, 2000).

The main threats to the Little Penguin population are those that affect nesting habitat at Manly, located about 10 kilometres to the north-east of the project. This includes overdevelopment of the foreshore, predation by dogs and foxes, movement, noise and light-related disturbance associated with human activities, stormwater runoff and rubbish dumping. The project would not impact upon nesting habitat for the Little Penguin at Manly.

Works within Sydney Harbour (ie construction of the cofferdam, dredging and piling) would cause an increase in turbidity and sedimentation of marine waters, in turn causing localised degradation of potential foraging habitat for the Little Penguin. An increase in suspended sediment near construction activities may adversely impact the occurrence and behaviour of fish and other prey species of the Little Penguin, and adversely impact the health of the Little Penguin.

In order to minimise the impact on the surrounding marine environment, the selected methodology for the project has considered dredging methods and controls to limit the potential for turbidity impacts and mobilisation of sediment (as listed in Section 5.4.3.1). Accordingly, any potential increase in turbidity and sedimentation of marine waters near construction activities would be minimal, localised and temporary.

The Little Penguin is known to forage widely throughout Sydney Harbour, and the impact of any temporary and localised reduction in foraging habitat or water quality near the project would be negligible. Upon completion of construction and during operation, the marine benthic environment would be rehabilitated, and the project is not expected to cause any further turbidity or sedimentation of marine waters.

Construction works within Sydney Harbour (ie installation of the cofferdams, dredging and piling) would generate noise that would be transmitted through seabed sediments and the water column. Construction-related underwater noise may be impulsive or continuous, and the propagation of noise would be strongly influenced by water depth and proximity of the source of the noise to the mainland or small islands. The various headlands and islands that are located within and near the subject land, such as Birchgrove, Ballast Point, Balls Head, Blues Point and Goat Island, are expected to reduce or block acoustic energy that would otherwise propagate through Sydney Harbour (JASCO, 2019).

The duration of construction-related underwater noise (noting some activities would be occurring concurrently, and the frequency of noise intensive activities would vary) is expected to be:

- About 18 months for the installation of temporary cofferdam structures (including dewatering and excavation of rock within cofferdam and trench) at Sydney Harbour south cofferdam (WHT5) and Sydney Harbour north cofferdam (WHT6)
- About 12 months for construction of the interface structure
- About 12 months for dredging and gravel placement
- About 15 months for tunnel element immersion
- About six months for removal of cofferdam structure.

The installation of the immersed tube tunnels would occur 24 hours a day, seven days a week. Dredging activities would mostly be carried out five days a week within normal construction hours. Although sound conduction mechanisms in aquatic birds such as the Little Penguin are poorly understood (Ketten, 2008, McCauley and Kent Salgado, 2008), it is expected that construction-related underwater noise would be perceived by the species, within a certain distance from construction activities.

An acoustic modelling study of underwater sound generated from installing piles and dredging (JASCO, 2019) has identified potential impacts on marine fauna. This study was unable to provide a specific assessment for the Little Penguin due to a lack of scientific studies or literature pertaining to acoustic impacts on the species and therefore a precautionary approach has been applied for the purposes of this assessment. Impulsive or continuous underwater noise as a result of the project may result in altered behaviour of the Little Penguin. The species may avoid foraging in areas subjected to continuous or high levels of sound. Sudden or high levels of sound may have the potential to result in hearing loss or damage to auditory tissues in the Little Penguin. The potential for an impact to occur and the scale or nature of impact would depend on an individual penguin's proximity to construction activities, lessening as distance from construction activities increases. Given the level of construction activity proposed in the harbour, it is expected that individuals of the species would avoid the area reducing the risk of hearing loss and/or auditory damage occurring. As detailed in the environmental impact statement, piling programs would be refined during further design development to consider reasonable and feasible alternatives, attenuating environmental management measures and programming to minimise underwater noise.

Upon completion of construction and during operation, the project is not expected to cause alterations in foraging behaviour nor physical injury.

5.4.3.1.2 *White-bellied Sea-Eagle*

As described in Section 3.6.2.4.5, White-bellied Sea-Eagle species was observed flying above Sydney Harbour near Balls Head Reserve, and above Goat Island. It has been previously recorded in the surrounding assessment area, foraging the waters of Sydney Harbour for fish, turtles and sea snakes.

The main threats to the White-bellied Sea-Eagle are the loss of habitat due to land development and the disturbance of nesting pairs by human activity. The project would not directly impact upon any known nesting habitat, nor does it include any construction or operational activities that are likely to disturb nesting pairs. The closest known nesting site is located in Newington Nature Reserve, next to the Parramatta River and about 12 kilometres north-west of the project.

Construction of the Sydney Harbour crossing, between Yurulbin Point at Birchgrove and Balls Head at Waverton would involve the installation of immersed tube tunnels. The installations of two temporary cofferdams near Yurulbin Point and Balls Head would involve dredging of the sea floor, piling and rock excavation.

Works within Sydney Harbour (ie installation of the cofferdams and dredging) would cause an increase in turbidity and sedimentation of marine waters, in turn causing localised degradation of potential foraging habitat for the White-bellied Sea-Eagle. An increase in suspended sediment near construction activities may adversely impact the occurrence and behaviour of fish and other prey species. However, the selected methodology for the project has considered dredging methods and controls to limit the potential for turbidity impacts and mobilisation of sediment, in order to minimise the impact on the surrounding marine environment. This includes, but is not limited to, the installation of floating silt curtains and other management measures listed in Section 5.4.3.1. Accordingly, any potential increase in turbidity and sedimentation of marine waters near construction activities would be minimal, localised and temporary.

Foraging conditions for the White-bellied Sea-Eagle in Sydney Harbour are poor due to existing high levels of on-water activity. The project would increase the levels of on-water activity in Sydney Harbour with additional vessels and cofferdam structures. This relatively small increase in on-water activity as a result of the project would contribute to the existing poor foraging conditions for the species. However, any additional impacts are anticipated to be very minor or negligible.

Upon completion of construction and during operation, the project is not expected to adversely impact foraging habitat that occurs within the subject land.

5.4.3.1.3 *Threatened shorebirds and wandering seabirds*

The subject land does not support preferred habitat of threatened shorebird or wandering seabird species identified during database searches (listed in Appendix A). No threatened shorebird or wandering seabird species were determined to have a high likelihood of occurrence in the subject land. The project is unlikely to adversely impact threatened shorebird or wandering seabird species identified during database searches.

5.4.3.2 *Freshwater habitats*

One highly modified waterway occurs within the subject land: Whites Creek. The lower reach of Whites Creek is located near Rozelle Rail Yards construction support site (WHT1). No instream works are proposed in this waterway as part of this project.

The catchments of three other waterways fall within the subject land: Willoughby Creek, Flat Rock Creek and Quarry Creek. No in-stream works are proposed in these waterways.

No threatened fauna species were identified within freshwater habitat in or downstream of the subject land. Accordingly, there would be no removal, fragmentation or modification to freshwater ecology or associated geomorphology of these waterways as a result of the project.

Construction activities near Whites Creek at Rozelle Rail Yards (WHT1), and along the Warringah Freeway corridor at Cammeray and Naremburn, could result in soil erosion, siltation and off-site movement of eroded sediments by stormwater into downstream waterways. The highest risk construction activity would be earthworks. If unmanaged, construction activities could increase levels of turbidity and sediment deposition, decrease dissolved oxygen and change pH levels in downstream waterways. Accidental fuel and chemical spills and contaminated runoff from construction vehicles, plant, equipment or chemical storage areas have the potential to reach downstream waterways.

Potential impacts of construction activities on water quality and surface flows would be managed by the implementation of standard environmental management measures as outlined in Technical working paper: Surface water quality and hydrology (Jacobs, 2020a), including erosion and sediment controls for all work sites and surface work areas. With the implementation of appropriate measures during construction, impacts to water quality would be temporary and manageable. Water treatment devices, such as construction sediment basins, would be located where they collect a high proportion of sediment-laden runoff from disturbed areas of the construction.

During construction, treated wastewater would be discharged to Rozelle Bay, Iron Cove, Snails Bay, Berrys Bay and Willoughby Creek. During operations, treated wastewater would be discharged to Rozelle Bay. Discharges from the wastewater treatment plants during construction and operation would be designed to improve or maintain water quality in the receiving environment.

5.5 Impacts on Matters of National Environmental Significance

Three MNES are known to occur in the subject land: *Acacia terminalis* subsp. *terminalis*, Grey-headed Flying-fox and White-bellied Sea Eagle. Significant Impact Assessments have been completed for these species and are provided in Appendix E.

The Significant Impact Assessment for *Acacia terminalis* subsp. *terminalis* concluded that the project would not have a significant impact on this Endangered species. The removal of a single isolated individual of the species from landscaped vegetation adjoining the Warringah Freeway in Cammeray does not comprise a significant proportion of the local population of the species or of its habitat in the surrounding locality.

The Significant Impact Assessment for Grey-headed Flying-fox concluded that the project would not have a significant impact on this Vulnerable species. The removal of about 7.29 hectares of planted and exotic vegetation, which contains varying abundance of the blossom and fruit trees that form part of the Grey-headed Flying-fox diet, does not comprise a significant proportion of foraging habitat available to the species in the surrounding locality.

The Significant Impact Assessment for White-bellied Sea Eagle found that impacts to this Migratory species are not likely to be significant due to the small amount of potential foraging habitat that would be temporarily removed (due the construction of temporary cofferdams). This habitat would be reinstated upon the completion of construction.

5.6 Impacts on groundwater dependent ecosystems

No direct impacts on groundwater dependent ecosystems are likely, given that the *Groundwater Dependent Ecosystem Atlas* (BOM, 2018) did not identify any Groundwater Dependent Ecosystems occurring within or in close proximity to the subject land. Groundwater dependent ecosystems with potential reliance on subsurface groundwater were mapped by BOM (2019) in the locality:

- Coastal Sandstone Gully Forest, Sandstone Riparian Scrub and Coastal Sand Forest with a moderate to high potential for groundwater interaction adjoining Flat Rock Creek, around 300 metres north east of the subject land.

No high priority groundwater dependent ecosystems as identified by NSW Office of Water (2011) are located in the subject land or adjacent areas. The closest high priority groundwater dependent ecosystem to the subject land is Coastal Saltmarsh, mapped by OEH (2016) in Jubilee Park at Glebe, around 540 metres to the south-east of the subject land. The project would not result in direct or indirect impacts to this area of Coastal Saltmarsh.

Groundwater drawdown would occur as a result of the project, because groundwater would flow into the project tunnels and lower pressure (and groundwater levels) in the surrounding aquifer (Jacobs, 2020b). Drawdown of the water table can cause wetlands to become recharge instead of discharge zones, altering the soil water regime and water chemistry, which then influences the

vegetation and fauna communities. A prolonged period of drawdown can result in the disconnection of the root zone from the water table, resulting in the subsequent drying out of the ecosystem over time (Serov et al., 2012). Drawdown may also result in reductions in groundwater baseflow to connected surface water systems.

The extent of groundwater drawdown as a result of the project was modelled by Jacobs (2020b). None of the areas mapped as a groundwater dependent ecosystem by BOM (2019) are within the area of predicted groundwater drawdown. The Coastal Saltmarsh mapped by OEH (2016) in Jubilee Park at Glebe, is also located outside the area of groundwater drawdown.

Given the distance between groundwater dependent ecosystems and the subject land and associated areas of predicted groundwater drawdown, the project is unlikely to adversely impact groundwater dependent ecosystems.

5.7 Impact summary

Table 5-6 provides a list of the impacts considered in this BDAR and provides a summary of the impact assessment carried out.

Table 5-6 Summary of impacts

Impact	Biodiversity values	Nature of impact	Extent of impact	Duration
Removal of 7.29 ha vegetation (that is not consistent with definition of any PCT)	Planted native and exotic vegetation.	Direct	Site based	Long-term
Removal of 7.29 ha of vegetation that offers limited habitat resources to locally occurring threatened fauna species	Potential threatened fauna species habitat.	Direct	Site based	Long-term
Removal of threatened plants	One individual of <i>Acacia terminalis</i> subsp. <i>terminalis</i> . Up to seven planted individuals of <i>Eucalyptus nicholii</i> . Up to two planted individuals of <i>Eucalyptus scoparia</i> .	Direct	Site based	Long-term
Degradation and/or temporary disturbance of marine and littoral habitats	Foraging habitat for White-bellied Sea-Eagle and Little Penguin.	Direct	Local	Short-term
Edge effects on adjacent native vegetation and habitat	Native vegetation and fauna habitat to be retained next to the subject land.	Indirect	Local	Long-term
Removal of one potential hollow-bearing tree	Roosting or nesting habitat for common urban fauna.	Direct	Site based	Long term
Injury and mortality of fauna	Protected and threatened species that may occur in the subject land during the construction period.	Direct	Site based	Short-term

Impact	Biodiversity values	Nature of impact	Extent of impact	Duration
Invasion and spread of weeds	Native vegetation and fauna habitat to be retained next to and/or near the subject land.	Indirect	Site based	Short-term
Invasion and spread of pests	Native vegetation and fauna habitat to be retained next to and/or near the subject land.	Indirect	Site based	Long-term (if unmanaged)
Invasion and spread of pathogens and disease	Native vegetation and fauna habitat to be retained next to and/or near the subject land.	Indirect	Site based	Long-term (if unmanaged)
Noise, light and vibration	Colony of Eastern Bentwing-bats that occupy one of four tunnels at the Coal Loader during autumn and winter.	Direct	Site based	Dependent upon timing and duration of piling and tunnelling near Coal Loader tunnel
	Little Penguins that move and forage in Sydney Harbour, including in the subject land.	Direct	Site based	Dependent upon timing and duration of piling and tunnelling between Birchgrove and Waverton
	Protected and threatened fauna species that may occur within the subject land on a temporary, transient or permanent basis.	Direct/ indirect	Site based	Short-term

6 Environmental management measures

Biodiversity impacts cannot be avoided for many aspects of the project. As such, the measures listed in Table 6-1 should be implemented to minimise impacts on terrestrial biodiversity.

Management measures that relate to avoiding, minimising and mitigating impacts in marine environments (ie Sydney Harbour) are included in Technical working paper: Marine ecology (Cardno, 2020). While not duplicated in Table 6-1, these measures would also be relevant to avoiding, minimising and mitigating impacts on wandering seabirds, shorebird species and Little Penguin, and their habitat within and near the subject land.

The BAM requires consideration of the timing, frequency, responsibility and risk of failure of environmental management measures, and of the risk and consequence of any residual impacts. Accordingly:

- With the exception of revegetation measures, all environmental management measures would be implemented prior to or during construction of the project
- The responsibility of implementing environmental management measures would be shared by both the construction contractor and Roads and Maritime
- No measures listed in Table 6-1 are anticipated to be at risk of failure.

While Section 4 describes how impacts on biodiversity have been avoided, and Table 6-1 outlines how impacts on biodiversity would be minimised, the project would have residual impacts on biodiversity. A residual impact is any impact on a biodiversity value, after all reasonable measures have been taken to avoid and minimise the impact.

In accordance with the BAM, offset requirements must be calculated for residual impacts on biodiversity. Section 7 outlines the offsets that have been calculated for residual impacts of the project on native vegetation, threatened flora and fauna species and aquatic habitat.

Table 6-1 Environmental management measures

Impact	Phase	Environmental management measure	Location
Removal of vegetation and threatened species habitat	Construction	Vegetation removal will be further minimised, where reasonable and feasible.	WHT/WFU
	Construction	Vegetation removal will be carried out in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	WHT/WFU
	Construction	The unexpected species find procedure included in <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) will be followed if threatened ecological communities, flora or fauna species, not assessed in the biodiversity assessment, are identified in the subject land.	WHT/WFU
	Construction	Vegetation will be re-established, where feasible and reasonable, in accordance with <i>Guide 3: Re-establishment of native vegetation</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	WHT/WFU

Impact	Phase	Environmental management measure	Location
Removal of threatened flora species	Construction	Pre-clearing surveys for threatened flora species will be carried out in accordance with <i>Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	WHT/WFU
	Construction	The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011) if threatened flora species, not assessed in the biodiversity assessment, are identified in the subject land.	WHT/WFU
Construction noise, vibration and light	Construction	Carry out inspections of Eastern Bentwing-bat roosting sites in the surrounding locality (eg concrete box culverts, jetties) prior to construction, to determine the roosting capacity of each site at times roosting numbers are expected to be high.	WHT
	Construction	Carry out monthly monitoring of Eastern Bentwing-bats in the Coal Loader tunnel prior to construction (in the months of March to September), preferably by utilising thermal camera imaging at tunnel entrances (a less invasive method than carrying out counts within the tunnel itself).	WHT
	Construction	Carry out monthly monitoring of Eastern Bentwing-bats in the Coal Loader tunnel during construction (in the months of March to September), preferably by utilising thermal camera imaging at tunnel entrances (a less invasive method than carrying out counts within the tunnel itself).	
	Construction	Adaptive management measures (supplemented by additional monitoring if required) to minimise impacts on the Eastern Bentwing-bat will be developed in consultation with Department of Planning, Industry and Environment (Environment, Energy and Science, and the Regions, Industry, Agriculture and Resources divisions), North Sydney Council and an appropriately qualified expert in microbat biology and behaviour, if monthly monitoring during construction suggests Eastern Bentwing-bat behaviour is affected by construction noise.	
Injury and mortality of fauna	Construction	Fauna will be managed in accordance with <i>Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	WHT/WFU
	Construction	Pre-clearing surveys will be carried out in accordance with <i>Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	WHT/WFU
	Construction	Pre-clearing surveys for microbat roosts will be carried out on the wharf structures to be demolished at Yurulbin Point (WHT4) and Berrys Bay (WHT7). If microbats are identified roosting in these structures, individuals will be excluded from this roosting habitat.	WHT
	Construction	An observer qualified to spot Little Penguins would be used during marine construction activities. A stop-work procedure will be implemented upon sighting of the species in the proximity of the works area.	WHT
Invasion and spread of weeds, pests, pathogens and disease	Construction	Weed species will be managed in accordance with <i>Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	WHT/WFU
	Construction	Pathogens will be managed in accordance with <i>Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	WHT/WFU

6.1 Adaptive management of Eastern Bentwing-bat roosting habitat

Given the uncertainty around the impact of construction-related noise on the roosting behaviour of Eastern Bentwing-bats in the Coal Loader tunnel, potential construction impacts would be mitigated by the implementation of adaptive management strategies.

Some potential adaptive management strategies have been discussed in consultation with the former DPI (now the Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources)), however, additional management measures to minimise impacts on the species will continue to be developed in consultation with Department of Planning, Industry and Environment (Environment, Energy and Science, and the Regions, Industry, Agriculture and Resources divisions) and/or an appropriately qualified expert in microbat biology and behaviour, during further design development.

Adaptive management strategies may include improving or creating additional alternative Eastern Bentwing-bat roosting sites in the surrounding locality, in consultation with North Sydney Council and Sydney Water. This could involve modifying concrete culverts to create favourable roosting habitat.

In discussing adaptive management strategies with the former DPI (Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources)), it was determined that excluding Eastern Bentwing-bats from the Coal Loader tunnel would not be a favourable strategy (L Gonsalves and B Law 2018, personal communication, 6 August 2018). Excluding microbats from a known roost site prior to construction is generally only implemented if that roost site is to be removed, to prevent injury and/or mortality of microbats.

Given that the project would not directly impact the Coal Loader tunnel (ie the Coal Loader tunnel would be retained in its existing condition), and winter roosting habitat offered by the Coal Loader tunnel would not be removed, exclusion measures are not required.

7 Offsetting

7.1 Offset credit requirements under the Biodiversity Offsets Scheme

7.1.1 Ecosystem credits

As specified in Section 10.4.1.1 of the BAM (OEH, 2017a), an assessor is not required to assess areas of land on the subject land for ecosystem credits without native vegetation. No native vegetation (that is consistent with the definition of a PCT) would be subject to direct impacts from the project. Therefore, no ecosystem credit offsets are required.

One fauna species classified as ecosystem credit species, Grey-headed Flying-fox, was recorded in the subject land, and another, Eastern Freetail-bat, has a high likelihood of occurrence. Ecosystem credits are not required to offset impacts to these species, as they are not associated with a PCT.

7.1.2 Species credits

Four threatened flora species were identified within or next to the subject land near the Warringah Freeway site: *Acacia terminalis* subsp. *terminalis*, *Eucalyptus nicholii*, *Eucalyptus scoparia* and *Syzygium paniculatum*. The single plant of *Acacia terminalis* subsp. *terminalis* was recorded in a disturbed landscaped area adjacent to Warringah Freeway. Although the individual of this species identified within the subject land is located in landscaped roadside vegetation, it is within the known range of the species, and is therefore assumed to be of wild provenance. As such, species credits would be required to offset the removal of this individual (Table 7-1).

Species credit values were calculated using equation 3 of the BAM (OEH, 2017a):

$$\text{Number of flora species credits required} = HL \times BRW$$

where HL represents the number of individuals of the threatened species to be impacted and BRW represents the biodiversity risk weighting for the threatened species as set out in the Threatened Biodiversity Data Collection.

Table 7-1 Species credits summary

Species	Vegetation zone name	Individuals/ Area (ha)	Biodiversity risk weighting [#]	Species credits
<i>Acacia terminalis</i> subsp. <i>terminalis</i> Sunshine Wattle	N/A	1	2	2

[#] See section 2.9 for definition of this term.

The other three threatened flora species recorded are outside their known geographic range and/or known habitat and occur as individual trees. It is assumed that these trees have been planted, and do not naturally occur within the subject land. The planted individuals of *Eucalyptus nicholii* and *Eucalyptus scoparia* to be impacted by the project are not considered to be of conservation significance and would not require species credit offsets. *Syzygium paniculatum* would not be impacted by the project and therefore does not require offsetting.

Two threatened fauna species classified as either species/ecosystem or species credit species are known to occur in the subject land: Eastern Bentwing-bat and White-bellied Sea-Eagle. Eastern Bentwing-bats that inhabit the Coal Loader tunnel between autumn and early spring would not be directly impacted. However, it would be subject to temporary indirect impacts from noise and vibration during construction.

A very small area of potential foraging habitat for White-bellied Sea-Eagle would be temporarily unavailable due to the dewatering of Sydney Harbour south and Sydney Harbour north cofferdams (WHT5 and WHT6, respectively). Following construction of the interface structures, the cofferdams

would be removed, and the marine environment would be rehabilitated. Accordingly, the loss of potential foraging habitat in marine waters at cofferdam locations would be minimal, localised and temporary. Given there are no direct impacts to fauna habitats to which species credits apply, no species credit offsets are required for threatened fauna.

7.1.3 Like-for-like and variation credits

The species and IBRA subregions that species credits must be sourced from, in order to satisfy the offset obligation for the project, are identified in Table 7-2.

Table 7-2 Like-for-like and variation offset options for species credits

Species	Credits required	Like-for-like offset options	Variation offset options
<i>Acacia terminalis</i> subsp. <i>terminalis</i> (Sunshine Wattle)	2	<i>Acacia terminalis</i> subsp. <i>terminalis</i> Anywhere in NSW	Any plant species with endangered or higher conservation status. Located in the Pittwater, Cumberland, Sydney Cataract, Wyong and Yengo IBRA subregions, or any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.

7.2 Delivery of offsets

In accordance with the available options for offsetting under the Biodiversity Offsets Scheme, it is proposed to use the Offsets Payment Calculator to determine the cost of all or part of the credit obligations and make a payment to the Biodiversity Conservation Fund.

8 References

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Appendix A – Habitat assessment tables

Likelihood of occurrence criteria (WSP, 2018)

Likelihood	Criteria
Recorded	The species was observed in the subject land during the current survey.
High	It is highly likely that a species inhabits the subject land and is dependent on identified suitable habitat (ie for breeding or important lifecycle periods such as winter flowering resources), has been recorded recently in the locality (10km) and is known or likely to maintain resident populations in the subject land. Also includes species known or likely to visit the subject land during regular seasonal movements or migration.
Moderate	Potential habitat is present in the subject land. Species unlikely to maintain sedentary populations but may seasonally use resources within the subject land opportunistically or during migration. The species is unlikely to be dependent (ie for breeding or important lifecycle periods such as winter flowering resources) on habitat within the subject land, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the subject land and has not been recorded recently in the locality (10km). It may be an occasional visitor, but habitat similar to the subject land is widely distributed in the local area, meaning that the species is not dependent (ie for breeding or important lifecycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the subject land or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
None	Suitable habitat is absent from the subject land.

