

12 Biodiversity

This chapter provides a summary of the biodiversity impacts associated with the project and outlines how the desired performance outcomes for biodiversity have been met. A detailed biodiversity development assessment report (BDAR) has been prepared for the project and is included in **Appendix H** (Biodiversity development assessment report). **Table 12-1** sets out the assessment requirements as provided in the SEARs relevant to biodiversity and where the requirements have been addressed in this EIS.

Table 12-1 SEARs – Biodiversity

Assessment requirements	Where addressed
Environmental Impact Assessment Process	
2. It is the Proponent's responsibility to determine whether the project needs to be referred to the Commonwealth Department of the Environment and Energy for an approval under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act</i> (EPBC Act).	An assessment of the project's impact on matters of national environmental significance is included in section 12.3 and section 12.4 . A referral to the Australian Government Department of the Environment and Energy for an approval under the EPBC Act is not required for the project. The assessment process and determination that the project does not need to be referred to the Australian Government Department of the Environment and Energy is included in Chapter 2 (Assessment process).
Biodiversity	
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).	The biodiversity assessment was undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR) (refer to Appendix H (Biodiversity development assessment 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 (BAM) including details of the measures proposed to address the offset obligation as follows: <ul style="list-style-type: none"> a) the total number and classes of biodiversity credits required to be retired for the developments/project; b) the number of classes of like-for-like biodiversity credits proposed to be retired; c) the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; d) any proposal to fund a biodiversity conservation action; and e) any proposal to make a payment to the Biodiversity Conservation Fund. 	The measures proposed to address offset obligations are included in section 12.5 and Appendix H (Biodiversity development assessment 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.	The BDAR does not propose to apply a variation rule to seeking offsets.
4. The BDAR must be prepared by a person accredited in accordance with the <i>Accreditation scheme for the Application of the Biodiversity Assessment Method Order 2017</i> under s. 6.10 of the <i>Biodiversity Conservation Act 2016</i> .	The biodiversity assessment was undertaken by accredited assessors, in accordance with the requirements of the Biodiversity Assessment Method Order 2017. Refer to Appendix H (