Threatened ecological communities

TECs listed under the BC Act	TECs listed under the EPBC Act	Potential occurrence in subject land
Blue Gum High Forest in the Sydney Basin Bioregion (Critically Endangered)	Blue Gum High Forest of the Sydney Basin Bioregion (Critically Endangered)	Low. The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC.
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion (Vulnerable)	Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion (Endangered)	Low The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	Subtropical and Temperate Coastal Saltmarsh (Vulnerable)	Low The subject land does not support preferred habitat for this TEC.
Coastal Upland Swamp in the Sydney Basin Bioregion (Endangered)	Coastal Upland Swamps in the Sydney Basin Bioregion (Endangered)	Low The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC.
Cooks River/Castlereagh ironbark forest in the Sydney Basin Bioregion (Endangered)	Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered)	Low. The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC
Duffys Forest Ecological Community in the Sydney Basin Bioregion (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC.
Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion (Endangered)	Eastern Suburbs Banksia Scrub of the Sydney Region (Endangered)	Low. The subject land does not support preferred habitat for this TEC.

TECs listed under the BC Act	TECs listed under the EPBC Act	Potential occurrence in subject land
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC.
Kurnell Dune Forest in the Sutherland Shire and City of Rockdale (Endangered)	-	Low The subject land does not support preferred habitat for this TEC.
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (Critically Endangered)	Low The subject land does not support preferred habitat for this TEC.
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC.
Pittwater and Wagstaffe Spotted Gum Forest in the Sydney Basin Bioregion (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC.
-	<i>Posidonia australis</i> seagrass meadows of the Manning-Hawkesbury ecoregion (Endangered)	Low. The subject land does not support preferred habitat for this TEC.
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC.

TECs listed under the BC Act	TECs listed under the EPBC Act	Potential occurrence in subject land
Shale Sandstone Transition Forest in the Sydney Basin Bioregion (Endangered)	Shale Sandstone Transition Forest of the Sydney Basin Bioregion (Critically Endangered)	Low. The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC.
Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC.
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	Coastal Swamp Oak (<i>Casuarina glauca</i>) Forest of New South Wales and South East Queensland ecological community (Endangered)	Low. The subject land does not support preferred habitat for this TEC.
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC.
Sydney Freshwater Wetlands in the Sydney Basin Bioregion (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC.
Sydney Turpentine-Ironbark Forest (Endangered)	Turpentine-Ironbark Forest in the Sydney Basin Bioregion (Critically Endangered)	Low. The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC
The Shorebird Community occurring on the relict tidal delta sands at Taren Point (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC.
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	Low. The subject land does not support preferred habitat for this TEC.

TECs listed under the BC Act	TECs listed under the EPBC Act	Potential occurrence in subject land
Western Sydney Dry Rainforest in the Sydney Basin Bioregion (Endangered)	Western Sydney Dry Rainforest and Moist Woodland on Shale (Critically Endangered)	Low. The subject land does not support preferred habitat for this TEC, and is located outside of the geographic range of this TEC

Threatened flora species

All habitat requirements from OEH (2019d) unless otherwise specified.

Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
<i>Acacia bynoeana</i> (Bynoe's Wattle)	E	V	Occurs from Morisset south to the Southern Highlands and west to the Blue Mountains. Grows mainly in heath or dry sclerophyll forest on sandy soils and seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas.	2 (most recent record from 1951)	19 (all but one record is from 1951 or before)	Low. Only one record of this species within 10 km of the subject land is recent (2008). No associated vegetation types occur on or near the subject land. Most of the subject land is highly modified and disturbed and does not represent habitat for the species.	Bionet (1.5km buffer), EPBC Protected Matters search
<i>Acacia pubescens</i> (Downy Wattle)	V	V	Distributed within the Bankstown-Fairfield-Rookwood areas and the Pitt Town area. Known from Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland on alluviums, shales and at the intergrade between shales and sandstones.	0	86	Low. The subject land is outside the known distribution of the species, with the closest record over 8 km to the west. No suitable habitat was identified within the subject land.	Bionet (10km buffer), EPBC Protected Matters search
<i>Acacia terminalis subsp. terminalis</i> (Sunshine Wattle)	E	E	Grows in scrub and dry sclerophyll woodland on sandy soils in mostly near-coastal area from Botany Bay	16	337	Recorded. One individual specimen in disturbed vegetation adjoining the Warringah Freeway.	Bionet (1.5km buffer),

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			and the northern foreshore of Port Jackson. Recent collections are mainly from the Quarantine Station, Clifton Gardens, Dover Heights, Parsley Bay, Nielsen Park, Cooper Park, Chifley and Watsons Bay.			There are records of the species in bushland adjoining Sydney Harbour, including near the subject land. Most of the subject land does not represent suitable habitat for the species.	EPBC Protected Matters search
<i>Allocasuarina glareicola</i>	E	E	Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. Grows in Castlereagh woodland on lateritic soil in open woodland.	0	0	Low. The species has not been recorded within the locality and no suitable habitat was identified within the subject land.	EPBC Protected Matters search
<i>Allocasuarina portuensis</i>	E	E	Known from only a single population within Sydney Harbour National Park. The original habitat is tall closed woodland. There are no plants left at the original site, however propagated plants have been established at a number of locations at Nielsen Park and nearby areas.	0	75	Low. No suitable habitat was identified within the subject land.	Bionet (10km buffer), BAM calculator outputs, EPBC Protected Matters search
<i>Amperea xiphoclada</i> var. <i>pedicellata</i>	E4	X	Known only from the type specimen collected in 1892 from Sydney, NSW. The species has not been observed since and is presumed to be extinct. Previously widespread in heath, woodland and forest in low-fertility, sandy soils.	0	1	Low. Known only from the type specimen collected in 1892. No suitable habitat was identified within the subject land.	Bionet (10km buffer)
<i>Asterolasia buxifolia</i>	E	-	Known from a single site at a granite outcrop in the riparian zone of the Lett River. Rediscovered in 2000, little is known about the species. Apparently	0	1	Low. The species is not generally known to occur within the Sydney Basin; the single record of the species within 10 km of the site	Bionet (10km buffer)

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			restricted to dense riparian scrub along rocky watercourses with a granitic substrate.			(dated from 2008) may be inaccurate. No suitable habitat was identified within the subject land.	
<i>Asterolasia elegans</i>	E	E	Occurs in sheltered forests on mid- to lower slopes and valleys on Hawkesbury Sandstone. Known from only seven populations north of Sydney in the Baulkham Hills. Hawkesbury and Hornsby local government areas. Found in sheltered forests on mid- to lower slopes and valleys.	0	0	Low. The species has not been recorded within the locality and no suitable habitat was identified within the subject land.	EPBC Protected Matters search
<i>Caladenia tessellata</i> (Thick Lip Spider Orchid)	E	V	Known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil.	0	8	Low. The species has not been recorded within the locality since 1945 and is thought to no longer occur within the Sydney region. No suitable habitat was identified within the subject land.	Bionet (10km buffer), EPBC Protected Matters search
<i>Callistemon linearifolius</i> (Netted Bottle Brush)	V	-	Occurs chiefly from Georges River to the Hawkesbury River, with recent records for the Sydney area limited to the Hornsby Plateau area near the Hawkesbury River. Grows in dry sclerophyll forest.	0	21	Low. Although the species has been recorded within the locality, no suitable habitat was identified within the subject land.	Bionet (10km buffer)
<i>Camarophyllopsis kearneyi</i>	E		Known only from the type location in Lane Cove Bushland Park (OEH, 2019d). Found growing under ferns and on creek banks (DECC, 2008b).	0	1	Low. Only know from type locality at Lane Cove Bushland Park. No suitable habitat was identified within the subject land.	Bionet (10km buffer)
<i>Chamaesyce psammogeton</i>	E	-	Found sparsely along the coast from south of Jervis Bay to Queensland.	0	3	Low. The species has been recently recorded once within the	Bionet (10km

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
(Sand Spurge)			Grows on fore-dunes, pebbly strandlines and exposed headlands, often with Spinifex (<i>Spinifex sericeus</i>).			locality (2002) and no suitable habitat was identified within the subject land.	buffer)
<i>Cryptostylis hunteriana</i> (Leafless Tongue Orchid)	V	V	Recorded from the Gibraltar Range south to Victoria, chiefly in coastal districts but also extends on to tablelands. Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.	0	0	Low. The species has not been recorded within the locality. No suitable habitat was identified within the subject land.	EPBC Protected Matters search
<i>Cynanchum elegans</i> (White-flowered Wax Plant)	E	E	Restricted to the east coast of NSW, inland to Merriwa. Occurs on margins of dry rainforest, also littoral rainforest, open forest and woodland, and scrub.	0	0	Low. The species has not been recorded within the locality. No suitable habitat was identified within the subject land.	EPBC Protected Matters search
<i>Darwinia biflora</i>	V	V	Recorded in Ku-ring-gai, Hornsby, Baulkham Hills and Ryde local government areas. Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone.	0	212	Low. No suitable habitat was identified within the subject land.	Bionet (10km buffer), EPBC Protected Matters search
<i>Deyeuxia appressa</i>	E	E	A highly restricted NSW endemic known only from two pre-1942 records in the Sydney area, south of Bankstown and in Killara. Has not been collected since and may now be extinct in the wild due to habitat loss and development within these areas. Almost nothing is known of the species' habitat and ecology	0	3	Low. The species has not been recorded within the locality since 1941. Habitat for the species is unknown, however most areas within the subject land are disturbed and modified.	Bionet (10km buffer), EPBC Protected Matters search
<i>Dichanthium setosum</i>	V	V	Occurs on the New England Tablelands, North West Slopes and	0	1	Low. The subject land falls outside the species' known	Bionet (10km

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
(Bluegrass)			Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. Associated with heavy basaltic black soils and red-brown loams with clay subsoil.			distribution, with the single record in the locality dated from 1913. There is no suitable habitat for the species within the subject land.	buffer)
<i>Dillwynia tenuifolia</i>	V	-	The core distribution is the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee, with other populations in western Sydney and disjunct occurrences at Yengo, Kurrajong Heights and Woodford in the Lower Blue Mountains. May be locally abundant, particularly within scrubby/dry heath areas on tertiary alluvium or laterised clays.	0	1	Low. The subject land is outside the known distribution of the species, with the closest record over 8 km to the west. No suitable habitat was identified within the subject land.	Bionet (10km buffer)
<i>Diuris arenaria</i> (Sand Doubletail)	E	-	Known from the Tomaree Peninsula near Newcastle. Occurs in coastal heath and dry grassy eucalypt forest on sandy flats. Grows in gently undulating country in eucalypt forest with a grassy understorey on clay soil.	0	1	Low. One record in the Sydney region dated from 2001. No suitable habitat was identified within the subject land.	Bionet (10km buffer)
<i>Doryanthes palmeri</i> (Giant Spear Lily)	V	-	Occurs in far north-east NSW and south-east Queensland. Habitat is exposed rocky outcrops on infertile soils or on bare rock.	0	2	Low. The records in the locality are planted and the subject land is far outside the natural range of the species.	Bionet (10km buffer)
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	V	-	Grows in sclerophyll forest, scrubs and swamps on sandstone from Gosford and Sydney districts. Found in a range of habitat types, most of which have a strong shale soil influence.	5	30	Low. Although the species has been recorded in the vegetation surrounding Artarmon Oval, located just to the north of the subject land, there is no suitable habitat for the species within the subject land.	Bionet (1.5km buffer)

Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
<i>Eucalyptus camfieldii</i> (Heart-leaved Stringybark aka Camfield's Stringybark)	V	V	Occurs in scattered locations within a restricted distribution from Raymond Terrace south to Waterfall. Grows in poor coastal country in shallow sandy soils overlying Hawkesbury Sandstone, in coastal heath mostly on exposed sandy ridges.	2 (most recent record is from 1959)	45	Low. There are no recent records of the species near the subject land; the closest recent records are at North Head, over 7 km to the east. There is no suitable habitat for the species within the subject land.	Bionet (1.5km buffer), EPBC Protected Matters search
<i>Eucalyptus fracta</i> (Broken Back Ironbark)	V	-	Confined largely to State Forests, restricted to the Broken Back Range, near Cessnock, where it is locally frequent. Occurs in dry eucalypt woodland on shallow soils.	0	1	Low. The single record in the locality is planted and the subject land is far outside the natural range of the species.	Bionet (10km buffer)
<i>Eucalyptus nicholii</i> (Narrow-leaved Black Peppermint)	V	V	Occurs from Nundle to north of Tenterfield where it grows in dry grassy sclerophyll woodland on shallow soils of slopes and ridges. Planted as urban trees, windbreaks and corridors.	5	14	Recorded. Planted specimens recorded in the Warringah Freeway site. Not likely to occur naturally as the subject land is far outside the species' known natural distribution.	Bionet (1.5km buffer)
<i>Eucalyptus pulverulenta</i> (Silver-leaved Gum)	V	V	Found in two quite separate areas, the Lithgow to Bathurst area and the Monaro (Bredbo to Bombala). Grows in shallow soils as an understorey plant in open forest.	0	1	Low. The single record in the locality is planted and the subject land is far outside the natural range of the species.	Bionet (10km buffer)
<i>Eucalyptus scoparia</i> (Wallangarra White Gum)	E	V	In NSW it is known from only three locations near Tenterfield, including Bald Rock National Park. Found in open eucalypt forest, woodland and heaths on well-drained granite/rhyolite hilltops, slopes and rocky outcrops, typically at high altitudes (OEH, 2019d). Widely planted as an urban street tree and in gardens.	0	3	Recorded. Planted specimens recorded in the Warringah Freeway site. Not likely to occur naturally as the subject land is outside the species' known natural distribution.	Bionet (10km buffer)
<i>Genoplesium baueri</i>	E	E	Recorded from locations between	0	10	Low. There are two recent	Bionet

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
(Bauer's Midge Orchid)			Ulladulla and Port Stephens, with over half of records dating from before 1960. No recent collections have been made from Sydney suburbs. Grows in dry sclerophyll forest and moss gardens over sandstone.			records in the north of Sydney, dated from 2017; these are located over 8 km from the subject land. There is no suitable habitat for the species within the subject land.	(10km buffer), EPBC Protected Matters search
<i>Grammitis stenophylla</i> (Narrow-leaf Finger Fern)	E	-	A fern which occurs in coastal regions from Queensland to the NSW south coast. It grows in moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest.	0	2	Low. The subject land is outside the species' known distribution and there is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Grevillea caleyi</i> (Caley's Grevillea)	CE	E	Restricted to an 8 km square area around Terrey Hills, around 20 kilometres north of Sydney. Occurs in three major areas of suitable habitat, namely Belrose, Ingleside and Terrey Hills/Duffys Forest. All sites occur on the ridgetop in association with laterite soils and open forest vegetation communities.	0	130	Low. The closest recent record is over 7 km to the north of the subject land. The subject land is outside the species' natural distribution and does not contain suitable habitat for the species.	Bionet (10km buffer), EPBC Protected Matters search
<i>Grevillea juniperina subsp. juniperina</i> (Juniper-leaved Grevillea)	V		Endemic to western Sydney. Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium.	0	1	Low. The single record in the locality is planted and the subject land is outside the natural distribution of the species.	Bionet (10km buffer)
<i>Haloragodendron lucasii</i>	E	E	Known locations of this species are confined to a very narrow distribution on the north shore of Sydney. Grows in dry sclerophyll forest; reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland. Associated with high soil moisture and relatively high soil-	0	18	Low. The closest record is over 7 km to the north of the subject land. The subject land is outside the species' natural distribution and does not contain suitable habitat for the species.	Bionet (10km buffer), EPBC Protected Matters search

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			phosphorus levels.				
<i>Hibbertia puberula</i>	E		Widespread, but never common. Extends from Wollemi National Park south to Morton National Park and the south coast near Nowra. Favours low heath on sandy soils or rarely in clay, with or without rocks underneath.	0	2	Low. The species has not been recorded within the locality since 1954. No suitable habitat for the species was identified within the subject land.	Bionet (10km buffer)
<i>Hibbertia spanantha</i> (Julian's Hibbertia)	CE	CE	Endemic to NSW where it is restricted to three locations. Grows in forest with canopy species including <i>Eucalyptus pilularis</i> , <i>E. resinifera</i> , <i>Corymbia gummifera</i> and <i>Angophora costata</i> and open understorey. The soil is identified as a light clay occurring on a shale sandstone soil transition.	0	3	Low. The closest record of the species is about 5 km from the subject land. No suitable habitat was identified within the subject land.	Bionet (10km buffer)
<i>Hibbertia superans</i>	E	-	Occurs from Baulkham Hills to South Maroota, with 16 known sites, and at one locality at Mount Boss, inland from Kempsey. Occurs on sandstone ridgetops often near the shale/sandstone boundary, in both open woodland and heathland, and appears to prefer open disturbed areas, such as tracksides.	0	1	Low. The subject land falls outside the species' known distribution and there is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Hygrocybe anomala</i> var. <i>ianthinomarginata</i>	V		Known from the type locality in Lane Cove Bushland Park with other records from the Royal National Park and the Blue Mountains National Park. Occurs in gallery warm temperate forests associated with alluvial sandy soils. Substrates include soil, humus, or moss.	0	1	Low. The only record in the locality is from Lane Cove Bushland Park. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Hygrocybe</i>	V		Known from the type locality in Lane	0	1	Low. The only record in the	Bionet

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
<i>aurantipes</i>			Cove Bushland Park with other records from the Blue Mountains National Park and Hazelbrook. Occurs in gallery warm temperate forests associated with alluvial sandy soils. Substrates include soil, humus, or moss.			locality is from Lane Cove Bushland Park. There is no suitable habitat for the species within the subject land.	(10km buffer)
<i>Hygrocybe austropratensis</i>	E		Known only from the type locality in Lane Cove Bushland Park. Occurs in gallery warm temperate forests associated with alluvial sandy soils. Substrates include soil, humus, or moss.	0	1	Low. The only record in the locality is from Lane Cove Bushland Park. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Hygrocybe collucera</i>	E		Known only from the type locality in Lane Cove Bushland Park. Occurs in gallery warm temperate forests associated with alluvial sandy soils. Substrates include soil, humus, or moss.	1	1	Low. The only record in the locality is from Lane Cove Bushland Park. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Hygrocybe griseoramosa</i>	E		Known only from the type locality in Lane Cove Bushland Park. Occurs in gallery warm temperate forests associated with alluvial sandy soils. Substrates include soil, humus, or moss.	1	1	Low. The only record in the locality is from Lane Cove Bushland Park. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Hygrocybe lanecovensensis</i>	E		Known only from the type locality in Lane Cove Bushland Park. Occurs in gallery warm temperate forests associated with alluvial sandy soils. Substrates include soil, humus, or moss.	0	1	Low. The only record in the locality is from Lane Cove Bushland Park. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Hygrocybe reesiaae</i>	V		Known from the type locality in Lane Cove Bushland Park with other records from the Blue Mountains National Park	1	2	Low. The only records in the locality are from Lane Cove Bushland Park. There is no	Bionet (10km buffer)

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			in Hazelbrook and Tasmania. Occurs in gallery warm temperate forests associated with alluvial sandy soils. Substrates include soil, humus, or moss.			suitable habitat for the species within the subject land.	
<i>Hygrocybe rubronivea</i>	V		Known from the type locality in Lane Cove Bushland Park with other records from the Blue Mountains and south east Queensland. Occurs in gallery warm temperate forests associated with alluvial sandy soils. Substrates include soil, humus, or moss.	0	1	Low. The only record in the locality is from Lane Cove Bushland Park. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Hypsela sessiliflora</i>		X	<i>Hypsela sessiliflora</i> has been determined to be a synonym of <i>Isotoma fluviatilis</i> subsp. <i>fluviatilis</i> , a widespread taxon not listed under the BC Act (OEH, 2019d). Although currently still listed as extinct under the EPBC Act, this species is on the current priority assessment list for review by the EPBC Act Threatened Species Scientific Committee and is likely to be removed from the Act. <i>Isotoma fluviatilis</i> subsp. <i>fluviatilis</i> grows in wet places around dams and creeks on coastal plains north and west of Sydney, sometimes becoming weedy in lawns (Royal Botanic Gardens and Domain Trust, 2019).	0	2	Low. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Lasiopetalum joyceae</i>	V	V	Has restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the	0	1	Low. Although the species has been recorded in the locality, there is no suitable habitat for the	Bionet (10km buffer)

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			Hawkesbury River; currently known from 34 sites between Berrilee and Duffys Forest. Grows in heath and open woodland in sandy soils on sandstone.			species within the subject land.	
<i>Leptospermum deanei</i>	V	V	Occurs in Hornsby, Warringah, Kuring-gai and Ryde local government areas in woodland on lower hills and slopes or near creeks, sandy alluvial soil or sand over sandstone. Occurs in riparian scrub and open forest.	0	2	Low. Although the species has been recorded in the locality, there is no suitable habitat for the species within the subject land.	Bionet (10km buffer), BAM calculator outputs, EPBC Protected Matters search
<i>Melaleuca biconvexa</i> (Biconvex Paperbark)	V	V	Occurs as scattered and dispersed populations found in Jervis Bay in the south and the Gosford/Wyong area in the north. Grows in damp places, often near streams, low-lying areas on alluvial soils of low slopes or sheltered aspects.	0	2	Low. Although the species has been recorded in the locality, there is no suitable habitat for the species within the subject land.	Bionet (10km buffer), BAM calculator outputs, EPBC Protected Matters search
<i>Melaleuca deanei</i> (Deane's Paperbark)	V	V	Occurs in two distinct areas, in the Kuring-gai/Berowra and Holsworthy/Wedderburn areas, with more isolated occurrences at Springwood, Wollemi National Park, Yalwal and Central Coast areas. The species occurs mostly in ridgetop woodland, with only five per cent of	1 (most recent record from 1886)	38	Low. Although the species has been recorded in the locality, there is no suitable habitat for the species within the subject land.	Bionet (1.5km buffer), EPBC Protected Matters search

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			sites in heath on sandstone.				
<i>Microtis angusii</i> (Angus's Onion Orchid)	E	E	Currently known from only one site at Ingleside, north of Sydney. It is not easy to define the preferred natural habitat of this orchid as the Ingleside location is highly disturbed. The dominant species occurring on the site are introduced weeds. The population occurs on modified soils that were originally those of the restricted ridgetop lateritic soils in the Duffys Forest/ Terrey Hills/Ingleside and Belrose areas.	0	1	Low. The subject land is outside the known distribution of the species. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Persoonia hirsuta</i> (Hairy Geebung)	E	E	The species has a scattered distribution around Sydney, from Singleton in the north to Bargo in the south and the Blue Mountains to the west. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone or very rarely on shale.	0	20	Low. Although the species has been recorded in the locality, there is no suitable habitat for the species within the subject land.	Bionet (10km buffer), EPBC Protected Matters search
<i>Persoonia mollis</i> <i>subsp. maxima</i>	E	E	Highly restricted, known from the Hornsby Heights/Mt Colah area north of Sydney. Occurs in sheltered aspects of deep gullies or on the steep upper hillsides of narrow gullies on Hawkesbury Sandstone.	0	0	Low. The subject land is outside the known distribution of the species. There is no suitable habitat for the species within the subject land.	EPBC Protected Matters search
<i>Pimelea curviflora</i> <i>var. curviflora</i>	V	V	Confined to the coastal area around the Sydney and Illawarra regions, with populations between northern Sydney and Maroota. Formerly recorded around the Parramatta River and Port	0	32	Low. Although the species has been recorded in the locality, there is no suitable habitat for the species within the subject land.	Bionet (10km buffer), EPBC Protected

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			Jackson region. Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.				Matters search
<i>Pimelea spicata</i> (Spiked Rice-flower)	E	E	Occurs in two disjunct areas: the Cumberland Plain and Illawarra, where it occurs on well-structured clay soils. On the Cumberland Plain, it is associated with Grey Box communities and in the coastal Illawarra it occurs commonly in Coast Banksia open woodland.	0	0	Low. The species has not been recorded within the locality. No suitable habitat was identified within the subject land.	EPBC Protected Matters search
<i>Pomaderris prunifolia</i>	EP	-	Known from only three sites in the Parramatta, Auburn, Strathfield and Bankstown local government areas. At one site it occurs along a road reserve near a creek, on sandstone, and at another it occurs on shale soils.	0	3	Low. The subject land is not within the defined extent of the endangered population, and there is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Prasophyllum fuscum</i> (Slaty Leek Orchid)	CE	V	Reported to be confined to the Blue Mountains area. Grows in moist heath, often along seepage lines; the known population grows in moist sandy soil over sandstone amongst sedges and grasses in a regularly slashed area.	0	1	Low. The species has not been recorded within the locality. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Prostanthera junonis</i> (Somersby Mintbush)	E	E	Has a north-south range of approximately 19 km on the Somersby Plateau in the Gosford and Wyong local government areas. Occurs on both the Somersby and Sydney Town soil landscapes on gently undulating country over weathered Hawkesbury sandstone within open forest/low	0	3	Low. The subject land is outside the species' known distribution; records of the species in the locality are likely to be <i>P. marifolia</i> . There is no suitable habitat for the species within the subject land.	Bionet (10km buffer), EPBC Protected Matters search

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			woodland/open scrub.				
<i>Prostanthera marifolia</i>	CE	CE	Currently only known from the northern Sydney suburb of Seaforth and has a very highly restricted distribution, fragmented by urbanisation into three small sites. Occurs in localised patches, in or in close proximity to the endangered Duffys Forest ecological community. Located on deeply weathered clay-loam soils associated with ironstone and scattered shale lenses.	1 (most recent record from 1905)	176	Low. The subject land is outside the species' current known distribution. There is no suitable habitat for the species within the subject land.	Bionet (1.5km buffer), EPBC Protected Matters search
<i>Pterostylis saxicola</i> (Sydney Plains Greenhood)	E	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines.	0	0	Low. The species has not been recorded within the locality. There is no suitable habitat for the species within the subject land.	EPBC Protected Matters search
<i>Rhodamnia rubescens</i>	CE		Occurs in coastal districts north from Batemans Bay in NSW to areas inland of Bundaberg in Queensland. Populations typically occur in coastal regions and occasionally extend inland onto escarpments. Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	1	7	Low. Although the species has been recorded in the locality, there is no suitable habitat for the species within the subject land.	Bionet (1.5km buffer)
<i>Sarcophilus hartmannii</i> (Hartman's Sarcophilus)	V	V	Distributed from the Richmond River in northern NSW to Gympie in south-east Queensland. Occurs on cliff faces on steep narrow ridges supporting	0	1	Low. One record dated from 1940 in the Sydney region. The subject land is outside the current known distribution of the species and	Bionet (10km buffer)

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			eucalypt forest and clefts in volcanic rock from 500 to 1000 m in altitude.			there is no suitable habitat for the species within the subject land.	
<i>Syzygium paniculatum</i> (Magenta Lilly Pilly)	E	V	Found in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. On the south coast the species occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast it occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	4	160	Recorded. Planted specimens recorded immediately next to the Warringah Freeway site. Not likely to occur naturally as the subject land does not represent suitable potential habitat.	Bionet (1.5km buffer), EPBC Protected Matters search
<i>Tetratheca glandulosa</i> (Glandular Pink-bell)	V	-	Restricted to the Baulkham Hills, Gosford, Hawkesbury, Hornsby, Kuring-gai, Pittwater, Ryde, Warringah, and Wyong local government areas. Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone. Occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam, and may include stony lateritic fragments. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest.	1 (most recent record from 1842)	66	Low. Although the species has been recorded in the locality, there is no suitable habitat for the species within the subject land.	Bionet (1.5km buffer)
<i>Tetratheca juncea</i> (Black-eyed Susan)	V	V	Confined to the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. Usually found in low open forest/woodland with a mixed	2	18	Low. Although the species has been recorded in the locality, there is no suitable habitat for the species within the subject land.	Bionet (1.5km buffer)

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			shrub understorey and grassy groundcover but has also been recorded in heathland and moist forest.				
<i>Thesium australe</i> (Austral Toadflax)	V	V	Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Grows on coastal headlands or grassland and grassy woodland away from the coast; often found in association with <i>Themeda triandra</i> (Kangaroo Grass).	1 (most recent record from 1803)	1	Low. The subject land is outside the species' current known distribution. There is no suitable habitat for the species within the subject land.	Bionet (1.5km buffer), EPBC Protected Matters search
<i>Triplarina imbricata</i> (Creek Triplarina)	E	E	Found only in a few locations in the ranges south-west of Glenreagh and near Tabulam in north-east NSW. The species was previously recorded in Parramatta, near Sydney, however, the species is no longer thought to occur in this area. Occurs along watercourses in low open forest with <i>Tristaniopsis laurina</i> (Water Gum) or in montane bogs.	0	1	Low. The species is no longer thought to occur within the Sydney area. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer), EPBC Protected Matters search
<i>Wahlenbergia multicaulis</i>	EP		There are 13 known sites, two of which are in northern Sydney (Thornleigh and Mt Ku-Ring-Gai) with the remainder in western Sydney (Rookwood, Chullora, Bass Hill, Bankstown, Georges Hall, Campsie, South Granville and Greenacre). Grows in a variety of habitats including forest, woodland, scrub, grassland and the edges of watercourses and wetlands. Typically occurs in damp,	0	20	Low. The subject land is outside the defined extent of the endangered population. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)

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Scientific Name (Common Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³
			disturbed sites (with natural or human disturbance of various forms), typically among other herbs rather than in the open.				
<i>Wilsonia backhousei</i> (Narrow-leafed Wilsonia)	V		Found on the coast between Mimosa Rocks National Park and Wamberal north of Sydney. Grows at the margins of salt marshes and lakes.	0	40	Low. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)
<i>Zannichellia palustris</i>	E		In NSW, known from the lower Hunter and in Sydney Olympic Park. Grows in fresh or slightly saline stationary or slowly flowing water. Flowers during warmer months. NSW populations behave as annuals, dying back completely every summer.	0	5	Low. There is no suitable habitat for the species within the subject land.	Bionet (10km buffer)

1. Listed on the BC Act as V= Vulnerable, E=Endangered species, CE= Critically Endangered, E4= presumed extinct
2. Listed on the EPBC Act as V= Vulnerable, Endangered, CE= Critically Endangered, X= Extinct
3. Data source: EPBC Search= database search using the Protected Matters Search Tool on the Department of the Environment web site, BioNet= search of the Office of Environment atlas database.

Threatened fauna species

All habitat requirements from OEH (2019d) unless otherwise specified.

Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
Amphibians								
Wallum Froglet (<i>Crinia tinnula</i>)	V		Wallum Froglets are found along the coastal margin from Litabella National Park in south-east Queensland to Kurnell in Sydney. Wallum Froglets are found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They typically occur in sedgeland and wet heathlands.	0	1	Low. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Species
Giant Burrowing Frog (<i>Heleioporus australiacus</i>)	V	V	Found on the sandstone geology of the Sydney Basin, and south to Jarvis Bay. There is a marked preference for sandstone ridgetop habitat. It occurs in semi-permanent to ephemeral sand or rock based streams, and infrequently in semi-permanent to permanent constructed dams with a sandy silt or clay base. (DoEE, 2019a).	0	3	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), BAM calculator outputs, EPBC Protected Matters search	Species
Green and Golden Bell Frog (<i>Litoria aurea</i>)	E	V	This species occurs in fragment patches near coastal locations from Vic to south of the NSW-QLD border. For breeding it uses a wide range of waterbodies, including both natural and man-made structures, such as	1 (most recent record from 1977)	10725	Low. The species was not identified during field surveys. The subject land does not support preferred	Bionet (1.5km buffer), EPBC Protected Matters	Species

Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
			marshes, dams, and stream sides, and ephemeral wetlands.			habitat for the species.	search	
Stuttering Frog (<i>Mixophyes balbus</i>)	E	V	Terrestrial species, found in rainforest, Antarctic beech forest or wet sclerophyll forest.	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	Species
Red-crowned Toadlet (<i>Pseudophryne australis</i>)	V		Confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings.	1	193	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer), BAM calculator outputs	Species
Birds								
Fork-tailed Swift (<i>Apus pacificus</i>)		M	In NSW, the Fork-tailed Swift is recorded in all regions. It is almost exclusively aerial. Occurs over a range of habitats, including inland plains, cliffs and beaches, settled areas (including towns, urban areas and cities), riparian woodland and tea-tree swamps, low scrub, heathland, saltmarsh, grassland and sandplains, rainforests, wet sclerophyll forest or open forest or plantations of pines (DoEE, 2019a).	5	11	Low. The species was not identified during field surveys. The species is almost entirely aerial, and therefore is unlikely to use terrestrial fauna habitat features occurring within the subject land, as the subject land does not support preferred	Bionet (1.5km buffer), EPBC Protected Matters search	-

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						habitat.		
Magpie Goose (<i>Anseranas semipalmata</i>)	V		Occurs in shallow wetlands such as large swamps and dams, especially with dense growth of rushes or sedges, and with permanent lagoons and grassland nearby.	0	10	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Regent Honeyeater (<i>Anthochaera phrygia</i>)	CE	CE	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills.	1 (most recent record from 1932)	11	Low. The species was not identified during field surveys. The subject land does not support preferred habitat (and does not support preferred feed trees) for the species.	Bionet (1.5km buffer), BAM calculator outputs, EPBC Protected Matters search	Species/ Ecosystem
Dusky Woodswallow (<i>Artamus cyanopterus</i>)	V		The Dusky Woodswallow occurs throughout most of New South Wales. Primarily inhabits dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest.	3 (most recent record from 1982)	34	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer)	Ecosystem

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Australasian Bittern (<i>Botaurus poiciloptilus</i>)	E	E	Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes.	0	12	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), EPBC Protected Matters search	Ecosystem
Bush Stone-curlew (<i>Burhinus grallarius</i>)	E		Found throughout most of Australia. Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.	2	9	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer)	Species
Glossy Black-Cockatoo (<i>Calyptorhynchus lathamii</i>)	V		Occurs in eucalypt woodland and forest with Casuarina/Allocasuarinas. Nests in tree hollows.	0	13	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), BAM calculator outputs	Species/ Ecosystem
Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>)	V		In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier, more open eucalypt forests and woodlands, particularly box-gum and box-ironbark	0	19	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), BAM calculator outputs	Species/ Ecosystem

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			assemblages, or in dry forest in coastal areas and often found in urban areas. Favours old growth forest and woodland attributes for nesting and roosting.					
Spotted Harrier (<i>Circus assimilis</i>)	V		Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	0	3	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Oriental Cuckoo (<i>Cuculus optatus</i>)		M	The Oriental Cuckoo in eastern New South Wales, eastern Queensland and Cape York Peninsula, and top end of Northern Territory. Habitat includes forest, woodland, riverside trees.	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	-
Varied Sittella (<i>Daphoenositta chrysoptera</i>)	V		The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gum with dead branches, mallee and Acacia woodland.	1	5	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer), BAM calculator outputs	Ecosystem
Eastern Bristlebird (<i>Dasyornis brachypterus</i>)	E	E	Confined to NW/Queensland border region, Illawarra region and NSW/Victorian border region. Habitat	0	0	Low. The species was not identified during field	EPBC Protected Matters	Species

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			for central and southern populations is characterised by dense, low vegetation including heath and open woodland with a heathy understorey.			surveys. The subject land does not support preferred habitat for the species.	search	
White-fronted Chat (<i>Epthianura albifrons</i>) and White-fronted Chat population in the Sydney Metropolitan Catchment Area	V, EP		In NSW, occurs in association with damp, open habitats below 1000 metres elevation along the coast (such as wetlands and saltmarsh), and in association with waterways in the west. Forages for insects on the ground. Nests in low vegetation elevated from the ground.	0	52	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem/Species
Red Goshawk (<i>Erythrotriorchis radiatus</i>)	CE	V	The species is very rare in NSW. In NSW, preferred habitats include mixed subtropical rainforest, <i>Melaleuca</i> swamp forest and riparian <i>Eucalyptus</i> forest of coastal rivers.	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Species
Beach Stone-curlew (<i>Esacus magnirostris</i>)	CE		Beach Stone-curlews are found exclusively along the coast, on a wide range of beaches, islands, reefs and in estuaries, and may often be seen at the edges of or near mangroves. They forage in the intertidal zone of beaches and estuaries, on islands, flats, banks and spits of sand, mud, gravel or rock, and among mangroves.	0	2	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offer marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer)	Species/ Ecosystem
<i>Eudyptula minor</i> Little Penguin in	EP		This endangered population occurs from just north of Smedley's Point to	0	14	High. There are a small	Bionet (10km	Species

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the Manly Point area (<i>Eudyptula minor</i>)			Cannae Point, North Sydney Harbour, Manly. Only known breeding population on the mainland in NSW. A range of nest sites are used by the penguins at Manly including under rocks on the foreshore, under seaside houses and structures, such as stairs, in wood piles and under overhanging vegetation including lantana and under coral tree roots.			number of records near the subject land, at the Spit and Sailors Bay (OEH, 2018a) The species was not identified during field surveys. Species occurs in Sydney Harbour and may forage within the subject land on occasion. The species nests at Manly and as such, the subject land does not support nesting habitat for the species.	buffer), BAM calculator outputs	
Black Falcon (<i>Falco subniger</i>)	V		The Black Falcon inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. The Black Falcon is usually associated with streams or wetlands, visiting them in search of prey and often using standing dead trees as lookout posts. In agricultural landscapes the Black Falcon tends to nest in healthy, riparian woodland remnants with a diverse avifauna.	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Little Lorikeet (<i>Glossopsitta pusilla</i>)	V		Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar	6	22	Low. The species was not identified during field	Bionet (1.5km buffer),	Ecosystem

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			and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria.			surveys. Nectivorous trees within the subject land offer marginal foraging habitat to the species. However, the subject land does not support preferred habitat for the species.	BAM calculator outputs	
Painted Honeyeater (<i>Grantiella picta</i>)	V	V	The species is nomadic and occurs at low densities throughout its range with the greatest concentrations being on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. Inhabits Boree/ Weeping Myall (<i>Acacia pendula</i>), Brigalow (<i>A. harpophylla</i>) and Box-Gum Woodlands and Box-Ironbark forests.	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	Ecosystem
White-bellied Sea Eagle (<i>Haliaeetus leucogaster</i>)	V		In NSW it is widespread along the east coast, and along all major inland rivers and waterways. Occurs in coastal areas such as bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh.	28	290	Known. This species was observed flying above Sydney Harbour near Balls Head Reserve, and above Goat Island. This species has been previously recorded in the subject land. The subject land is not known to support nesting habitat for the species; the closest known nesting site is at	Bionet (1.5km buffer), BAM calculator outputs	Species/ Ecosystem

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						Newington Nature Reserve, about 12 kilometres north-west of the subject land. The subject land offers foraging habitat to the species, due to the presence of preferred prey species that inhabit Sydney Harbour. It also offers potential perching habitat, due to the presence of trees that occur along the harbour foreshore at Balls Head, Birchgrove and Waverton.		
Little Eagle (<i>Hieraaetus morphnoides</i>)	V		The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used.	0	11	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), BAM calculator outputs	Species/ Ecosystem
White-throated Needletail (<i>Hirundapus caudacutus</i>)		M	In Australia the species is widespread in eastern and south-eastern Australia, from the islands in Torres Strait and the tip of Cape York south to Tasmania. It does not breed in Australia. Occurs in airspace over open forest, rainforest, heathland,	10	56	Low. The species was not identified during field surveys. The species is almost entirely aerial, and therefore is unlikely to	Bionet (1.5km buffer), EPBC Protected Matters search	-

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			farmlands, sandy beaches, mudflats and islands (DoEE, 2019a).			use terrestrial fauna habitat features occurring within the subject land, as the subject land does not support preferred habitat.		
Black Bittern (<i>Ixobrychus flavicollis</i>)	V		The Black Bittern has a wide distribution, from southern NSW north to Cape York and along the north coast to the Kimberley region. 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.	2	12	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offer marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer)	Ecosystem
Swift Parrot (<i>Lathamus discolor</i>)	E	CE	Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes. 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	2	33	Low. The species was not identified during field surveys. Nectivorous trees within the subject land offer marginal foraging habitat to the species. However, the subject land does not support preferred habitat for the species.	Bionet (1.5km buffer), BAM calculator outputs, EPBC Protected Matters search	Species/ Ecosystem

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			<i>Eucalyptus robusta</i> , Spotted Gum <i>Corymbia maculata</i> , Red Bloodwood <i>C. gummifera</i> , Forest Red Gum <i>E. tereticornis</i> , Mugga Ironbark <i>E. sideroxylon</i> , and White Box <i>E. albens</i> .					
Square-tailed Kite (<i>Lophoictinia isura</i>)	V		Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.	1	10	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer), BAM calculator outputs	Species/Ecosystem
Black-chinned Honeyeater (eastern subspecies) (<i>Melithreptus gularis gularis</i>)	V		Eastern subspecies occurs from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range. Inhabits forests or woodlands dominated by box and ironbark eucalypts where it forages for insects and nectar.	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Black-faced Monarch (<i>Monarcha melanopsis</i>)		M	The Black-faced Monarch mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	-

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			and (occasionally) cool temperate rainforest.					
Spectacled Monarch (<i>Monarcha trivirgatus</i>)		M	The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	-
Yellow Wagtail (<i>Motacilla flava</i>)		M	This species occupies a range of damp or wet habitats with low vegetation, from damp meadows, marshes, waterside pastures, sewage farms and bogs to damp steppe and grassy tundra. In the north of its range, it is also found in large forest clearings.	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	-
Satin Flycatcher (<i>Myiagra cyanoleuca</i>)		M	Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (DoEE, 2019a).	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	-
Orange-bellied Parrot (<i>Neophema chrysogaster</i>)	CE	CE	Orange-bellied Parrot breeds in the south-west of Tasmania and migrates in autumn to spend the winter on the mainland coast of south-eastern South Australia and southern Victoria. On the mainland, the Orange-bellied Parrot spends winter mostly within 3 km of the coast in sheltered coastal habitats including bays, lagoons,	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	Species

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			estuaries, coastal dunes and saltmarshes.					
Turquoise Parrot (<i>Neophema pulchella</i>)	V		In NSW, occurs from the coastal plains to the western slopes of the Great Diving Range. Found along the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Forages on the ground for seeds and grasses. Nests in a tree hollow, log or post.	0	4	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Cotton Pygmy-Goose (<i>Nettapus coromandelianus</i>)	E		Found on freshwater lakes, lagoons, swamps and dams, particularly those vegetated with waterlilies and other floating and submerged aquatic vegetation.	0	4	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Species
Barking Owl (<i>Ninox connivens</i>)	V		Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (eg western NSW) due to the higher density of prey on these fertile riparian soils. Roosts in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. Requires very large permanent territories in most habitats due to sparse prey densities.	2	15	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer)	Species/ Ecosystem

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Powerful Owl (<i>Ninox strenua</i>)	V		In NSW, the Powerful Owl is widely distributed throughout the eastern forests from the coast inland to tablelands. It inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest requiring large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old.	97	835	High. This species has been previously recorded in the subject land and surrounding locality. A small area of vegetation within the subject land, next to construction support site WHT7, offers potential foraging habitat to the Powerful Owl. The subject land does not support preferred nesting habitat, given the absence of hollow-bearing trees. The subject land does not support preferred roosting habitat.	Bionet (1.5km buffer), BAM calculator outputs	Species/ Ecosystem
Eastern Osprey (<i>Pandion cristatus</i>)	V	M	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. Feeds on fish over clear, open water. Breeds from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	0	12	Moderate. The Sydney Harbour estuary within the subject land offers potential foraging habitat to the species. The subject land is not known to support nesting habitat for the species.	Bionet (10km buffer), BAM calculator outputs, EPBC Protected Matters search	Species/ Ecosystem
Scarlet Robin	V		In NSW, it occurs from the coast to	0	5	Low.	Bionet	Ecosystem

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<i>(Petroica boodang)</i>			the inland slopes. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs.			The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	(10km buffer)	
Flame Robin <i>(Petroica phoenicea)</i>	V		In NSW, the species breeds in tall moist eucalypt forests and woodlands in upland areas. In winter, moves to dry forests, open woodlands and grasslands of the inland slopes and plains.	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species	Bionet (10km buffer)	Ecosystem
Glossy Ibis <i>(Plegadis falcinellus)</i>		M	The Glossy Ibis' preferred habitat for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation (DoEE, 2019a).	0	57	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species	Bionet (10km buffer)	-
Rose-crowned Fruit-Dove <i>(Ptilinopus regina)</i>	V		Rose-crowned Fruit-doves occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful.	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species	Bionet (10km buffer)	Ecosystem
Superb Fruit-Dove <i>(Ptilinopus superbus)</i>	V	V	The Superb Fruit-dove occurs principally from north-eastern in Queensland to north-eastern NSW. It inhabits rainforest and similar closed forests.	3	31	Low. The species was not identified during field surveys. The subject land does	Bionet (1.5km buffer)	Ecosystem

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						not support preferred habitat for the species		
Rufous Fantail (<i>Rhipidura rufifrons</i>)		M	In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts, usually with a dense shrubby understorey often including ferns. They also occur in subtropical and temperate rainforests (DoEE 2019a).	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species	EPBC Protected Matters search	-
Australia Painted Snipe (Painted Snipe) (<i>Rostratula australis</i>)	E	E	The Australian Painted Snipe is restricted to Australia. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	0	3	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species	Bionet (10km buffer), EPBC Protected Matters search	Ecosystem
Diamond Firetail (<i>Stagonopleura guttata</i>)	V		Widely distributed in NSW, the species is found in grassy eucalypt woodlands, open forest, mallee, Natural Temperate Grasslands, secondary derived grasslands, riparian area and occasionally in wooded farmland.	0	3	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Freckled Duck (<i>Stictonetta naevosa</i>)	V		Widely distributed in NSW, the species is found in grassy eucalypt woodlands, open forest, mallee, Natural Temperate Grasslands, secondary derived grasslands, riparian area and occasionally in wooded farmland.	0	2	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem

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Eastern Grass Owl (<i>Tyto longimembris</i>)	V		Widely distributed in NSW, the species is found in grassy eucalypt woodlands, open forest, mallee, Natural Temperate Grasslands, secondary derived grasslands, riparian area and occasionally in wooded farmland.	0	2	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), BAM calculator outputs	Ecosystem
Masked Owl (<i>Tyto novaehollandiae</i>)	V		Occurs from the eastern coast of NSW inland to the western plains. Found in eucalypt forests and woodlands from sea level to 1100 m. Hunts in and along the edges of forests, including roadsides for arboreal and terrestrial mammals. Roosts and nests in large tree hollows within moist eucalypt forested gullies.	0	4	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), BAM calculator outputs	Species/ Ecosystem
Sooty Owl (<i>Tyto tenebricosa</i>)	V		Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Nests in very large tree-hollows.	0	2	Low The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Species/ Ecosystem
Seabirds								
Common Noddy (<i>Anous stolidus</i>)		M	Seabird species have similar habitat requirements, occurring in pelagic oceanic habitats, and have therefore been assessed together.	0	2	Low These species were not identified during field surveys. The subject land does not support preferred habitat for these species. These pelagic	Bionet (10km buffer), EPBC Protected Matters search	-

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Flesh-footed Shearwater (<i>Ardenna carneipes</i>)	V			0	1	species unlikely to occur in marine and intertidal habitats offered by the Sydney Harbour estuary within the subject land.	Bionet (10km buffer), EPBC Protected Matters search	EEC/Marine
Sooty Shearwater (<i>Ardenna grisea</i>)		M		4	6		Bionet (1.5km buffer)	-
Wedge-tailed Shearwater (<i>Ardenna pacificus</i>)		M		1	17		Bionet (1.5km buffer)	-
Short-tailed Shearwater (<i>Ardenna tenuirostris</i>)		M		0	35		Bionet (10km buffer)	-
Streaked Shearwater (<i>Calonectris leucomelas</i>)		M		0	0		EPBC Protected Matters search	-
Antipodean Albatross (<i>Diomedea antipodensis</i>)	V	V		0	0		EPBC Protected Matters search	-
Gibson's Albatross (<i>Diomedea</i>)	V	V		0	0		EPBC Protected	-

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<i>antipodensis gibsoni</i>)							Matters search	
Grey-headed Albatross (<i>Diomedea chrysostoma</i>)		EM		0	1		Bionet (10km buffer)	-
Southern Royal Albatross (<i>Diomedea epomophora</i>)		VM		0	0		EPBC Protected Matters search	-
Wandering Albatross (<i>Diomedea exulans</i>)	E	E		1 (most recent record from 1985)	7		Bionet (1.5km buffer), EPBC Protected Matters search	EEC/ Marine
Northern Royal Albatross (<i>Diomedea sanfordi</i>)		E		0	0		EPBC Protected Matters search	-
Lesser Frigatebird (<i>Fregata ariel</i>)		M		0	0		EPBC Protected Matters search	-
Greater Frigatebird (<i>Fregata minor</i>)		M		0	0		EPBC Protected Matters	-

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							search	
White-bellied Storm-Petrel (<i>Fregetta grallaria</i>)	V	V		0	0		EPBC Protected Matters search	EEC/ Marine
Southern Giant- Petrel (<i>Macronectes giganteus</i>)	E	E		0	1		Bionet (10km buffer), EPBC Protected Matters search	EEC/ Marine
Northern Giant- Petrel (<i>Macronectes halli</i>)	V	V		0	0		EPBC Protected Matters search	EEC/ Marine
Fairy Prion (southern) (<i>Pachyptila turtur subantarctica</i>)		V		0	0		EPBC Protected Matters search	-
Sooty Albatross (<i>Phoebastria fusca</i>)	V	VM		0	1		Bionet (10km buffer), EPBC Protected Matters search	EEC/ Marine

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Gould's Petrel (<i>Pterodroma leucoptera leucoptera</i>)	V	E		1	1		Bionet (10km buffer), EPBC Protected Matters search	EEC/ Marine
Kermadec Petrel (western) (<i>Pterodroma neglecta neglecta</i>)	V	V		0	0		EPBC Protected Matters search	EEC/ Marine
Long-tailed Jaeger (<i>Stercorarius longicaudus</i>)		M		0	1		Bionet (10km buffer)	-
Arctic Jaeger (<i>Stercorarius parasiticus</i>)		M		0	5		Bionet (10km buffer)	-
Pomarine Jaeger (<i>Stercorarius pomarinus</i>)		M		1	2		Bionet (1.5km buffer)	-
Fairy Tern (Australian) (<i>Sternula nereis nereis</i>)		V		0	0		EPBC Protected Matters search	Species
Buller's Albatross (<i>Thalassarche</i>)		V, M		0	0		EPBC Protected	blank

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<i>bulleri</i>)							Matters search	
Shy Albatross (<i>Thalassarche cauta</i>)	V	V		0	2		Bionet (10km buffer), EPBC Protected Matters search	EEC/Marine
Tasmanian Shy Albatross (<i>Thalassarche cauta cauta</i>)	V	VM		0	0		EPBC Protected Matters search	-
White-capped Albatross (<i>Thalassarche cauta steadi</i>)		V		0	0		EPBC Protected Matters search	
Chatham Albatross (<i>Thalassarche eremita</i>)		E		0	0		EPBC Protected Matters search	-
Campbell Albatross (<i>Thalassarche impavida</i>)		V		0	0		EPBC Protected Matters search	-
Black-browed	V	V		0	3		Bionet	EEC/ Marine

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Albatross (<i>Thalassarche melanophris</i>)							(10km buffer), EPBC Protected Matters search	
Salvin's Albatross (<i>Thalassarche salvini</i>)		V		0	0		EPBC Protected Matters search	-
White-capped Albatross (<i>Thalassarche steadii</i>)		V		0	0		EPBC Protected Matters search	-
Terns								
White-winged Black Tern (<i>Chlidonias leucopterus</i>)		M	Terns have similar habitat requirements, sometimes occurring in estuaries and harbours and foraging on intertidal mudflats and sandflats, and have therefore been assessed together.	0	1	Low-moderate. These species were not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to some of these species, although many preferred habitat features are absent.	Bionet (10km buffer)	-
Gull-billed Tern (<i>Gelochelidon nilotica</i>)		M		0	15		Bionet (10km buffer)	-
Caspian Tern (<i>Hydroprogne caspia</i>)		M		2	34		Bionet (1.5km buffer)	-
Sooty Tern (<i>Onychoprion fuscata</i>)	V			0	3		Bionet (10km buffer)	Species

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Common Tern (<i>Sterna hirundo</i>)		M		3	51		Bionet (1.5km buffer)	-
Little Tern (<i>Sternula albifrons</i>)	E			1	56		Bionet (1.5km buffer), EPBC Protected Matters search	Species/ Ecosystem
Shorebirds and waders								
Common Sandpiper (<i>Actitis hypoleucos</i>)		M	Found along all coastlines of Australia and in many areas inland. Occurs in a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity. It is mostly encountered along muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties (DoEE, 2019a).	2	33	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer), EPBC Protected Matters search	-
Ruddy Turnstone (<i>Arenaria interpres</i>)		M	In Australasia, the Ruddy Turnstone is mainly found on coastal regions with exposed rock coast lines or coral reefs. It also lives near platforms and	0	10	Low. The species was not identified during field surveys.	Bionet (10km buffer), EPBC	-

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			shelves, often with shallow tidal pools and rocky, shingle or gravel beaches. Sometimes in estuaries, harbours, bays and coastal lagoons, among low saltmarsh or on exposed beds of seagrass, around sewage ponds and on mudflats (DoEE, 2019a).			Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Protected Matters search	
Sharp-tailed Sandpiper (<i>Calidris acuminata</i>)		M	In Australia, mostly found in the south-east. Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves (DoEE, 2019a).	35 (most recent record from 1983)	612	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer), EPBC Protected Matters search	-
Sanderling (<i>Calidris alba</i>)	V	M	A regular summer migrant from Siberia and other Arctic breeding grounds to most of the Australian coastline. Often found in coastal areas on low beaches of firm sand, near reefs and inlets, along tidal mudflats and bare open coastal lagoons; individuals are rarely recorded in near-coastal wetlands.	0	2	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer), EPBC Protected Matters search	Species/ Ecosystem
Red Knot (<i>Calidris</i>		E	In Australasia, they mainly inhabit	0	21	Low-moderate.	Bionet	Species/

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<i>canutus</i>)			intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. Sometimes seen in terrestrial saline wetlands near the coast. They rarely use inland lakes or swamps (DoEE, 2019a).			The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	(10km buffer), EPBC Protected Matters search	Ecosystem
Curlew Sandpiper (<i>Calidris ferruginea</i>)	E	CE	Occurs along the entire coast of NSW. In NSW is mainly found in intertidal mudflats of sheltered coasts, but also in non-tidal swamps, lakes and lagoons.	8 (most recent record from 1959)	488	Low-moderate. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer), EPBC Protected Matters search	Species/ Ecosystem
Pectoral Sandpiper (<i>Calidris melanotos</i>)		M	The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands in coastal or near coastal habitat but occasionally further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or	0	42	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many	Bionet (10km buffer), EPBC Protected Matters search	-

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			samphire (DoEE, 2019a).			preferred habitat features are absent.		
Red-necked Stint (<i>Calidris ruficollis</i>)		M	In Australasia, 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 (DoEE, 2019a).	0	166	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer), EPBC Protected Matters search	-
Long-toed Stint (<i>Calidris subminuta</i>)		M	In Australia, the Long-toed Stint occurs in a variety of terrestrial wetlands. They prefer shallow freshwater or brackish wetlands including lakes, swamps, river floodplains, streams, lagoons and sewage ponds. They are uncommon, but not unknown, at tidal estuaries, saline lakes, salt ponds and bore swamps (DoEE, 2019a).	0	0	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	EPBC Protected Matters search	-
Great Knot (<i>Calidris tenuirostris</i>)	V	CE	In NSW, the species has been recorded at scattered sites along the coast down to about Narooma. Found within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons,	0	7	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats	Bionet (10km buffer), EPBC Protected Matters search	Species/ Ecosystem

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			sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms.			offers marginal habitat to the species, although many preferred habitat features are absent.		
Double-banded Plover (<i>Charadrius bicinctus</i>)		M	The Double-banded Plover is found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers (DoEE, 2019a).	0	0	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	EPBC Protected Matters search	-
Greater Sand Plover (<i>Charadrius leschenaultii</i>)	V	V	Almost entirely restricted to coastal areas in NSW, occurring mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks.	0	4	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer), EPBC Protected Matters search	Species/ Ecosystem
Lesser Sand Plover (<i>Charadrius mongolus</i>)	V	E	Almost entirely coastal in NSW, favouring the beaches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats;	0	4	Low. The species was not identified during field surveys.	Bionet (10km buffer), EPBC	Species/ Ecosystem

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			occasionally occurs on sandy beaches, coral reefs and rock platforms.			Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Protected Matters search	
Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>)	E		Widespread in coastal and subcoastal northern and eastern Australia; in NSW, the species becomes increasingly uncommon south of the Northern Rivers region. Rarely occurs south of Sydney. Found in association with wetlands, swamps, billabongs, estuaries and surrounding vegetation.	0	1	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer)	Ecosystem
Oriental Plover (<i>Charadrius veredus</i>)		M	Immediately after arriving in non-breeding grounds in northern Australia, Oriental Plovers spend a few weeks in coastal habitats such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches or nearby reefs, or in near-coastal grasslands, before dispersing further inland (DoEE, 2019a)	1	2	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer), EPBC Protected Matters search	-
Latham's Snipe		M	In Australia, the range extends inland	0	232	Low.	Bionet	-

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(<i>Gallinago hardwickii</i>)			over the eastern tablelands in south-eastern Queensland and to west of the Great Dividing Range in NSW. Usually inhabit open, freshwater wetlands with low, dense vegetation. Can also inhabit areas with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity (DoEE, 2019a).			The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	(10km buffer), EPBC Protected Matters search	
Swinhoe's Snipe (<i>Gallinago megala</i>)		M	During the non-breeding season Swinhoe's Snipe occurs at the edges of wetlands, such as wet paddy fields, swamps and freshwater streams. The species is also known to occur in grasslands, drier cultivated areas (including crops of rapeseed and wheat) and market gardens (DoEE, 2019a).	0	0	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	EPBC Protected Matters search	-
Pin-tailed Snipe (<i>Gallinago stenura</i>)		M	During non-breeding period, the Pin-tailed Snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as claypans in more arid parts of species' range. It is also commonly seen at sewage	0	0	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many	EPBC Protected Matters search	-

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			ponds; not normally in saline or intertidal wetlands (DoEE, 2019a).			preferred habitat features are absent.		
Sooty Oystercatcher (<i>Haematopus fuliginosus</i>)	V		Sooty Oystercatchers are found around the entire Australian coast. Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries.	0	8	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer)	Species
Pied Oystercatcher (<i>Haematopus longirostris</i>)	E		In NSW the species is thinly scattered along the entire coast. Favours intertidal flats of inlets and bays, open beaches and sandbanks.	1	6	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer)	Species
Broad-billed Sandpiper (<i>Limicola falcinellus</i>)	V		The Broad Billed Sandpiper breeds in northern Siberia before migrating southwards in winter to Australia. During winter, the species inhabits sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons,	0	4	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats	Bionet (10km buffer) EPBC Protected Matters search	Species/ Ecosystem

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			saltmarshes and reefs as feeding and roosting habitat.			offers marginal habitat to the species, although many preferred habitat features are absent.		
Bar-tailed Godwit (<i>Limosa lapponica</i>)		M	The species has been recorded in the coastal areas of all Australian states. Found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays (DoEE, 2019a).	2	969	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer), EPBC Protected Matters search	-
Bar-tailed Godwit (<i>baueri</i>) (<i>Limosa lapponica baueri</i>)		V	The Bar-tailed Godwit (western Alaskan) occurs mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It has also been recorded in coastal sewage farms and saltworks, salt lakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats (DoEE, 2019a).	0	0	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	EPBC Protected Matters search	Species/ Ecosystem
Northern Siberian Bar-tailed Godwit (<i>Limosa lapponica menzbieri</i>)		CE	The Bar-tailed Godwit (northern Siberian) occurs mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries,	0	0	Low. The species was not identified during field surveys.	EPBC Protected Matters search	-

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			inlets, harbours, coastal lagoons and bays. It has also been recorded in coastal sewage farms and saltworks, salt lakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats (DoEE, 2019a).			Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.		
Black-tailed Godwit (<i>Limosa limosa</i>)	V		Breeds in Mongolia and Eastern Siberia (Palearctic). In NSW, it is most frequently recorded at Kooragang Island, with occasional records elsewhere along the north and south coast, and inland. Primarily a coastal species. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Roosts and loafs on low banks of mud, sand and shell bars.	0	19	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer), EPBC Protected Matters search	Species/ Ecosystem
Eastern Curlew (<i>Numenius madagascariensis</i>)		CE	Within Australia, the Eastern Curlew has a primarily coastal distribution. In NSW is mainly found in intertidal mudflats and sometimes saltmarsh of sheltered coasts. Occasionally, found on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets.	0	10	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer), EPBC Protected Matters search	Species/ Ecosystem
Little Curlew		M	In NSW most records are scattered	1	5	Low.	Bionet	-

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Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
<i>(Numenius minutus)</i>			east of the Great Dividing Range, from Casino, south to Greenwell Point with a few scattered records west of the Great Dividing Range. Most often found in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated (DoEE 2019a).			The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	(1.5km buffer), EPBC Protected Matters search	
Whimbrel <i>(Numenius phaeopus)</i>		M	Primarily has a coastal distribution. Often found on the intertidal mudflats of sheltered coasts. It is also found in harbours, lagoons, estuaries and river deltas, often those with mangroves, but also open, unvegetated mudflats. It is occasionally found on sandy or rocky beaches, on coral or rocky islets, or on intertidal reefs and platforms (DoEE, 2019a).	0	3	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer), EPBC Protected Matters search	-
Ruff (Reeve) <i>(Philomachus pugnax)</i>		M	In Australia the Ruff is found on generally fresh, brackish or saline wetlands with exposed mudflats at the edges. It is found in terrestrial wetlands including lakes, swamps, pools, lagoons, tidal rivers, swampy fields and floodlands. They are occasionally seen on sheltered coasts, in harbours, estuaries, seashores and are known to visit sewage farms and saltworks (DoEE,	0	3	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat	Bionet (10km buffer), EPBC Protected Matters search	-

Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
			2019a).			features are absent.		
Pacific Golden Plover (<i>Pluvialis fulva</i>)		M	In non-breeding grounds in Australia this species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. Usually found on beaches, mudflats and sandflats (sometimes in vegetation such as mangroves, low saltmarsh such as <i>Sarcocornia</i> , or beds of seagrass) in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in saltworks. (DoEE, 2019a).	2 (most recent record from 1986)	317	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer), EPBC Protected Matters search	-
Grey Plover (<i>Pluvialis squatarola</i>)		M	In non-breeding grounds in Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, reefs within muddy lagoons, around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes. (DoEE, 2019a).	1	11	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (1.5km buffer), EPBC Protected Matters search	-
Grey-tailed Tattler (<i>Tringa brevipes</i>)		M	Grey-tailed Tattlers breed in Siberia. In Australia, more commonly found in the north. Usually seen in small flocks on sheltered coasts with reefs and rock platforms or with intertidal mudflats. They are also found in intertidal rocky, coral or stony reefs, platforms and islets that are exposed	0	4	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat	Bionet (10km buffer), EPBC Protected Matters search	-

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			at high tide, also shores of rock, shingle, gravel and shells and on intertidal mudflats in embayments, estuaries and coastal lagoons, especially those fringed with mangroves. (DoEE, 2019a).			to the species, although many preferred habitat features are absent.		
Wood Sandpiper (<i>Tringa glareola</i>)		M	In NSW there are records east of the Great Divide, from Stratheden and Casino, south to Nowra and elsewhere, mostly from the Riverina, but also from the Upper and Lower Western Regions. Usually found in well-vegetated, shallow, freshwater wetlands such as swamps, billabongs, lakes, pools and waterholes. (DoEE, 2019a).	0	5	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	-
Wandering Tattler (<i>Tringa incana</i>)		M	The Wandering Tattler is generally found on rocky coasts with reefs and platforms, points, spits, piers, offshore islands and shingle beaches or beds. It is occasionally seen on coral reefs or beaches and tends to avoid mudflats. (DoEE, 2019a).	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), EPBC Protected Matters search	-
Common Greenshank (<i>Tringa nebularia</i>)		M	The species has been recorded in most coastal regions. It is widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions. It occurs in sheltered coastal	0	33	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat	Bionet (10km buffer), EPBC Protected Matters search	-

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Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
			habitats, typically with large mudflats and saltmarsh, mangroves or seagrass and a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. (DoEE, 2019a).			to the species, although many preferred habitat features are absent.		
Marsh Sandpiper (<i>Tringa stagnatilis</i>)		M	The Marsh Sandpiper lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. (DoEE, 2019a).	0	29	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer), EPBC Protected Matters search	-
Terek Sandpiper (<i>Xenus cinereus</i>)	V		A rare migrant to the eastern and southern Australian coasts. The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary. Recorded on coastal mudflats, lagoons, creeks and estuaries.	0	5	Low. The species was not identified during field surveys. Small areas of highly modified intertidal mudflats and sandflats offers marginal habitat to the species, although many preferred habitat features are absent.	Bionet (10km buffer), EPBC Protected Matters search	Species/ Ecosystem
Mammals								
Rufous Bettong (<i>Aepyprymnus</i>)	V		In NSW it has largely vanished from inland areas but there are sporadic,	0	1	Low. The species was not	Bionet (10km	Species

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<i>rufescens</i>)			unconfirmed records from the Pilliga and Torrington districts. Inhabits a variety of forests from tall, moist eucalypt forest to open woodland, with a tussock grass understorey.			identified during field surveys. The subject land does not support preferred habitat for the species.	buffer)	
Eastern Pygmy-possum (<i>Cercartetus nanus</i>)	V		Found in a broad range of habitats from rainforest through to sclerophyll 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. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum dreys or thickets of vegetation. Frequently spends time in torpor especially in winter.	2 (most recent record from 1863)	367	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer), BAM calculator outputs	Species
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	V	V	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, mud nests of the Fairy Martin (<i>Petrochelidon ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features.	0	5	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), BAM calculator outputs, EPBC Protected Matters search	Species

Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
Spotted-Tailed Quoll (<i>Dasyurus maculatus</i>)	V	E	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites.	1 (most recent record from 1863)	13	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer), BAM calculator outputs, EPBC Protected Matters search	Ecosystem
Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>)	V		Occurs along the east coast of NSW, where it inhabits tall moist forests. Roosts in hollows of eucalypts, occasionally under loose bark on trees or in buildings.	0	8	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Southern Brown Bandicoot (eastern) (<i>Isoodon obesulus obesulus</i>)	E	E	The Southern Brown Bandicoot is generally only found in heath or open forest with a heathy understorey on sandy or friable soils. Nest during the day in a shallow depression in the ground covered by leaf litter, grass or other plant material. Nests may be located under grass trees <i>Xanthorrhoea</i> spp., blackberry bushes and other shrubs, or in rabbit burrows.	0	95	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), EPBC Protected Matters search	Species
Little Bentwing-bat (<i>Miniopterus australis</i>)	V		The Little Bentwing-bat is found in moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal	1	23	High. This species has been previously recorded in the subject land.	Bionet (1.5km buffer), BAM	Species/ Ecosystem

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			forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings. Maternity colonies form in spring and birthing occurs in early summer. Only five nursery sites /maternity colonies are known in Australia.			The subject land supports potential roosting habitat for the species, due to the presence of stormwater drains, culverts and buildings, such as those located at Berrys Bay. The subject land supports limited foraging habitat due to the absence of forested areas. However, the species may forage in well-vegetated areas such as Balls Head Reserve, near the subject land.	calculator outputs	
Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>)	V		The Eastern Bentwing-bat forages in forested areas. Caves are the primary roosting habitat, but they also use derelict mines, storm-water tunnels, buildings and other man-made structures. They form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Populations disperse within about 300 km range of maternity caves.	56	254	High. This species is known to roost in one of four Coal Loader tunnels at Waverton (during autumns and winter), within the subject land. The subject land supports limited foraging habitat due to the absence of forested areas. However, the species may forage in well-	Bionet (1.5km buffer), BAM calculator outputs	Species/ Ecosystem

Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
						vegetated areas such as Balls Head Reserve, near the subject land.		
Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>)	V		The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in man-made structures.	10	27	High. This species has been previously recorded in the subject land. The subject land supports potential roosting habitat for the species, due to the presence of buildings, such as those located at Berrys Bay. The subject land supports limited foraging habitat due to the absence of forested areas. However, the species may forage in well-vegetated areas such as Balls Head Reserve, near the subject land.	Bionet (1.5km buffer), BAM calculator outputs	Ecosystem
Southern Myotis (<i>Myotis macropus</i>)	V		Southern Myotis generally roost in groups of 10-15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage. They forage over streams and pools catching insects and small fish by raking their feet across the water	5	503	High. This species has been previously recorded in the subject land. This species is known to roost in a wharf structure in West Harbour. The Sydney	Bionet (1.5km buffer), BAM calculator outputs	Species

Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
			surface.			Harbour estuary within the subject land, particularly sheltered bays, offers foraging habitat to the species.		
Long-nosed Bandicoot, North Head (<i>Perameles nasuta</i>)	EP		The endangered population occurs in the local government areas of Marrickville and Canada Bay, with the likelihood that it also includes Canterbury, Ashfield and Leichhardt local government areas. The species shelters mostly under older houses and buildings and forages in parkland and backyards.	0	2138	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), BAM calculator outputs	Species
Greater Glider (<i>Petauroides volans</i>)		V	The Greater Glider has restricted distribution in eastern Australia, from the Windsor Tableland in north Queensland to central Victoria, with an elevated range from sea level to 1200 metres above sea level. The species is largely restricted to eucalypt forests and woodlands. It is found in abundance in montane eucalypt forest with relatively old trees and an abundance of hollows and with a diversity of eucalypts (DoEE, 2019a).	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), EPBC Protected Matters search	Species
Yellow-bellied Glider (<i>Petaurus australis</i>)	V		The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Occurs in tall mature eucalypt forest generally in areas with	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred	Bionet (10km buffer)	Ecosystem

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			high rainfall and nutrient rich soils.			habitat for the species.		
Squirrel Glider (<i>Petaurus norfolcensis</i>)	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 with a shrub or Acacia mid-storey. Requires abundant tree hollows for refuge and nest sites.	0	1	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Species
Brush-tailed Rock-wallaby (<i>Petrogale penicillata</i>)	E	V	In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit. Occupys rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north.	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	Species
Koala (<i>Phascolarctos cinereus</i>)	V	V	In NSW, koala populations are found on the central and north coasts, southern highlands, southern and northern tablelands, Blue Mountains, southern coastal forests, with some smaller populations on the plains west of the Great Dividing Range. Inhabit eucalypt woodlands and forests.	1	12	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (1.5km buffer), BAM calculator outputs, EPBC Protected Matters search	Species/ Ecosystem
Long-nosed Potoroo (SE)	V	V	In NSW it is generally restricted to coastal heaths and forests east of the	0	0	Low. The species was not		Ecosystem

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mainland) (<i>Potorous tridactylus tridactylus</i>)			Great Dividing Range, with an annual rainfall exceeding 760 mm. Inhabits coastal heaths and dry and wet sclerophyll forests with a dense understorey.			identified during field surveys. The subject land does not support preferred habitat for the species.		
New Holland Mouse (<i>Pseudomys novaehollandiae</i>)		V	Distribution is patchy in time and space. Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes.	0	5	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer), EPBC Protected Matters search	Ecosystem
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	V	V	Occurs in subtropical and temperate rainforests, tall sclerophyll forest and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	352	3875	Known. This species was observed flying over Berrys Bay during the survey carried out in February 2018. This species was also recorded by WSP flying over a number of locations within the subject land, during surveys carried out in 2017. The subject land does not support a camp, and therefore does not support critical roosting habitat for the species. The subject land provides foraging	Bionet (1.5km buffer), BAM calculator outputs, EPBC Protected Matters search	Species/ Ecosystem

Common Name (Scientific Name)	BC Act ¹	EPBC Act ²	Habitat requirements	No. of records within 1.5km of subject land	No. of records within 10km of subject land	Likelihood of occurrence	Source ³	Ecosystem or species credit species?
						habitat for the Grey-headed Flying-fox, given the presence of preferred blossom and fruit tree species that occur within parks, road verges and private land (eg residential gardens)		
Yellow-bellied Sheathtail-bat (<i>Saccolaimus flaviventris</i>)	V		Occurs throughout tropical and south-east of Australia, excluding Tasmania. Found in a variety of habitat types including wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grassland and desert. Forages for insects above the tree canopy. Roosts in tree hollows, abandoned sugar glider nests or animal burrows.	0	12	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>)	V		In NSW it is widespread on the New England Tablelands. 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.	0	3	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	Bionet (10km buffer)	Ecosystem
Invertebrates								
Giant Dragonfly (<i>Petalura gigantea</i>)	E		Found along the east coast of NSW from the Victorian border to northern NSW. It is not found west of the Great Dividing Range. There are known occurrences in the Blue Mountains and Southern Highlands, in the	1	1	Low. The species was not identified during field surveys. The subject land does not support preferred	Bionet (1.5km buffer)	Species/ Ecosystem

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			Clarence River catchment, and on a few coastal swamps from north of Coffs Harbour to Nadgee in the south. Inhabits permanent swamps and bogs with some free water and open vegetation.			habitat for the species.		
Dural Land Snail (<i>Pommerhelix duralensis</i>)	E	E	The species is a shale-influenced-habitat specialist, which occurs in low densities along the western and northwest fringes of the Cumberland IBRA subregion on shale-sandstone transitional landscapes. The species has a strong affinity for communities in the interface region between shale-derived and sandstone-derived soils, with forested habitats that have good native cover and woody debris. It favours sheltering under rocks or inside curled-up bark.	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	EPBC Protected Matters search	Species
Reptiles								
Broad-headed Snake (<i>Hoplocephalus bungaroides</i>)	E	V	The Broad-headed Snake is largely confined to Triassic and Permian sandstones. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring.	0	0	Low. The species was not identified during field surveys. The subject land does not support preferred habitat for the species.	BAM calculator outputs, EPBC Protected Matters search	Species/ Ecosystem
Rosenberg's Goanna (<i>Varanus rosenbergi</i>)	V		Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. It shelters in	0	42	Low. The species was not identified during field surveys. The subject land does	Bionet (10km buffer), BAM calculator	Ecosystem

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			burrows, hollow logs and rock crevices.			not support preferred habitat for the species.	outputs	

1. Listed on the BC Act as V= Vulnerable, E=Endangered species, CE= Critically Endangered, E4= presumed extinct
2. Listed on the EPBC Act as M= Migratory, VM= Vulnerable and Migratory, EM= Endangered and Migratory, V= Vulnerable, Endangered, CE= Critically Endangered, X= Extinct
3. Data source: EPBC Search= database search using the Protected Matters Search Tool on the Department of the Environment web site, BioNet= search of the Office of Environment atlas database.

Appendix B – EPBC Protected Matters Search Tool Results



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 20/03/19 15:30:46

[Summary](#)

[Details](#)

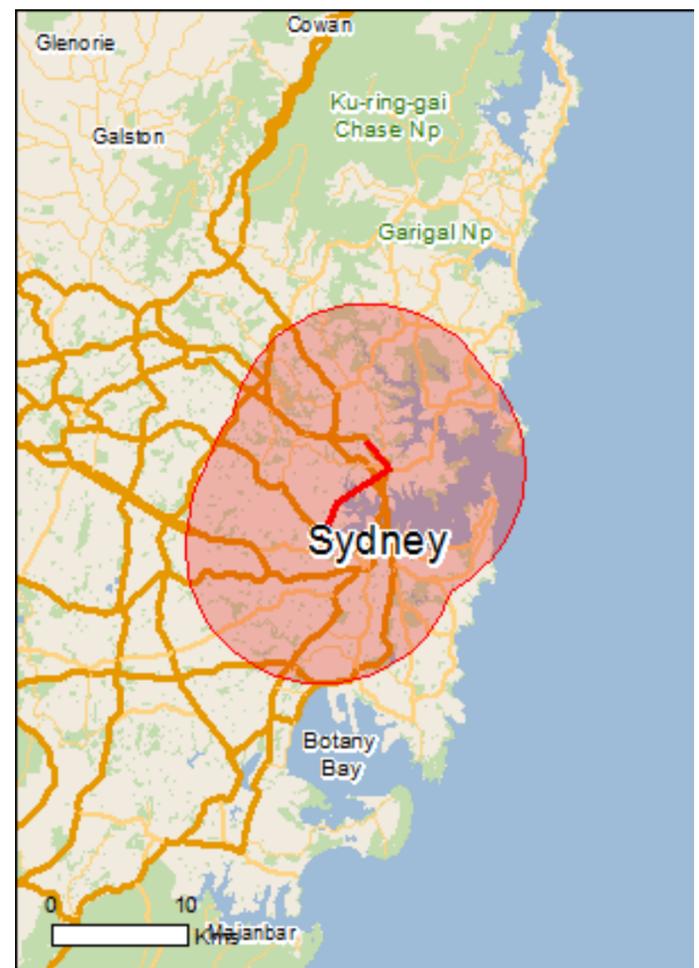
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

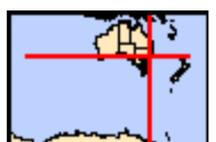
[Acknowledgements](#)



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	6
National Heritage Places:	10
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	12
Listed Threatened Species:	91
Listed Migratory Species:	79

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	61
Commonwealth Heritage Places:	74
Listed Marine Species:	103
Whales and Other Cetaceans:	14
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	9
Regional Forest Agreements:	None
Invasive Species:	49
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

World Heritage Properties [\[Resource Information \]](#)

Name	State	Status
Australian Convict Sites (Cockatoo Island Convict Site Buffer Zone)	NSW	Buffer zone
Australian Convict Sites (Hyde Park Barracks Buffer Zone)	NSW	Buffer zone
Sydney Opera House - Buffer Zone	NSW	Buffer zone
Australian Convict Sites (Cockatoo Island Convict Site)	NSW	Declared property
Australian Convict Sites (Hyde Park Barracks)	NSW	Declared property
Sydney Opera House	NSW	Declared property

National Heritage Properties [\[Resource Information \]](#)

Name	State	Status
Indigenous		
Cyprus Hellene Club - Australian Hall	NSW	Listed place
Historic		
Bondi Beach	NSW	Listed place
Centennial Park	NSW	Listed place
Cockatoo Island	NSW	Listed place
First Government House Site	NSW	Listed place
Hyde Park Barracks	NSW	Listed place
North Head - Sydney	NSW	Listed place
Sydney Harbour Bridge	NSW	Listed place
Sydney Opera House	NSW	Listed place
Bondi Surf Pavilion	NSW	Within listed place

Wetlands of International Importance (Ramsar) [\[Resource Information \]](#)

Name	Proximity
Towra point nature reserve	Within 10km of Ramsar

Listed Threatened Ecological Communities [\[Resource Information \]](#)

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Blue Gum High Forest of the Sydney Basin Bioregion	Critically Endangered	Community likely to occur within area
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	Endangered	Community may occur within area
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Coastal Upland Swamps in the Sydney Basin Bioregion	Endangered	Community likely to occur within area
Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered	Community may occur within area
Eastern Suburbs Banksia Scrub of the Sydney Region	Endangered	Community known to occur within area
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
Posidonia australis seagrass meadows of the Manning-Hawkesbury ecoregion	Endangered	Community likely to occur within area
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Turpentine-Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered	Community likely to occur within area
Western Sydney Dry Rainforest and Moist	Critically Endangered	Community likely to

Name	Status	Type of Presence
Woodland on Shale		occur within area
Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or

Name	Status	Type of Presence related behaviour likely to occur within area
Fish		
Epinephelus daemeli Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Heleioporus australiacus Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat known to occur within area
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
Mixophyes balbus Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Other		

Name	Status	Type of Presence
Pommerhelix duralensis Dural Land Snail [85268]	Endangered	Species or species habitat likely to occur within area
Plants		
Acacia bynoeana Bynoe's Wattle, Tiny Wattle [8575]	Vulnerable	Species or species habitat may occur within area
Acacia pubescens Downy Wattle, Hairy Stemmed Wattle [18800]	Vulnerable	Species or species habitat known to occur within area
Acacia terminalis subsp. terminalis MS Sunshine Wattle (Sydney region) [88882]	Endangered	Species or species habitat known to occur within area
Allocasuarina glareicola [21932]	Endangered	Species or species habitat may occur within area
Allocasuarina portuensis Nielsen Park She-oak [21937]	Endangered	Species or species habitat known to occur within area
Asterolasia elegans [56780]	Endangered	Species or species habitat may occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat known to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Darwinia biflora [14619]	Vulnerable	Species or species habitat likely to occur within area
Deyeuxia appressa [7438]	Endangered	Species or species habitat likely to occur within area
Eucalyptus camfieldii Camfield's Stringybark [15460]	Vulnerable	Species or species habitat likely to occur within area
Genoplesium baueri Yellow Gnat-orchid [7528]	Endangered	Species or species habitat known to occur within area
Grevillea caleyi Caley's Grevillea [9683]	Critically Endangered	Species or species habitat known to occur within area
Haloragodendron lucasii Hal [6480]	Endangered	Species or species habitat likely to occur within area
Leptospermum deanei Deane's Tea-tree [21777]	Vulnerable	Species or species habitat likely to occur within area
Melaleuca biconvexa Biconvex Paperbark [5583]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Melaleuca deanei Deane's Melaleuca [5818]	Vulnerable	Species or species habitat likely to occur within area
Persoonia hirsuta Hairy Geebung, Hairy Persoonia [19006]	Endangered	Species or species habitat known to occur within area
Persoonia mollis subsp. maxima [56075]	Endangered	Species or species habitat may occur within area
Pimelea curviflora var. curviflora [4182]	Vulnerable	Species or species habitat known to occur within area
Pimelea spicata Spiked Rice-flower [20834]	Endangered	Species or species habitat may occur within area
Prostanthera junonis Somersby Mintbush [64960]	Endangered	Species or species habitat known to occur within area
Prostanthera marifolia Seaforth Mintbush [7555]	Critically Endangered	Species or species habitat known to occur within area
Pterostylis saxicola Sydney Plains Greenhood [64537]	Endangered	Species or species habitat may occur within area
Syzygium paniculatum Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat known to occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area
Triplarina imbricata [64543]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hoplocephalus bungaroides Broad-headed Snake [1182]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sternula albifrons Little Tern [82849]		Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Foraging, feeding or related behaviour known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Foraging, feeding or related behaviour known to occur within area
Calidris alba Sanderling [875]		Foraging, feeding or related behaviour known

Name	Threatened	Type of Presence
Calidris canutus Red Knot, Knot [855]	Endangered	to occur within area Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Foraging, feeding or related behaviour known to occur within area
Calidris subminuta Long-toed Stint [861]		Foraging, feeding or related behaviour known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Foraging, feeding or related behaviour known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Foraging, feeding or related behaviour known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Foraging, feeding or related behaviour likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Foraging, feeding or related behaviour likely to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Foraging, feeding or related behaviour known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Foraging, feeding or related behaviour known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Numenius phaeopus Whimbrel [849]		Foraging, feeding or related behaviour known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Foraging, feeding or related behaviour known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Foraging, feeding or related behaviour known to occur within area
Pluvialis squatarola Grey Plover [865]		Foraging, feeding or related behaviour known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Foraging, feeding or related behaviour known to occur within area
Tringa incana Wandering Tattler [831]		Foraging, feeding or related behaviour known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Foraging, feeding or related behaviour known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [\[Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Airservices Australia
Commonwealth Land - Australia Post
Commonwealth Land - Australian & Overseas Telecommunications Corporation
Commonwealth Land - Australian Broadcasting Commission
Commonwealth Land - Australian Broadcasting Corporation
Commonwealth Land - Australian National University
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Australian Telecommunications Corporation
Commonwealth Land - Commonwealth Bank of Australia
Commonwealth Land - Commonwealth Scientific & Industrial Research Organisation
Commonwealth Land - Commonwealth Trading Bank of Australia
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Director of Defence Service Homes
Commonwealth Land - Director of War Service Homes
Commonwealth Land - Reserve Bank of Australia
Commonwealth Land - Telstra Corporation Limited
Defence - 21 CONST REGT - HABERFIELD DEPOT

Name
Defence - COCKATOO ISLAND DOCKYARD
Defence - CONCORD OFFICE ACCN
Defence - DEFENCE PLAZA SYDNEY
Defence - DEGAUSSING RANGE
Defence - DSTO PYRMONT - (SEE SITE 1177)
Defence - FLEET BASE WHARVES
Defence - FOREST LODGE (SYDNEY) TRG DEP
Defence - GARDEN ISLAND
Defence - GLADESVILLE TRAINING DEPOT
Defence - HMAS KUTTABUL (AC 30/5 Lot4 DP218946)
Defence - HMAS PENGUIN
Defence - HMAS PLATYPUS - SPDU FOR DISPOSAL
Defence - HMAS WATERHEN
Defence - HMAS WATSON
Defence - JENNER BUILDING
Defence - KENSINGTON DEPOT
Defence - KISMET/HMAS KUTTABUL-POTTS PT
Defence - LADY GOWRIE HOUSE
Defence - LEICHHARDT STORES DEPOT
Defence - MARITIME COMD CTRE-POTTS POINT ; BOMERAH/TARANA
Defence - MARITIME HEADQUARTERS
Defence - MATERIAL RESEARCH LAB
Defence - MILLER'S POINT TRAINING DEPOT
Defence - NFI CHOWDER BAY (fuel depot)
Defence - NORTH SYDNEY - HYDRO OFFICE
Defence - OXFORD ST SYDNEY
Defence - PARKVIEW BUILDING - SYDNEY
Defence - PYMBLE MULTI-USER DEPOT
Defence - RANDWICK (CARRINGTON RD)
Defence - RANDWICK BARRACKS
Defence - RANDWICK FRENCHMANS TRG
Defence - SPECTACLE ISLAND
Defence - SYDNEY UNIVERSITY REGIMENT - DARLINGTON
Defence - TRAINING SHIP CONDAMINE
Defence - TRESKO
Defence - VAUCLUSE TRAINING DEPOT
Defence - VICTORIA BARRACKS - PADDINGTON
Defence - WILLOUGHBY TRG DEP
Defence - WOOLLOOMOOLOO CARPARK
Defence - ZETLAND NAVY SUPPLY CENTRE

Commonwealth Heritage Places **[Resource Information]**

Name	State	Status
Historic		
Admiralty House Garden and Fortifications	NSW	Listed place
Admiralty House and Lodge	NSW	Listed place
Army Cottage with return verandah	NSW	Listed place
Barracks Block	NSW	Listed place
Barracks Group HMAS Watson	NSW	Listed place
Batteries A83 and C9A	NSW	Listed place
Battery B42	NSW	Listed place
Battery for Five Guns	NSW	Listed place
Biloela Group	NSW	Listed place
Bondi Beach Post Office	NSW	Listed place
Botany Post Office	NSW	Listed place
Building VB1 and Parade Ground	NSW	Listed place
Building VB2 Guard House	NSW	Listed place
Buildings 31 and 32	NSW	Listed place
Buildings MQVB16 and VB56	NSW	Listed place
Buildings VB13, 15, 16 & 17	NSW	Listed place
Buildings VB41, 45 & 53	NSW	Listed place
Buildings VB60 and VB62	NSW	Listed place
Buildings VB69, 75 & 76 including Garden	NSW	Listed place
Buildings VB83, 84, 85, 87 & 89	NSW	Listed place
Buildings VB90, 91, 91A & 92	NSW	Listed place
Chain and Anchor Store (former)	NSW	Listed place

Name	State	Status
Chowder Bay Barracks Group	NSW	Listed place
Cliff House	NSW	Listed place
Cockatoo Island Industrial Conservation Area	NSW	Listed place
Commonwealth Avenue Defence Housing	NSW	Listed place
Cottage at Macquarie Lighthouse	NSW	Listed place
Customs Marine Centre	NSW	Listed place
Defence site - Georges Heights and Middle Head	NSW	Listed place
Factory	NSW	Listed place
Fitzroy Dock	NSW	Listed place
Garden Island Precinct	NSW	Listed place
Gazebo	NSW	Listed place
General Post Office	NSW	Listed place
Golf Clubhouse (former)	NSW	Listed place
HMAS Penguin	NSW	Listed place
Headquarters 8th Brigade Precinct	NSW	Listed place
Headquarters Training Command Precinct	NSW	Listed place
Kirribilli House	NSW	Listed place
Kirribilli House Garden & Grounds	NSW	Listed place
Macquarie Lighthouse	NSW	Listed place
Macquarie Lighthouse Group	NSW	Listed place
Macquarie Lighthouse Surrounding Wall	NSW	Listed place
Marine Biological Station (former)	NSW	Listed place
Marrickville Post Office	NSW	Listed place
Mess Hall (former)	NSW	Listed place
Military Guard Room	NSW	Listed place
Military Road Framework - Defence Land	NSW	Listed place
Naval Store	NSW	Listed place
Navy Refuelling Depot and Caretakers House	NSW	Listed place
North Head Artillery Barracks	NSW	Listed place
North Sydney Post Office	NSW	Listed place
Office Building	NSW	Listed place
Officers Mess, HQ Training Command	NSW	Listed place
Paddington Post Office	NSW	Listed place
Power House / Pump House	NSW	Listed place
Prison Barracks Precinct	NSW	Listed place
Pyrmont Post Office	NSW	Listed place
Reserve Bank	NSW	Listed place
Residences Group	NSW	Listed place
Rigging Shed and Chapel	NSW	Listed place
Shark Point Battery	NSW	Listed place
Snapper Island	NSW	Listed place
Spectacle Island Explosives Complex	NSW	Listed place
Sutherland Dock	NSW	Listed place
Sydney Airport Air Traffic Control Tower	NSW	Listed place
Sydney Customs House (former)	NSW	Listed place
Ten Terminal Regiment Headquarters and AusAid Training Centre	NSW	Listed place
Thirty Terminal Squadron Precinct	NSW	Listed place
Underground Grain Silos	NSW	Listed place
Victoria Barracks Perimeter Wall and Gates	NSW	Listed place
Victoria Barracks Precinct	NSW	Listed place
Victoria Barracks Squash Courts	NSW	Listed place
Woolwich Dock	NSW	Listed place

Listed Marine Species [[Resource Information](#)]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Foraging, feeding or related behaviour known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Foraging, feeding or related behaviour known to occur within area
Calidris alba Sanderling [875]		Foraging, feeding or related behaviour known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Foraging, feeding or related behaviour known to occur within area
Calidris subminuta Long-toed Stint [861]		Foraging, feeding or related behaviour known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus Double-banded Plover [895]		Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Foraging, feeding or related behaviour known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Foraging, feeding or related behaviour known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Foraging, feeding or related behaviour likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Foraging, feeding or related behaviour likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Foraging, feeding or related behaviour known to occur within area
Heteroscelus incanus Wandering Tattler [59547]		Foraging, feeding or related behaviour known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Foraging, feeding or related behaviour known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Foraging, feeding or related behaviour known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Foraging, feeding or related behaviour likely to occur within area
Numenius phaeopus Whimbrel [849]		Foraging, feeding or related behaviour known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Foraging, feeding or related behaviour known to occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Pluvialis squatarola Grey Plover [865]		Foraging, feeding or related behaviour known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Foraging, feeding or related behaviour known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Foraging, feeding or related behaviour known to occur within area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat known to occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area
Whales and other Cetaceans		
		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

Name	Status	Type of Presence within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
102 Rosedale Road	NSW
Dalrymple-Hay	NSW
Garigal	NSW
Lane Cove	NSW
North Head	NSW
Parramatta River	NSW
Sydney Harbour	NSW
Wallumatta	NSW
Wolli Creek	NSW

Invasive Species	[Resource Information]
Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.	

Name	Status	Type of Presence
Birds		
<i>Acridotheres tristis</i> Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
<i>Alauda arvensis</i> Skylark [656]		Species or species

Name	Status	Type of Presence
<p>Anas platyrhynchos Mallard [974]</p>		<p>habitat likely to occur within area</p> <p>Species or species habitat likely to occur within area</p>
<p>Carduelis carduelis European Goldfinch [403]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Carduelis chloris European Greenfinch [404]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Lonchura punctulata Nutmeg Mannikin [399]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Passer domesticus House Sparrow [405]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Passer montanus Eurasian Tree Sparrow [406]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Pycnonotus jocosus Red-whiskered Bulbul [631]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Streptopelia chinensis Spotted Turtle-Dove [780]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Sturnus vulgaris Common Starling [389]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Turdus merula Common Blackbird, Eurasian Blackbird [596]</p>		<p>Species or species habitat likely to occur within area</p>
Frogs		
<p>Rhinella marina Cane Toad [83218]</p>		<p>Species or species habitat known to occur within area</p>
Mammals		
<p>Bos taurus Domestic Cattle [16]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Canis lupus familiaris Domestic Dog [82654]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Felis catus Cat, House Cat, Domestic Cat [19]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Feral deer Feral deer species in Australia [85733]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Lepus capensis Brown Hare [127]</p>		<p>Species or species habitat likely to occur within area</p>

Name	Status	Type of Presence
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

Nationally Important Wetlands		[Resource Information]
Name	State	
Botany Wetlands	NSW	
Eve St. Marsh, Arncliffe	NSW	

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-33.87206 151.1709,-33.86549 151.17216,-33.84804 151.18108,-33.82953 151.21461,-33.81477 151.20007

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- [-Other groups and individuals](#)

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

Appendix C – Species recorded

Recorded flora

Flora species recorded in the subject land by Arcadis (2018) are listed below. An inventory of flora species recorded by WSP during field investigations is provided in *Harbourlink Terrestrial Biodiversity Survey Report* (WSP, 2018).

Family	Exotic	Scientific name	Common name	BC Act Status [^]	EPBC Act Status [^]
Gymnosperms					
Pinaceae	*	<i>Pinus radiata</i>	Radiata Pine	-	-
Angiosperms – Dicotyledons					
Anacardiaceae	*	<i>Schinus mole var. areira</i>	Pepper Tree	-	-
Apocynaceae	*	<i>Nerium oleander</i>	Oleander	-	-
Asteraceae	*	<i>Bidens pilosa</i>	Cobblers Pegs	-	-
Asteraceae	*	<i>Taraxacum officinale</i>	Dandelion	-	-
Casuarinaceae		<i>Casuarina glauca</i>	Swamp Oak	-	-
Convolvulaceae		<i>Dichondra repens</i>	Kidney-weed	-	-
Euphorbiaceae	*	<i>Triadica sebifera</i>	Chinese Tallow Tree	-	-
Fabaceae Caesalpinioideae	*	<i>Senna pendula var. glabrata</i>	Easter Cassia	-	-
Fabaceae Faboideae	*	<i>Wisteria sinensis</i>	Chinese Wisteria	-	-
Fabaceae Mimosoideae		<i>Acacia parramattensis</i>	Parramatta Green Wattle	-	-
Fabaceae Mimosoideae	#	<i>Acacia podalyriifolia</i>	Queensland Wattle	-	-
Fabaceae Mimosoideae		<i>Acacia terminalis subsp. terminalis</i>	-	E	E
Lauraceae	*	<i>Cinnamomum camphora</i>	Camphor-laurel	-	-
Moraceae		<i>Ficus macrophylla</i>	Moreton Bay Fig	-	-
Moraceae		<i>Ficus microcarpa var. hillii</i>	Hill's Weeping Fig	-	-
Myrtaceae		<i>Angophora costata</i>	Smooth-barked Apple	-	-
Myrtaceae		<i>Callistemon viminalis</i>	Weeping Bottlebrush	-	-
Myrtaceae	#	<i>Corymbia citriodora</i>	Lemon-scented Gum	-	-
Myrtaceae		<i>Corymbia gummifera</i>	Red Bloodwood	-	-
Myrtaceae		<i>Corymbia maculata</i>	Spotted Gum	-	-
Myrtaceae		<i>Eucalyptus botryoides</i>	Bangalay	-	-
Myrtaceae	#	<i>Eucalyptus microcorys</i>	Tallowwood	-	-

Family	Exotic	Scientific name	Common name	BC Act Status^	EPBC Act Status^
Myrtaceae	#	<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint	-	-
Myrtaceae		<i>Eucalyptus saligna</i>	Sydney Blue Gum	-	-
Myrtaceae	#	<i>Lophostemon confertus</i>	Brush Box	-	-
Myrtaceae		<i>Melaleuca decora</i>	White Cloud Tree	-	-
Myrtaceae		<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	-	-
Myrtaceae		<i>Melaleuca styphelioides</i>	Prickly Paperbark	-	-
Myrtaceae		<i>Syncarpia glomulifera</i>	Turpentine	-	-
Ochnaceae	*	<i>Ochna serrulata</i>	Mickey Mouse Plant	-	-
Oleaceae	*	<i>Ligustrum lucidum</i>	Broad-leaved Privet	-	-
Oleaceae	*	<i>Ligustrum sinense</i>	Small-Leaved Privet	-	-
Oleaceae	*	<i>Olea europaea subsp. cuspidata</i>	African Olive	-	-
Phyllanthaceae		<i>Glochidion ferdinandi</i>	Cheese Tree	-	-
Pittosporaceae		<i>Pittosporum undulatum</i>	Pittosporum	-	-
Platanaceae	*	<i>Platanus x hybrida</i>	London Plane	-	-
Proteaceae		<i>Banksia integrifolia</i>	Coast Banksia	-	-
Proteaceae		<i>Banksia spinulosa</i>	Hairpin Banksia	-	-
Proteaceae	#	<i>Grevillea robusta</i>	Silky Oak	-	-
Rutaceae		<i>Correa alba</i>		-	-
Rutaceae	*	<i>Murraya paniculata</i>	Jasmine-orange	-	-
Salicaceae	*	<i>Populus deltoides</i>	Eastern Cottonwood	-	-
Sapindaceae	*	<i>Cardiospermum grandiflorum</i>	Balloon Vine	-	-
Ulmaceae	*	<i>Celtis sinensis</i>	Chinese Hackberry	-	-
Angiosperms – Monocotyledons					
Alliaceae	*	<i>Agapanthus praecox subsp. orientalis</i>	Agapanthus	-	-
Arecaceae	*	<i>Phoenix canariensis</i>	Canary Island Date	-	-
Cyperaceae		<i>Cyperus gracilis</i>	Slender Sedge	-	-
Lomandraceae		<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	-	-
Phormiaceae		<i>Dianella caerulea</i>	Blue Flax-lily	-	-
Poaceae	*	<i>Axonopus fissifolius</i>	Narrow-leaved Carpet Grass	-	-
Poaceae		<i>Bothriochloa decipiens</i>	Redleg Grass	-	-

Family	Exotic	Scientific name	Common name	BC Act Status^	EPBC Act Status^
Poaceae	*	<i>Cenchrus clandestinus</i>	Kikuyu	-	-
Poaceae	*	<i>Cenchrus setaceus</i>	Fountain Grass	-	-
Poaceae		<i>Cynodon dactylon</i>	Couch	-	-
Poaceae	*	<i>Ehrharta erecta</i>	Panic Veldtgrass	-	-
Poaceae		<i>Microlaena stipoides</i>	Weeping Grass	-	-
Poaceae	*	<i>Paspalum dilatatum</i>	Paspalum	-	-

*=exotic species, #=non-local native species.

^E=Endangered

Recorded fauna

Fauna species recorded by Arcadis (2018). An inventory of fauna species recorded by WSP during field investigations is provided in *Harbourlink Terrestrial Biodiversity Survey Report* (WSP, 2018).

Fauna group	Common name	Scientific name	BC Act Status*	EPBC Act Status*	Ecosystem or species credit species?
Mammals	Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V	-	Species/ ecosystem credit species
Mammals	Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V	Ecosystem credit species
Mammals	Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	-	-	-
Birds	Australian magpie	<i>Cracticus tibicen</i>	-	-	-
Birds	Noisy miner	<i>Manorina melanocephala</i>	-	-	-
Birds	Australian brush turkey	<i>Alectura lathami</i>	-	-	-
Mammal	Common ringtail possum	<i>Pseudocheirus peregrinus</i>	-	-	-
Birds	Rainbow lorikeet	<i>Trichoglossus moluccanus</i>	-	-	-
Birds	Grey butcherbird	<i>Cracticus torquatus</i>	-	-	-
Birds	Masked Lapwing	<i>Vanellus miles</i>	-	-	-
Birds	Laughing Kookaburra	<i>Dacelo novaeguineae</i>	-	-	-
Birds	Red Wattlebird	<i>Anthochaera carunculata</i>	-	-	-
Birds	Magpie-lark	<i>Grallina cyanoleuca</i>	-	-	-
Birds	Silver Gull	<i>Larus novaehollandiae</i>	-	-	-
Birds	White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	-	M	Ecosystem credit species

*V=Vulnerable, M=Migratory

Appendix D – Freshwater Ecology Impact Assessment

59917134

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St Leonards 2065
Australia

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Fax +61 2 9496 7748

www.cardno.com

Dear Ms Bennett,

WESTERN HARBOUR TUNNEL AND WARRINGAH FREEWAY UPGRADE PROJECT - FRESHWATER ECOLOGY IMPACT ASSESSMENT

1 Introduction

1.1 Background

The Western Harbour Tunnel and Beaches Link initiative would provide additional road network capacity across Sydney Harbour and improve connectivity with Sydney's northern beaches. The Western Harbour Tunnel and Warringah Freeway Upgrade component (the project) of the package comprises a new tolled motorway tunnel connection across Sydney Harbour and the Warringah Freeway Upgrade that would integrate the new motorway infrastructure with the existing road network and connect the Beaches Link and Gore Hill Freeway Connection.

The project would be located within the Inner West, North Sydney and Willoughby local government areas, connecting Rozelle in the south with Naremburn in the north. Commencing at the Rozelle Interchange, the mainline tunnels would pass under Balmain and Birchgrove, then cross Sydney Harbour between Birchgrove and Balls Head. The tunnels would then continue under Waverton and North Sydney, linking directly to the Warringah Freeway to the north of the existing Falcon Street overpass. The motorway control centre would be located at Waltham Street, Artarmon, with a trenched communications cable connecting the motorway control centre to the Western Harbour tunnel along the Gore Hill Freeway and Warringah Freeway road reserves. The Warringah Freeway Upgrade would be carried out on the Warringah Freeway from around Fitzroy Street at Milsons Point to around Willoughby Road at Naremburn. Upgrade works would include improvements to bridges across the Warringah Freeway, and upgrades to surrounding roads. The key features of the project are detailed in Chapter 5 (Project description) of the environmental impact statement.

The area required to facilitate the construction of the project is referred to as the construction footprint. The majority of the construction footprint would be located underground within the main alignment tunnels. However, surface areas would be required to support tunnelling activities and to construct the tunnel connections, tunnel portals and operational ancillary facilities. A detailed description of the construction sites are provided in Chapter 6 (Construction works) of the environmental impact statement.

1.2 Avoid and minimise impacts through design

Under the Roads and Maritime Services (Roads and Maritime) *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority (RTA), 2011) the management of biodiversity should aim to:

1. Avoid and minimise impacts first
2. Mitigate impacts where avoidance is not possible
3. Offset where residual impacts cannot be avoided (Section 7).

Similarly, the NSW Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources (formerly the NSW Department of Primary Industries (Fisheries)) requires that proponents should, as a first priority, aim to avoid impacts to key fish habitat (KFH) as a general principle. Where avoidance is impossible or impractical, proponents should then aim to minimise impacts. Any remaining impacts should then be offset with compensatory works (see Section 6). The NSW Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources) assesses activity and development proposals in relation to general policies with consideration for the 'sensitivity' (Type) and 'function' (Class) of the affected fish habitat detailed in Section 3.2 of the *Policy and Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) (the Policy). Project controls would be implemented and maintained in accordance with the Policy and the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).

The Secretary's environmental assessment requirements for the project identified the following as a key issue and desired performance outcome:

"The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity."

The project has been designed to avoid and minimise potential impacts to freshwater ecology under this hierarchy of 'avoid, minimise and mitigate'. The construction footprint, as well the management of discharges to waterways from the project during construction and operation, have reduced as far as practicable to reduce the risk of impacts to nearby waterways. Standard safeguards would be implemented at construction sites to minimise potential impacts to freshwater ecology and associated geomorphology including:

- > Consideration of industry recognised design requirements for water quality and spill containment
- > Site-specific design targets for water quality or neutral or beneficial impacts where design targets cannot be practically met
- > Site-specific design and maintenance considerations to avoid/minimise water quality and/or geomorphology impacts
- > Implementation of safeguards in accordance with industry recognised guidelines and Roads and Maritime's guidelines and codes during construction and operation.

These are detailed in Section 2.3 of the Technical Working Paper: Surface water quality and hydrology (Jacobs, 2020) and would be further refined during the detailed design process.

1.3 Legislative context

NSW and Commonwealth legislation with relevance to this assessment are:

- > NSW *Environmental Planning and Assessment Act 1979* (EPA Act)
- > NSW *Fisheries Management Act 1994* (FM Act)
- > Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.3.1 Environmental Planning and Assessment Act 1979

All projects assessed as state significant infrastructure (SSI) under Division 5.2 of the EPA Act requires an environmental impact statement to address the Secretary's environmental assessment requirements. The environmental impact statement must assess biodiversity impacts. Freshwater biodiversity matters have been assessed in accordance with the *Policy and Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) (the Policy).

1.3.2 Fisheries Management Act 1994

The FM Act contains provisions for the conservation of fish stocks, KFH, biodiversity, threatened species, populations and ecological communities. The FM Act regulates the conservation of fish, aquatic vegetation and some aquatic macroinvertebrates and the development and sharing of fishery resources of NSW for present and future generations. Part 7 of the FM Act identifies requirements for the protection of aquatic habitats while Part 7A of the FM Act lists threatened species, populations and ecological communities and KTPs for species, populations and ecological communities in NSW waters. Section 220ZZ of the FM Act outlines significant impact considerations to threatened species, populations and ecological communities listed under the FM Act.

1.3.3 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act protects nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as MNES. The significance of impacts on MNES is determined in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (Department of the Environment (DoE), 2013). Where an action is likely to have a significant impact on a MNES, the action is referred to the Australian Government Environment Minister. The referral process involves a decision on whether or not the action is a 'controlled action'. When an action is declared a controlled action, approval from the Minister is required.

1.4 Definitions

The following definitions are used in this memo:

- > The project: refers to that described in Section 1.1
- > Construction footprint: refers to the above ground area to be directly impacted by the project
- > Study area: refers to an area encompassing the construction footprint and areas immediately adjacent (about 500 metres around the project alignment).

2 The aquatic ecology assessment approach

This assessment used existing environment information about freshwater ecology and geomorphology compiled during the desktop review by Jacobs (Jacobs, 2020). The field surveys which informed these documents included a site inspection to describe the extent and condition of freshwater habitats within the study area. No fish or macroinvertebrate sampling were undertaken and their occurrence have been predicted based on the availability of suitable habitat.

Impacts to freshwater ecology and associated geomorphology as a result of the project are based on water quality and geomorphology studies details in the Technical Working Paper: Surface water quality and hydrology (Jacobs, 2020).

2.1 Personnel

This memo was prepared by the following personnel:

- > Dr Craig Blount (BSc (Hons), PhD, Grad Dip) – Technical Lead
- > Dilys Zhang (BSc (Hons)) – Environmental Scientist (Aquatic Ecologist).

2.2 Aims

The aims of the assessment were to:

- > Identify the location, extent and condition of waterways with potential to be impacted by the project
- > Identify any key threatening processes (KTPs) listed under the FM Act and EPBC Act relevant to the project and their potential to be triggered
- > Assess impacts to freshwater ecology, including threatened species and ecological communities, and associated geomorphology due to construction and operation of the project
- > Recommend potential mitigation of impacts to aquatic ecology in alignment with the Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources) and Roads and Maritime's 'avoid, minimise, mitigate and offset' strategy
- > Identify any potential ecological offsets required to compensate for any residual impacts in accordance with the Policy.

This assessment has been completed in accordance with:

- > *Policy and Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) (the Policy)
- > *Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge, 2003)
- > *Aquatic Ecology in Environmental Impact Assessment – EIA Guideline* (Lincoln Smith, 2003).

2.3 Components of the project relevant to freshwater ecology

2.3.1 Construction

Components of the project relevant to freshwater ecology are associated with construction support sites and construction activities in the vicinity of waterways. This would include locations for tunnel launch and support, earthworks and workforce amenities.

The key component includes the commissioning of five construction wastewater treatment plants. The wastewater treatment plants would be required to treat ground and surface wastewater generated/captured from tunnelling activities (including dust suppression water), and rainfall runoff captured from tunnel declines. One of the five wastewater treatment plants would discharge treated wastewater into a natural freshwater waterway via the local stormwater network while four would discharge into the marine environment and their impact are assessed elsewhere (Table 2-1 and Figure 2-1).

Construction activities, including those at construction support sites have potential to generate runoff which may enter freshwater waterways. Project activities with potential to impact the freshwater environments are

detailed in sections 6 and 7 of the Technical Working Paper: Surface water quality and hydrology (Jacobs, 2020). A summary of these are provided in Table 2-2.

Construction sites would be decommissioned following project completion.

Table 2-1 Groundwater discharge plants locations, receiving environments, volumes and velocities

Construction site	Receiving waterways	Estimates inflow (kL/d)	Volumes (kL/day)
Cammeray Golf Course (WHT10)	Local stormwater then Willoughby Creek	135	196

2.3.2 Operation

The key operational infrastructure relevant to freshwater ecology include:

- > Increase in impervious surfaces
- > Erosion and sedimentation of newly revegetated areas during establishing.

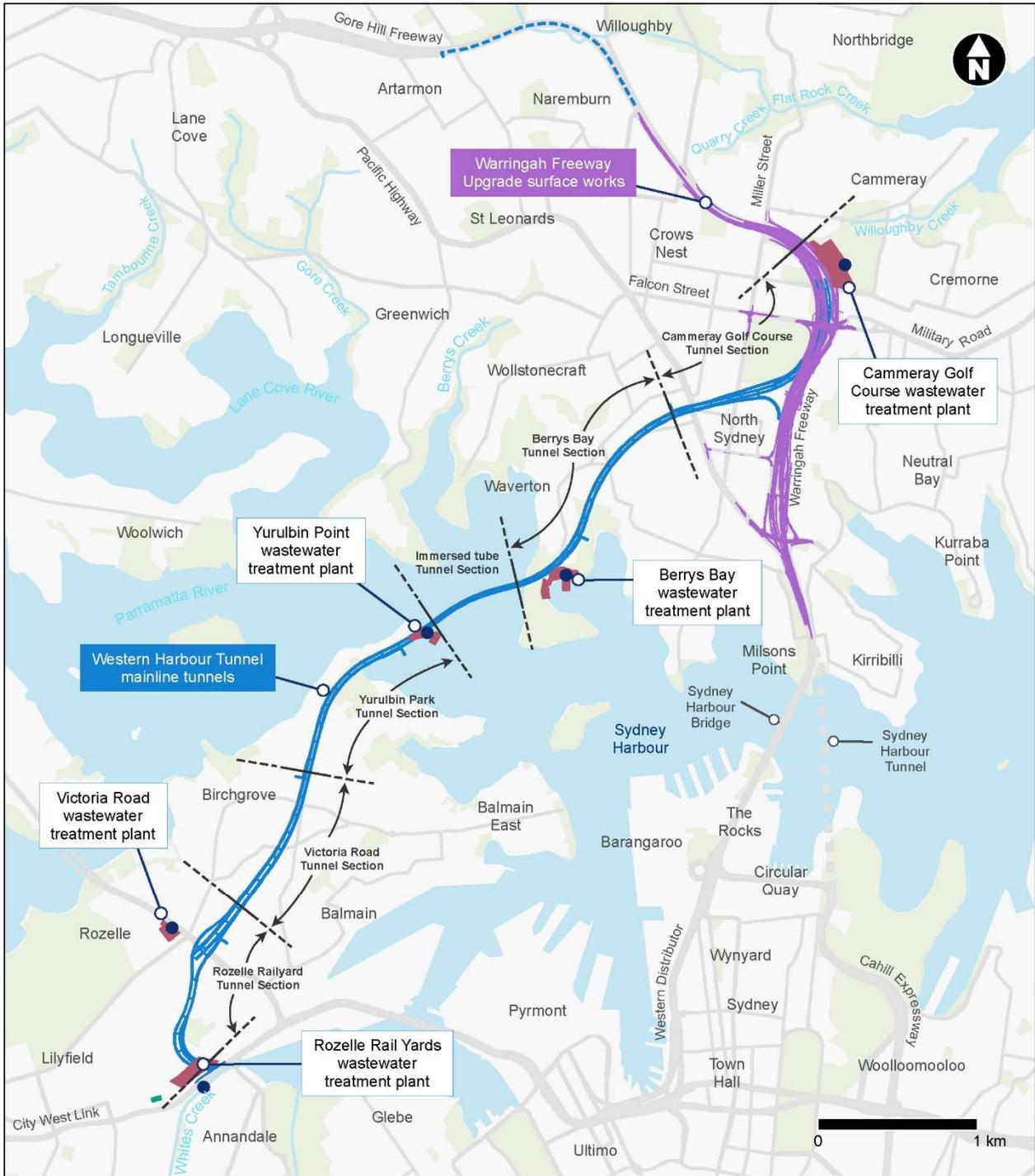
The selection and sizing of new operational water quality basins would be determined during detailed design. The NSW Office of Environment and Heritage design targets for water quality, as described in *Draft Managing Urban Stormwater – Council Handbook* (Environmental Protection Agency, 2007) have been adopted as the design targets for the project.

The design of the wastewater treatment plant would be determined during detailed design. The plant would be designed to treat key indicators of concern to a level that is consistent with the ANZECC/ARMCANZ (2000) water quality guidelines and the NHMRC (2008) recreational water quality guidelines.

Table 2-2 Specific project aspects relevant to freshwater ecology and associated geomorphology (source: Jacobs, 2020)

Project feature	Project activities	Potential impacts	Waterways potentially impacted	Project phase
Rozelle Rail Yards construction site (WHT1)	<ul style="list-style-type: none"> ▪ Vegetation clearing and ground disturbance for site establishment ▪ Stockpiling of topsoil and vegetation ▪ Storage of chemicals ▪ Vehicle and equipment washdown ▪ Refuelling ▪ Movement of plant and transport of materials and spoil ▪ Excavation of tunnels ▪ Construction of support structures and road integration works 	<ul style="list-style-type: none"> ▪ Erosion and sedimentation ▪ Contaminated runoff ▪ Increase in impervious surfaces increasing the volume and velocity of runoff 	Whites Creek	Construction Operation
Cammeray Golf Course construction site (WFU 8 and WHT10)	<ul style="list-style-type: none"> ▪ Vegetation clearing and ground disturbance for site establishment ▪ Replacement of cross drainage structures near Willoughby Creek ▪ Stockpiling of topsoil and vegetation ▪ Storage of chemicals ▪ Vehicle and equipment washdown ▪ Refuelling 	<ul style="list-style-type: none"> ▪ Erosion and sedimentation ▪ Contaminated runoff ▪ Mobilisation of pesticides and/or herbicides ▪ Increase in impervious surfaces increasing the volume and velocity of runoff 	Willoughby Creek, Flat Rock Creek and Quarry Creek	Construction

Project feature	Project activities	Potential impacts	Waterways potentially impacted	Project phase
	<ul style="list-style-type: none"> ▪ Movement of plant and transport of materials and spoil ▪ Wastewater treatment plant which discharges into local stormwater and then Willoughby Creek. 	<ul style="list-style-type: none"> ▪ Alterations to water quality and geomorphology from Wastewater treatment plant discharges. 		
Surface works within construction footprint (including construction sites)	<ul style="list-style-type: none"> ▪ Vegetation clearing and ground disturbance ▪ Demolition works ▪ Installation of infrastructure ▪ Relocation of utilities ▪ Increase in impervious surfaces ▪ Temporary increase in traffic ▪ Movement of plant and transport of materials and spoil ▪ Management and haulage of spoil. 	<ul style="list-style-type: none"> ▪ Erosion and sedimentation ▪ Mobilisation of contaminants and acid sulfate soils (ASS) to waterways ▪ Alteration of flow velocities and volumes. 	Whites Creek, Willoughby Creek, Flat Rock Creek and Quarry Creek	Construction
Tunnel construction	<ul style="list-style-type: none"> ▪ Tunnelling under waterways ▪ Management and haulage of materials and spoil ▪ Wastewater discharge. 	<ul style="list-style-type: none"> ▪ Subsidence of waterways ▪ Mobilisation of contaminants and ASS to waterways ▪ Alterations to water quality and geomorphology from wastewater treatment plant discharges ▪ Reduction in baseflows from groundwater drawdowns. 	Whites Creek, Willoughby Creek, Flat Rock Creek and Quarry Creek	Construction



Legend

- Western Harbour Tunnel
- Warringah Freeway Upgrade
- Communications cable for motorway control centre
- Waterways
- Treated wastewater discharge location
- Construction wastewater treatment plant
- Operational wastewater treatment plant

Figure 2-1 Construction footprint, relevant construction sites, wastewater treatment plant discharge locations and associated waterways (source: Jacobs 2020)

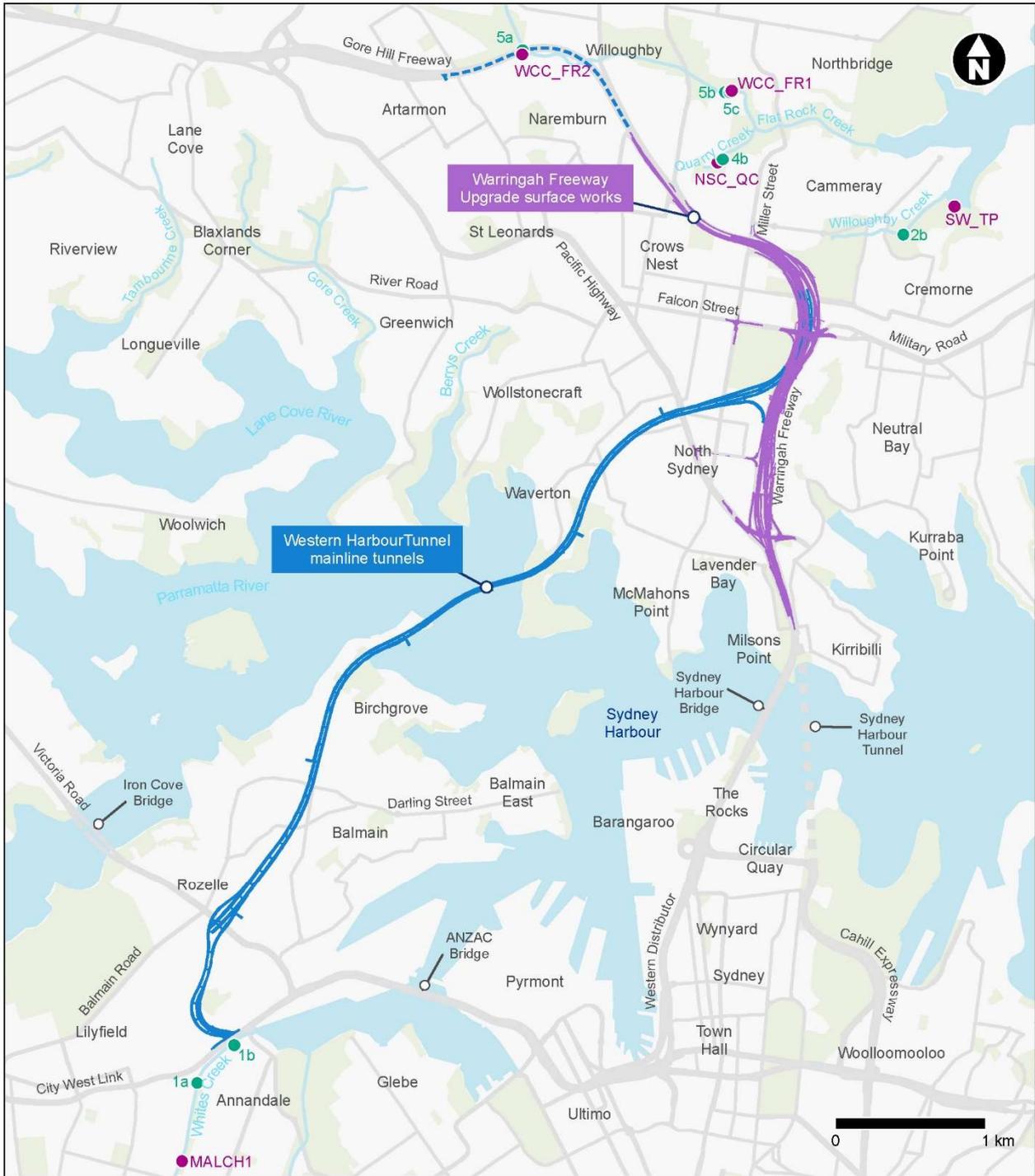
2.4 Field survey locations

The field survey was completed at seven locations across four waterways (Jacobs, 2020) on 31 October 2017 and 1 November 2017. Site names and location details are detailed in **Table 2-3**. The sites included a 100 metre reach of waterway centred at each location point illustrated in **Figure 2-2**.

Table 2-3 Field survey sites (source: Jacobs, 2020)

Site code	Site name	Site details
1a	Whites Creek upstream	Upstream of the project alignment
1b	Whites Creek downstream	Downstream of the project alignment
2b	Willoughby Creek downstream	Downstream of the project alignment
4b	Quarry Creek (Flat Rock Creek tributary)	Downstream of the project alignment
5a	Flat Rock Creek upstream	Upstream of the project alignment
5b	Flat Rock Creek downstream	Downstream of the project alignment, upstream of Quarry Creek
5c	Flat Rock Creek downstream	Downstream of the project alignment and site 5b

The sections of waterways visited were considered representative of those that could be impacted by the project (Jacobs, 2020).



Legend

- Western Harbour Tunnel
- Warringah Freeway Upgrade
- Communications cable for motorway control centre
- Waterways
- Project monitoring site
- Existing monitoring site

Figure 2-2 Field survey sites (source: Jacobs, 2020)

3 Existing environment

The study area includes the following waterways within the Willoughby, North Sydney and Inner West local government areas (Figure 2-2):

- > Whites Creek at Rozelle, about 40 metres south-east from the construction footprint at Rozelle
- > Willoughby Creek at Cammeray, about 60 metres east from the construction footprint at Cammeray Golf Course
- > Flat Rock Creek at Naremburn, about one kilometre north from the construction footprint at the Cammeray Golf Course and over 500 metres from the Waltham Street construction support site (WHT11). The trenched communications cable connecting the motorway control centre to the Western Harbour tunnel along the Gore Hill Freeway and Warringah Freeway road reserves would pass over this creek, however, the creek travels underground from between Grandview Drive at Naremburn and Flat Rock Drive at Willoughby
- > Quarry Creek at Cammeray, about 800 metres north from the construction footprint at the Cammeray Golf Course.

3.1 Aquatic habitat and geomorphology summary

3.1.1 Whites Creek

Whites Creek is a first order waterway (Strahler, 1957) that flows in a north-easterly direction from Annandale to Lilyfield into Rozelle Bay. At the two survey sites at Lilyfield (Table 2-3 and Figure 2-2) the channel was a heavily modified with concrete channel and banks (Figure 3-1). The riparian corridor was also heavily modified and included transport infrastructure (roads and light rail station) and parkland. Riparian vegetation consisted of plantings with no remnant native riparian vegetation. Whites Creek receives input from wastewater and road runoff from the catchment. No fish habitat of value was identified and the waterway was not mapped KFH (NSW DPI, 2016a). The sections of creek visited were not considered sensitive receiving environments (as defined in Section 3.3.1 of the *Technical working paper: Surface water quality and hydrology* (Jacobs, 2020)). Overall, this section of creek is heavily modified. Sydney Water has begun works on naturalising the creek to help improve its condition.



Figure 3-1 Whites Creek at the upstream site (1a) (left) and downstream site (1b) (right)

3.1.2 Willoughby Creek

Willoughby Creek is a first order waterway (Strahler, 1957) that flows in a general easterly direction from Cammeray Golf Course to Primrose Park into Willoughby Bay at Cammeray. At one site (2b) (Table 2-3 and Figure 2-2) next to Primrose Park Tennis Courts it appeared a semi-natural waterway partially modified to accept stormwater discharge. Modifications included entrenched bedrock and a concrete-lined channel around 10 metres downstream from the survey point (site 2b). A natural bedrock/boulder waterfall and a shallow plunge pool was located around 50 metres upstream from the survey point (site 2b). Banks in the

upstream section were vegetated by dense tree cover and shrubs with a groundcover consisting primarily of ferns. Walking tracks and tennis courts were present on the south-east bank and on the opposite bank the riparian vegetation corridor was around 70 metres wide and continuous. Further downstream, the riparian corridor included Primrose Park sporting fields. This riparian vegetation would provide shade and potentially, other ecological functions (eg a source of food and habitat, in the form of wood debris, for aquatic biota). The section visited provided minimal aquatic habitat and no instream vegetation or woody debris (Figure 3-2). The survey reach is mapped as KFH (NSW DPI, 2016a) and was considered Type 3 – minimally sensitive KFH. It was not considered a sensitive receiving environment.

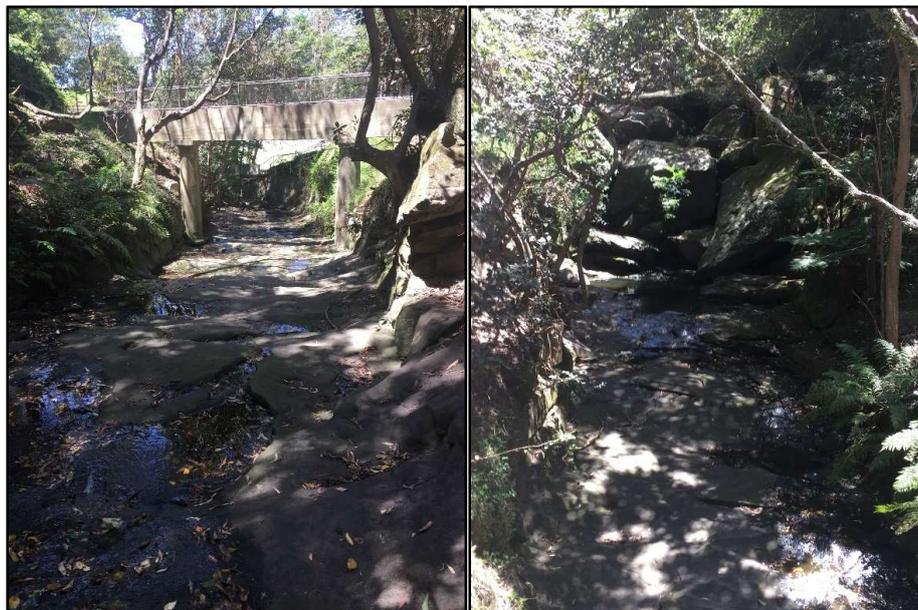


Figure 3-2 Willoughby Creek looking downstream (left) and upstream (right)

3.1.3 Flat Rock Creek

Flat Rock Creek is a first order waterway upstream of the Quarry Creek confluence and a second order waterways downstream (Strahler, 1957). It flows in a general easterly direction from Marlow Road at Artarmon into Middle Harbour at Tunks Park at Cammeray. The waterway was assessed at two sites at Flat Rock Drive at Naremburn (5b and 5c) (Table 2-3 and Figure 2-2). It appeared to be freshwater upstream of its confluence with Quarry Creek (site 5b) and estuarine downstream (site 5c).

The reach immediately upstream of the Quarry Creek confluence (5b) consisted of a steep gorge with natural bedrock and large boulders. Dense riparian vegetation encroached on the channel and were likely attributed to frequent low flow conditions in the main channel. Riparian vegetation consisted of native, tall, woody trees, dense shrubs and groundcover which were managed in some areas by conservation groups. The site forms part of a popular bushwalking track connecting Bicentennial Reserve at Willoughby to Tunks Park. Instream woody debris (less than three metres long) would provide aquatic habitat along this reach albeit some were emergent at the time of survey (Figure 3-3).



Figure 3-3 Flat Rock Creek at the downstream site looking downstream (5b) (left) and upstream (right)

Downstream of the Quarry Creek confluence (5c) Flat Rock Creek appeared estuarine with an alluvium bed. This reach of Flat Rock Creek appeared to be subjected to stormwater discharge with evidence of channel and bank erosion a likely result of high flow events. The south bank had dense native and exotic, overhanging riparian vegetation. Fish habitat included woody debris and some undercut banks with potential to provide refuge (Figure 3-4). Large woody debris (greater than three metres long) and dense instream common reed (*Phragmites australis*) were present in some sections about 50 metres downstream of the confluence under the current suspension bridge. Coastal Sandstone Gully Forest, a groundwater dependent ecosystem (GDE), was identified within 500 metres downstream of the predicted receiving environment. The survey sites 5b and 5c contained Type 1 – highly sensitive KFH and were considered to be sensitive receiving environments. The freshwater reach (site 5b) was considered a Class 2 – moderate KFH for fish passage waterway while the estuarine reach (site 5c) was considered Class 1 – major KFH for fish passage waterway.



Figure 3-4 Flat Rock Creek at the estuarine site looking downstream (5c) (left) and looking at the right bank (right)

3.1.4 Quarry Creek

Quarry Creek is a first order tributary (Strahler, 1957) of Flat Rock Creek which flows from the southern end of Quarry Street in a general north-easterly direction connecting with Flat Rock Creek around 250 metres downstream. Limited access only allowed a visual inspection at the confluence (4b) (Table 2-3 and Figure 2-2). Here, the channel flowed through a steep rocky gorge. Upstream it appeared freshwater and ephemeral with bedrock steps, rocky riffles and runs with low to moderate flow during dry conditions (Figure 3-5).

Quarry Creek becomes estuarine near the Flat Rock Creek confluence with a silt/clay substratum. Riparian vegetation included dense exotic species and the Coastal Sandstone Gully Forest GDE previously identified within 500 metres of Flat Rock Creek is also close by. Quarry Creek contained Type 1 – highly sensitive KFH and was classified as a Class 2 – moderate KFH for fish passage. It was considered a sensitive receiving environment.



Figure 3-5 Quarry Creek looking downstream (4b)

3.2 Existing water quality

Existing surface water quality is described in detail in the *Technical working paper: Surface water quality and hydrology* (Jacobs, 2020). In summary, the surface water quality of these four waterways is likely to be substantially influenced by the surrounding urban development. Sources of contaminants such as suspended sediments, heavy metals and persistent organic pollutants (POPs) include stormwater, wastewater overflows and leachate from contaminated lands. Some of these waterways have also undergone significant change from natural channels to artificial, hard (concrete-lined) channels to accommodate higher volume and velocity flows from an increase in urban, impervious surfaces. This hydrological alteration from natural conditions would have also promoted the transport of sediments and contaminants to downstream receiving environments (ie Sydney Harbour and Middle Harbour). A summary of existing water quality across these aquatic environments is outlined in Table 3-1.

3.3 Freshwater fauna

The waterways in the Sydney region support a diversity of aquatic fauna due to the diversity and connectivity of aquatic habitats spanning freshwater, estuarine and marine areas. This leads to many aquatic species (up to 70 per cent) migrating across these areas during part of their lifecycles (Fairfull & Witheridge, 2003). Common native fish species found in waterways in the Sydney region include short-finned and long-finned eels (*Anguilla australis* and *A. reinhardtii*), common jollytails (*Galaxias brevipinnis*), Australian bass (*Macquaria novemaculeata*) and a number of gudgeon species (Nichols & McGirr, 2005). Exotic fish species are also widespread across the Sydney region (Section 3.9). These waterways also support an array of macroinvertebrates including the Sydney crayfish (*Euastacus australasiensis*) and the freshwater shrimp (*Paratya australiensis*) as well as smaller insects and freshwater mussels. These species depend on healthy waterways and access to diverse habitats including swamps, floodplains, wetland, streams and rivers of which only streams occur within the study area. Although no fish or macroinvertebrate sampling were undertaken for this assessment, the waterways in the study area are suitable for the majority of these species. Thus, these species are likely to occur in these waterways with the natural reaches (ie Willoughby Creek, Quarry Creek and some reaches of Flat Rock Creek) being more suitable. Inundation and the presence of pools may also dictate freshwater fauna distribution which limits their occurrence in waterways such as Willoughby Creek.

3.4 Threatened ecological communities, species and endangered populations

It was considered unlikely that any threatened freshwater fauna, flora species or ecological communities or endangered populations listed under the FM Act and/or the EPBC Act occurred within the study area (Jacobs, 2020). No predicted freshwater threatened species distributions coincide with the study area. The

waterways within the study area were highly modified and disturbed thus, not representative of optimal habitat for any threatened freshwater species.

3.5 Migratory species

No freshwater migratory species listed under the EPBC Act were considered likely to occur within the study area. Species associated with the waterways and riparian corridors, including birds and marine/estuarine fauna are addressed in the Technical working paper: Biodiversity Development Assessment Report (Arcadis, 2020) and the Western Harbour Tunnel and Warringah Freeway Upgrade Technical Working Paper: Marine Ecology (Cardno, 2020).

3.6 Protected species

Some species of fish or invertebrates have been formally protected because they are naturally scarce or their numbers have been substantially reduced over recent decades. These species are protected to help prevent them becoming threatened in the future. Fishing and collecting of these species without a permit will incur a penalty in accordance with Section 19 of the FM Act.

The isopod *Crenoicus harrisoni* is the only freshwater species listed as protected under the FM Act. This species is only known from Saxby's Swamp in the Barrington Tops areas which is around 240 kilometres north of the study area. Estuarine species with potential to occur within the study area are addressed in the Technical working paper: Marine ecology (Cardno, 2020).

3.7 Critical habitat

Critical habitat refers only to those areas listed in the Register of Critical Habitat kept by the NSW Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources) and the Commonwealth Department of the Environment and Energy (DoEE). There are no freshwater critical habitats listed in either registers with potential to occur within the study area.

3.8 Wetlands and conservation areas

No RAMSAR or coastal wetlands (*State Environmental Planning Policy (Coastal Management) 2018*) occur along the waterways within the study area. The closest RAMSAR wetland is at Towra Point at Kurnell, around 24 kilometres south of the study area. The closest coastal wetland identified in the *State Environmental Planning Policy (Coastal Management) 2018* to the project (located outside of the study area) is along Johnsons Creek about 400 metres south-east of Whites Creek.

3.9 Pests and diseases

A number of exotic fish species have been intentionally or unintentionally introduced into NSW waterways since European settlement. Some of these species have become problematic, widespread pests altering native community structure and interactions through competition for resources, predation and the introduction of diseases (NSW DPI, 2017). Carp (Family Cyprinidae), redfin perch (*Perca fluviatilis*), eastern Gambusia (*Gambusia holbrooki*), oriental weatherloach (*Misgurnus anguillicaudatus*), banded grunter (*Amniataba percooides*) and goldfish (*Carassius auratus*) are freshwater pest fish species which have established in NSW waterways. Of these redfin perch, eastern Gambusia and carp are the most widespread.

Species of carp are native to Asia and Europe while eastern Gambusia are native to the south-eastern United States of America (USA) (NSW DPI, 2017). These two species are able to tolerate a wide range of environmental conditions contributing to a widespread distribution in NSW and have potential to currently occur within study area waterways. Redfin perch are native to northern Europe and prefer still or slow-flowing waters (eg lotic systems) hence, are less likely to occur within the study area due to the lack of optimal habitat.

3.10 Commercial and recreational fisheries

Aquaculture or commercial fisheries have not been identified within the freshwater or estuarine waterways in the study area. Recreational fishing is not a common activity along these waterways.

3.11 Key threatening processes

A KTP is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key Threatening Processes are listed under the FM Act and the EPBC Act. At present, there are eight KTPs listed under the FM Act and 21 listed under the EPBC Act. KTPs include threats to threatened species, population and ecological communities as well as cause species, population or ecological communities to become threatened. One KTP is listed under the FM Act and three listed under the EPBC Act are potentially relevant to the project:

- > Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (EPBC Act) from the disturbance or landscaped areas and the repurposing of materials containing propagules
- > Human-caused climate change (FM Act) mainly from an increase of fossil fuel vehicles as a result of the project
- > Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases (EPBC Act) mainly from an increase of fossil fuel vehicles as a result of the project
- > Novel biota and their impact on biodiversity (EPBC Act) from the use of contaminated equipment, plant, vehicles and foot traffic.

Potential exacerbation of these KTPs are assessed in the impact assessment.

3.12 Summary

All four creeks are first order waterways flowing into Sydney Harbour or Middle Harbour. They are located in highly urbanised catchments. Whites Creek, Willoughby Creek and reaches of Flat Rock Creek have been modified to receive stormwater inflows. The natural reaches of Flat Rock Creek and Quarry Creek were considered sensitive receiving environments and Type 1 KFH. However, being in an urbanised catchment all of these waterways have elevated concentrations of contaminants and impaired water quality. These sections of waterways are also very unlikely to provide habitat for any threatened freshwater ecology. A summary of the existing environment to be assessed in the impact assessment is outlined in **Table 3-1**.

Table 3-1 Existing environment summary of assessment sites (source: Jacobs, 2020)

KFH Type and Class	Sensitive receiving environment	Geomorphology	General water quality	Riparian condition	Instream habitat
Whites Creek upstream (1a)					
Not KFH	No	<ul style="list-style-type: none"> ▪ Concrete-lined channel ▪ Vertical concrete slabs up the banks. 	<ul style="list-style-type: none"> ▪ Estuarine ▪ Periodically experiences microbiological contamination ▪ Occasionally low dissolved oxygen and elevated pH and turbidity ▪ Elevated nutrient concentrations ▪ Elevated heavy metal concentrations. 	Highly modified with linear infrastructure and landscaped parks and reserves.	No instream fish habitat.

KFH Type and Class	Sensitive receiving environment	Geomorphology	General water quality	Riparian condition	Instream habitat
Whites Creek downstream (1b)					
Not KFH	No	<ul style="list-style-type: none"> Concrete-lined channel Vertical concrete slabs up the banks. 	<ul style="list-style-type: none"> Estuarine Periodically experiences microbiological contamination Occasionally low dissolved oxygen and elevated pH and turbidity Elevated nutrient concentrations Elevated heavy metal concentrations. 	Highly modified with linear infrastructure and landscaped parks and reserves.	No instream fish habitat.
Willoughby Creek (2b)					
Type 3 – minimally sensitive KFH Class 3 – minimal KFH for fish passage	No	<ul style="list-style-type: none"> Entrenched bedrock in the upstream reaches of the survey site modified to form a stormwater channel Concrete-lined channel approximately 10 metres downstream of the survey point. 	<ul style="list-style-type: none"> Freshwater Periodically elevated heavy metal concentrations Elevated nitrogen concentrations Low dissolved oxygen. 	Dense, woody riparian corridor wider on the north-western bank (approximately 70 metres) while a thinner riparian corridor lies adjacent to cleared sporting facilities.	No instream vegetation or woody debris. The waterway was substantially shaded from woody riparian vegetation.
Flat Rock Creek (5a)					
Not KFH	No	<ul style="list-style-type: none"> Concrete-lined channel Vertical concrete slabs up the banks. 	<ul style="list-style-type: none"> Freshwater Elevated heavy metal concentrations Elevated nutrient concentrations Microbiological contamination evident. 	Limited, landscaped riparian vegetation.	No instream vegetation.
Flat Rock Creek (5b)					
Type 1 – highly sensitive KFH Class 2 – moderate KFH for fish passage	Yes	<ul style="list-style-type: none"> Steep banks comprising bedrock and boulders. 	<ul style="list-style-type: none"> Freshwater Elevated heavy metal concentrations Elevated nutrient concentrations 	Dense native woody and shrubby riparian vegetation some of which were encroaching instream.	Some small snags.

KFH Type and Class	Sensitive receiving environment	Geomorphology	General water quality	Riparian condition	Instream habitat
Flat Rock Creek (5c)					
Type 1 – highly sensitive KFH Class 1 – major KFH for fish passage	Yes	<ul style="list-style-type: none"> Alluvium bed with banks prone to inundation, erosion and bank destabilisation. 	<ul style="list-style-type: none"> Estuarine Elevated heavy metal concentrations Elevated nutrient concentrations 	Dense native and exotic riparian vegetation along the south bank and some native trees along the north bank.	Large snags and dense instream, emergent vegetation in some areas.
Quarry Creek (4b)					
Type 1 – highly sensitive KFH Class 2 – moderate KFH for fish passage	Yes	<ul style="list-style-type: none"> Channel cut into a steep gorge Transitions from an ephemeral waterway to low/moderate flow bedrock channel of riffles and runs flowing into an estuarine reach Silty clay substrate along the estuarine reach. 	<ul style="list-style-type: none"> Freshwater and estuarine Elevated heavy metal concentrations Elevated nutrient concentrations Microbiological contamination evident. 	Dense exotic riparian vegetation.	Not captured due to access.

4 Impact assessment

Several aspects associated with construction and ongoing operation of the project could potentially impact freshwater ecology or geomorphology. These were summarised in Section 2.3. This section determines the likelihood and magnitude of these impacts in accordance with the approach outlined in Section 2.

The majority of potential impacts would occur during project construction. The only operational impacts to freshwater ecology or geomorphology would be associated with runoff from impervious surfaces and erosion and sedimentation of newly revegetated areas during establishment.

No direct impacts to freshwater ecology have been predicted for the project as no instream works or clearing of riparian vegetation have been proposed for the project. Thus, only indirect impacts are predicted and discussed below.

Cumulative impacts from other projects considered in Section 7 of the Technical working paper: Surface water quality and hydrology (Jacobs, 2020) have potential to increase pressures on maintaining water quality. Jacobs (2020) suggests that cumulative impacts as a result of other projects are minimal on freshwater environments provided controls are implemented, maintained and monitored. Hence, cumulative impacts on freshwater ecology as a result of these projects would also likely to be minimal.

4.1 Indirect impacts

The greatest potential risk to freshwater ecology during project construction would likely be changes to water quality and flow in nearby waterways. This is of particular relevance to the construction sites of Rozelle Rail Yards (WHT1) and Cammeray Golf Course (WHT10 / WFU8), due to their proximity to freshwater waterways.

4.1.1 Water quality

Alterations to water quality can arise from the inadvertent mobilisation of sediments and contaminants offsite. These could arise if the safeguards outlined in Section 2.3 of the Technical working paper: Surface water quality and hydrology (Jacobs, 2020) are not implemented effectively. Sediment mobilised by runoff or through site discharges and dewatering of sediment control basins has the potential to increase turbidity in receiving waters. Elevated turbidity can clog the gills and feeding apparatus of aquatic invertebrates and fish and potentially reduce photosynthesis in submerged macrophytes via light attenuation. The mobilisation of sediments could also increase sedimentation in the receiving waters which would alter of the existing substratum/or smother freshwater habitats (eg snags) and benthic fauna. In particular, any benthic fauna along any of the waterways within the study area would be exposed to smothering while sedimentation along other reaches could cover the existing hard substratum and/or smother aquatic habitat. Although no aquatic invertebrates or fish were sampled during the field survey, it would be precautionary to assume that they occur in the waterways of the study area, particularly in areas considered to be KFH (ie sections of Willoughby Creek, Flat Rock Creek and Quarry Creek) (Table 3-1). The waterways in the study area are currently likely to be exposed to elevated turbidity and sedimentation intermittently from highly urbanised catchment flows, thus the biota in the waterways are likely to have developed a level of tolerance.

Contaminants (if present) bound to sediments and/or from accidental releases could also reach waterways. The solubility, bioavailability and persistence of contaminants is compound-specific. Common compounds which may be mobilised during construction include those in the sediments (eg nutrients, heavy metals, and ASS) and those associated with the use of construction plant, equipment and vehicles (eg petroleum hydrocarbons). There is currently evidence of heavy metal and nutrient contamination in all four waterways (Table 3-1) thus, biota are likely to already be exposed to some of these contaminants. Freshwater biota toxicity varies between species, life stages of species and distribution. Algal blooms have potential to affect water chemistry and clarity. Further contributions to contaminant concentrations or the introduction of new contaminants as a result of the project has potential to affect freshwater biota through toxicity (from, for example, heavy metals) and induce algal blooms (from nutrients). However, taking into account the proposed management measures and safeguards, the likely volumes of such in flows are likely to be very small. The likelihood of occurrence of ASS was considered to be low to extremely low (Jacobs, 2020) thus, associated potential impacts to freshwater ecology are considered low.

Increases in impervious surfaces and traffic during project operation has potential to expose waterways to contaminant-laden runoff including litter with subsequent impacts to biota (see above). However, the project

design would consider the management of stormwater quality through the operation of the Rozelle Rail Yards (WHT1) wastewater treatment plant which would discharge into Sydney Harbour and impacts are assessed elsewhere.

With the development of site-specific water quality targets for wastewater treatment plants (Section 2) and the implementation of mitigation measures recommended in Section 5, the likelihood of sediments and contaminants entering the waterways as a result of the project is low and impacts to freshwater ecology are expected to be minimal. Additional mitigation measures include routine and event-based monitoring of water quality during construction (Section 5) to ensure project controls are effective and any offsite discharge adheres to water quality guidelines.

4.1.2 Geomorphology and flow regimes

It is understood that surface water intercepted at the site and any groundwater encountered during tunnelling activities would be treated at wastewater treatment plants and discharged to either Parramatta River estuary or waterways within the study area. The wastewater treatment plant and discharge locations are outlined in Table 2-2. The only wastewater treatment plant discharge predicted to enter waterways of the study area is from Cammeray Golf Course (WHT10 / WFU8) which would enter local stormwater before Willoughby Creek (Table 2-2). Willoughby Creek is currently equipped to receive existing stormwater inflows and the reach which is expected to receive project discharges (ie site 2b) comprises entrenched bedrock with limited potential for bank/bed erosion.

The potential for alterations to waterway geomorphology within the study area as a result of increased flows associated with project construction was considered to be low (Jacobs, 2020), especially in highly modified, concrete channels. Subsidence was also considered highly unlikely based on an assessment of geological conditions (Jacobs, 2020). Thus the project is unlikely to significantly modify the existing geomorphology of waterways within the study area so that the habitat of freshwater biota would be impacted.

Only minimal changes to flow volumes are expected from wastewater treatment plant discharges during project construction (Jacobs, 2020) thus, associated impacts to freshwater ecology are unlikely. It is possible that any increases in flows to waterways/reaches of waterways currently with low flow (eg Willoughby Creek, Quarry Creek and Flat Rock Creek) may be beneficial to freshwater ecology if it is associated with greater creek connectivity and greater mixing of the water column.

Tunnelling activities in the Rozelle construction footprint have potential to result in groundwater drawdowns affecting water availability and flows in surface waterways. The only waterway identified to occur in the drawdown area is Whites Creek. However, the reach of Whites Creek is currently concrete-lined and not dependent on groundwater baseflows. Thus, groundwater drawdowns as a result of the project are unlikely to impact the geomorphology or flow regimes of freshwater waterways within the study area.

4.2 Key threatening processes

4.2.1 Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (EPBC Act)

This KTP relates to the risk of the spread or establishment of exotic species in native vegetation. This KTP is unlikely to be triggered/further exacerbated by the project as controls would be implemented to avoid and minimise any introduction or further spread of exotic vegetation during construction (**Section 5**).

4.2.2 Human-caused climate change (FM Act) and Loss of climatic habitat caused by anthropogenic emissions of greenhouse gasses (EPBC Act)

The project construction and operation has potential to increase greenhouse gas emissions associated with this KTP. However, greenhouse gases emitted during project construction is negligible in comparison to that emitted in the wider Sydney region and would not continue beyond the construction phase. Increases in vehicles on the roads, although likely to occur in the Sydney region, are unlikely to be a result of the project. Identified threat abatement actions for this KTP includes:

- > Community and stakeholder liaison, awareness and education
- > Research/monitoring
- > Habitat rehabilitation for threatened species impacted by climate change.

The project is unlikely to interfere with any of these actions.

4.2.3 Novel biota and their impact on biodiversity (EPBC Act)

Threat abatement guidelines for this KTP outlines objectives for community and stakeholder liaison and awareness, legislative development and implementation and research and monitoring. The project is unlikely to interfere for the objectives of these guidelines albeit the potential to introduce and spread novel biota as it currently widely distributed throughout the study area. Strict controls would be implemented to prevent novel biota from spreading further than their current distribution or introduce new species as a result of the project (see Recommendations). Hence, the project is unlikely to trigger or further exacerbate this KTP.

5 Impact mitigation and offsets

The project has been designed to avoid and minimise potential impacts to freshwater ecology (Section 4) under this hierarchy of 'avoid, minimise and mitigate'. Under the Roads and Maritime Services (Roads and Maritime) *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) the management of biodiversity should aim to mitigate impacts where avoidance is not possible.

The primary potential impacts to freshwater ecology or geomorphology identified are associated with alterations to water quality and flow. Recommended mitigation measures in addition to those detailed in the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) and the NSW Department of Planning, Industry and Environment (Regions, Industry, Agriculture and Resources) Policy and project controls outlined in Section 1 that are applicable to freshwater ecology are provided in **Table 5-1**.

No KFH would be lost as a result of the project. Thus, no associated offsets have been identified.

Table 5-1 Mitigation measures to protect freshwater ecology and geomorphology

Identifier	Potential impact pathway	Mitigation measure	Timing	Responsibility
FE1	Increased erosion and sedimentation input into watercourses	<ul style="list-style-type: none"> ▪ Development and implementation of a soil and water management plan (SWMP). ▪ Minimise the extent of disturbed areas exposed at any one time, where practicable. ▪ Landscape any disturbed riparian corridors as soon as practicable using native species that are representative of the local area. ▪ Implement erosion and sedimentation controls while revegetated areas are establishing. 	Construction Post-construction	Construction contractor
FE2	Discharge of contaminant-laden runoff	<ul style="list-style-type: none"> ▪ Management of contaminated soils and ASS in accordance with relevant management plans ▪ Water quality monitoring as per the SWMP. 	Construction	Construction contractor
FE3	Accidental spills of contaminants such as hydrocarbons	<ul style="list-style-type: none"> ▪ Development and implementation of an emergency spill plan ▪ All fuels and chemicals stored at least 50 metres from waterways in bunded areas ▪ Washdowns and refuelling to occur in bunded areas ▪ Spill kits readily available and staff made aware of location. 	Construction	Construction contractor
FE3	Spread of Exotic species	<ul style="list-style-type: none"> ▪ Weed management controls would be implemented in accordance with Roads and Maritime's <i>Biodiversity Guidelines</i> (RTA, 2011). 	Construction	Construction contractor

6 Conclusion

The Western Harbour Tunnel and Warringah Freeway Upgrade construction footprint is mostly in underground tunnels but there would be a number of aboveground sites to facilitate the construction of the project. While no direct impacts to freshwater ecology are expected, indirect impacts have potential to occur to aquatic habitat and biota via alterations to water quality and flows and removal of riparian vegetation.

All surface and groundwater intercepted during construction and operation of the project would be treated to site-specific water quality criteria prior to discharging into local stormwater networks before entering waterways within the study area. This and the implementation of additional mitigation measures to ensure the effectiveness of controls would result in few, if any, impacts to freshwater ecology from poor water quality as a result of the project.

The potential for alterations to waterway geomorphology within the study area as a result of increased flows associated with project construction and reduced flows as a result of groundwater drawdowns was considered to be low and subsidence was also considered to be highly unlikely.

Based on this assessment and assuming successful implementation of the control measures described here and in the Technical Working Paper: Surface water (Jacobs, 2020) potential impacts to freshwater ecology or geomorphology would be acceptable.

7 References

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Appendix E – EPBC Significant Impact Assessments

Acacia terminalis subsp. terminalis (Sunshine Wattle)

Acacia terminalis subsp. *terminalis* is listed as Endangered under the EPBC Act. The subspecies has a very limited distribution, mainly near-coastal areas from the northern shores of Sydney Harbour south to Botany Bay, with most records from the Port Jackson area and the eastern suburbs of Sydney. It is found in coastal scrub and dry sclerophyll woodland on sandy soils.

One individual of *Acacia terminalis* subsp. *terminalis* was recorded in disturbed landscaped areas adjoining the Warringah Freeway, adjacent to a retaining wall of the Falcon Street shared user bridge, Cammeray. The single plant recorded was observed to be in poor health at the time of survey in March 2019, with most branches dead and live foliage only present on one branch.

This individual *Acacia terminalis* subsp. *terminalis* in the subject land was recorded in landscaped roadside areas characterised by planted native species and it is possible that it was planted. However seedlings of *Acacia terminalis* subsp. *terminalis* are known to grow on the edge of roads and tracks in long unburnt vegetation, and it is possible that physical disturbance triggers recruitment (DECCW, 2010). Given that the individual of *Acacia terminalis* subsp. *terminalis* is located within the known range of the species, it is assumed for the purpose of this assessment to be of wild local provenance.

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

Lead to a long-term decrease in the size of a population

The National Recovery Plan for *Acacia terminalis* subsp. *terminalis* (DECCW, 2010) defines a population of the species as comprising records within 300 metres of each other, as dispersal of the subspecies is unlikely to exceed this distance.

Given the location of the single *Acacia terminalis* subsp. *terminalis* recorded in the subject land, between a major freeway and the retaining wall beneath the shared user bridge, it is likely that it is already isolated from other populations of the species. The closest record of the species in the Bionet Atlas Database (OEH, 2019a) is located about 375 metres south-east of the individual in the subject land, in Forsyth Park on the opposite side of the Warringah Freeway.

The project would result in removal of one individual of *Acacia terminalis* subsp. *terminalis* from disturbed habitat in landscaped areas next to the Warringah Freeway. Given that *Acacia terminalis* subsp. *terminalis* is self-incompatible and therefore a single individual of the subspecies cannot reproduce, this isolated individual does not appear to represent part of a functional population.

Reduce the area of occupancy of the species

The small area of disturbed vegetation that *Acacia terminalis* subsp. *terminalis* was recorded in would be removed for the project, and one individual would be removed. This reduction in area of occupancy of the subspecies is considered negligible.

Fragment an existing population into two or more populations

The individual of *Acacia terminalis* subsp. *terminalis* recorded next to Warringah Freeway in the subject land is currently isolated and fragmented from other areas of habitat for the species and does not appear to be part of a functional population of the subspecies. The project would not result in further fragmentation.

Adversely affect habitat critical to the survival of a species

The recovery plan for *Acacia terminalis* subsp. *terminalis* identifies habitat critical to the survival of the species as:

- The area of occupancy of populations
- Areas of similar habitat surrounding and linking populations; and
- Additional occurrences of similar habitat that may contain undiscovered populations of the species or be suitable for future translocations.

The small area of disturbed roadside vegetation that would be cleared for the project is not considered likely to be habitat critical to the survival of the subspecies. This vegetation is not linked to other populations of the species, and the species was not recorded in other areas of similarly disturbed vegetation in the subject land.

Disrupt the breeding cycle of a population

The natural pollinators of *Acacia terminalis* subsp. *terminalis* appear to be small birds (including Thornbills, Silvereyes, and Spinebills), and honeybees may also share pollination in the summer months (DECCW, 2010). Seeds of *Acacia terminalis* subsp. *terminalis* are initially dispersed by gravity, and sometimes ants carry the seed further; this means the species dispersal is limited to a few metres distance (DECCW, 2010). The species has a long-lived persistent soil seed bank which may last up to 50 years. Germination of the species occurs mainly after fire, but it is possible it may also be triggered by disturbance (DECCW, 2010).

The individual of *Acacia terminalis* subsp. *terminalis* in the subject land is isolated from other populations of the species, and its removal is not likely to disrupt the breeding cycle of a population.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The action would not require the removal of any PCTs known to be associated with *Acacia terminalis* subsp. *terminalis*. Although the individual of *Acacia terminalis* subsp. *terminalis* was identified in disturbed roadside vegetation that would not have been considered likely to form potential habitat for the species, it has also not been identified in other areas of disturbed or planted native vegetation in the subject land during targeted surveys. The removal of one individual of *Acacia terminalis* subsp. *terminalis* from disturbed roadside habitat is considered unlikely to result in further decline of the species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

DECCW (2010) lists 19 species of major environmental weeds invading the habitat of *Acacia terminalis* subsp. *terminalis*; of these, only one, *Ligustrum lucidum*, was recorded in the vicinity of the *Acacia terminalis* subsp. *terminalis* in the subject land.

Construction activities may facilitate the introduction or spread of exotic grasses and other weeds that currently occur in and adjacent to the subject land. However there are no known populations of *Acacia terminalis* subsp. *terminalis* in areas within or adjacent to the subject land, beyond the one individual recorded in disturbed roadside vegetation. Management measures would be implemented to minimise the risk of introduction and spread of weeds.

Introduce disease that may cause the species to decline, or

It is not known whether *Acacia terminalis* subsp. *terminalis* is susceptible to infection of native plants by *Phytophthora cinnamomi*. If sufficient precautionary measures are in place the action is unlikely to result in the introduction of *Phytophthora* or any other disease that may cause the species to decline.

Interfere with the recovery of the species.

The recovery plan for *Acacia terminalis* subsp. *terminalis* identifies a range of actions for recovery of the species. The project would not interfere with any of these recovery actions.

Conclusion

Under the EPBC Act an action requires approval from the Australian Government Minister for the Environment and Energy (DoEE) if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance such as *Acacia terminalis* subsp. *terminalis*.

Based on the above assessment, it is concluded that the action would not have a significant impact on *Acacia terminalis* subsp. *terminalis*. The removal of one individual of the species from disturbed vegetation adjoining the Warringah Freeway does not comprise a significant proportion of the local

population of the species or of its habitat in the surrounding locality. The project is unlikely to introduce diseases or invasive species that would impact known populations of this species. As such the action does not require referral to DoEE.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox is listed as Vulnerable under the EPBC Act. In NSW, the Grey-headed Flying-fox occurs along the east coast, eastern slopes of the Great Dividing Range and the tablelands. The species may be found in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps, while additional foraging is provided by urban gardens and cultivated fruit crops.

Roosting camps are generally located within 20 kilometres of a regular food source and are commonly found in gullies in vegetation with a dense canopy. Individuals are loyal to camps but will travel up to 50 kilometres from the camp to forage. They are known to feed on nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines.

This species was observed flying over Berrys Bay during the survey carried out in February 2018. This species was also recorded by WSP flying over a number of locations within the subject land during surveys carried out in 2017.

The subject land does not support a camp, and therefore does not support critical roosting habitat for the species. Two nationally important Grey-headed Flying-fox camps are in the locality of the subject land in the *National Flying-fox monitoring viewer* (DoEE, 2019b): at Centennial Park (seven kilometres from the subject land), and at Burnt Bridge Creek, Balgowlah (nine kilometres from the subject land).

It is likely that the individuals recorded flying over the subject land were from these camps (although a number of other camps are located within the species' foraging range) and were observed flying overhead during their nightly foraging activities. The subject land provides foraging habitat for the Grey-headed Flying-fox, given the presence of preferred blossom and fruit tree species that occur within parks, road verges and private land (eg residential gardens).

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

Lead to a long-term decrease in the size of an important population of a species

Important populations are those that may be identified as such in recovery plans, and/or that are:

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

The Grey-headed Flying-fox has no separate or distinct populations (DoEE, 2019b). The species constantly exchanges genetic information between camps throughout its geographic range. The subject land is not used for permanent roosting or as maternity camps. They are not at the limit of the species range. The removal of a small amount of potential foraging habitat for the species would not lead to a long-term decrease in the size of the population, including any local camps.

Reduce the area of occupancy of an important population

The project would result in the removal of a very small amount of potential foraging habitat for the Grey-headed Flying-fox in an urban and developed environment. This would not reduce the area of occupancy of the species.

Fragment an existing important population into two or more populations

The removal of potential foraging habitat for the project would not fragment the population of the Grey-headed Flying-Fox into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is critical to the survival of the species as identified in the species' Draft National Recovery Plan (DECCW, 2009) is natural foraging habitat that meets at least one of the following criteria:

- Productive during winter and spring, when food bottlenecks have been identified
- Known to support populations of greater than 30,000 individuals within a 50-kilometre radius (the maximum foraging distance of an adult)
- Productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (September to May)
- Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes (months vary between regions)
- Known to support a continuously occupied camp.

The foraging habitat in the subject land is located seven kilometres from the Centennial Park camp, which has supported up to 50,000 flying foxes in recent years. As such, it technically falls within the criteria of habitat that is critical to the survival of the species. However, the potential foraging habitat to be removed consists of very small areas of mostly planted exotic and native trees, and a large amount of similar foraging habitat is readily available throughout the surrounding locality and wider bioregion. As such, the foraging habitat in the subject land is not considered to be critical to the survival of the species.

Disrupt the breeding cycle of an important population

There is no known maternity roosting camp of Grey-headed Flying-foxes in the subject land nor could it support one. The breeding cycle of this species would not be disrupted as a result of the project.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The project would involve the removal of a small number of feed trees of the Grey-headed Flying-fox. This foraging resource does not comprise a significant area of foraging habitat within the locality such that the species is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action is unlikely to result in the establishment of an invasive species that is harmful to the Grey-headed Flying-fox.

Introduce disease that may cause the species to decline, or

The action is highly unlikely to introduce disease that may cause the Grey-headed Flying-fox to decline.

Interfere with the recovery of the species

There is currently no approved Recovery Plan in place for the Grey-headed Flying-fox. A Draft National Recovery Plan for the Grey-headed Flying-fox was prepared in July 2009 (DECCW, 2009). The Draft National Recovery Plan lists 13 specific objectives for the five-year timeframe of the Plan. Of these, two could be considered relevant to the project:

- Objective 1: To identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range
- Objective 2: To protect and increase the extent of key winter and spring foraging habitat of Grey-headed Flying-foxes.

The project is consistent with these two objectives of the Draft National Recovery Plan. The potential foraging habitat that would be removed as a result of the project is not likely to be key winter or spring foraging habitat nor is it likely to be critical to the survival of this species in the locality.

Conclusion

The project would require the removal of a small amount of potential foraging habitat for this species. The amount of potential foraging habitat to be cleared is not considered to be a significant area of habitat or of importance to the long-term survival of Grey-headed Flying-fox in the locality. As a result, it is considered unlikely that the project represents a significant impact to the vulnerable species Grey-headed Flying-fox. A Referral to the Minister is not required for this species.

White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

The White-bellied Sea-Eagle is listed as a Vulnerable species under the BC Act.

This species was observed flying above Sydney Harbour from Balls Head Reserve and flying above Goat Island. It has been previously recorded in the subject land, foraging the waters of Sydney Harbour near Balls Head (OEH, 2019a).

The White-bellied Sea-Eagle is a large eagle that is distributed along the east coast of NSW (around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves), and along all major inland rivers, swamps, freshwater lakes and reservoirs. This species hunts above large areas of open water for fish, freshwater turtles, waterbirds, reptiles, mammals and carrion. White-bellied Sea-Eagles typically construct a large stick nest in a large emergent eucalypt, within mature tall open forest, open forest, tall woodland and swamp sclerophyll forest close to foraging habitat. However, nests may be built in a variety of sites including bushes, mangroves, cliffs, rocky outcrops, caves, crevices, on the ground or on artificial structures (DoEE, 2019a). White-bellied Sea-Eagles may be solitary or live in pairs or small family groups consisting of a pair of adults and dependent young. Resident pairs are territorial and occupy nesting territories of hundreds of hectares.

The subject land is not known to support a White-bellied Sea Eagle nest. The closest known nesting site is located in Newington Nature Reserve, next to the Parramatta River and about 12 kilometres north-west of the subject land. A pair of White-bellied Sea Eagles currently occupies this nest, and these birds are often observed feeding on mullet or other fish from nearby wetlands (Birdlife, 2018).

The subject land offers foraging habitat to the species, due to the presence of preferred prey species that inhabit Sydney Harbour. The wider assessment area, outside of the subject land, offers potential perching habitat, due to the presence of trees that occurs along the harbour foreshore at Balls Head, Birchgrove and Waverton.

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

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

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

- Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or
- Habitat that is of critical importance to the species at particular lifecycle stages, and/or
- Habitat used by a migratory species which is at the limit of the species range, and/or
- Habitat within an area where the species is declining.

The small area of potential foraging habitat occurring within the subject land does not comprise important habitat for the White-bellied Sea Eagle. The subject land does not support an ecologically significant proportion of the population of the species. The subject land does not support nesting habitat for the species (the nearest nest site is located at Newington Nature Reserve), and as such, foraging habitat within the subject land is not of critical importance to the species at particular lifecycle stages. The White-bellied Sea-Eagle is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia; the subject land is not located at the limit of the species range. While there have been no published estimates of the area of occupancy, and no specific information is available on changes in the area of occupancy (DoEE, 2019a), the persistence of the species at the Newington Nature Reserve nest site, and successful fledging of White-bellied Sea-Eagle chicks from this same nest site in recent years, suggest that the species is not declining in the subject land, wider assessment area and the Sydney Harbour estuary.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

The project is not expected to introduce, or facilitate the introduction, of an invasive species that is harmful to White-bellied Sea Eagles.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

Works within Sydney Harbour (ie installation of the cofferdams and dredging) would cause an increase in turbidity and sedimentation of marine waters, in turn causing localised degradation of potential foraging habitat for the White-bellied Sea-Eagle. An increase in suspended sediment near construction activities may adversely impact the occurrence and behaviour of fish and other prey species. However, the selected methodology for the project has considered dredging methods and controls to limit the potential for turbidity impacts and mobilisation of sediment, in order to minimise the impact on the surrounding marine environment. This includes, but is not limited to, the installation of floating silt curtains and other management measures. Accordingly, any potential increase in turbidity and sedimentation of marine waters near construction activities would be minimal, localised and temporary.

While in operation, the cofferdams would temporarily remove a small proportion of potential foraging habitat for White-bellied Sea-Eagles, as the cofferdam structures would be dewatered following installation. However, these areas comprise a very small proportion of the foraging habitat available to the White-bellied Sea-Eagles in Sydney Harbour. Following construction of the interface structures, the cofferdams would be removed and the marine environment would be rehabilitated. Accordingly, the loss of potential foraging habitat in marine waters at cofferdam locations would be minimal, localised and temporary.

Upon completion of construction and during operation, the project is not expected to adversely impact foraging habitat that occurs within the subject land. The project is not expected to seriously disrupt the lifecycle of the White-bellied Sea Eagles that are known to range throughout the Sydney Harbour estuary.

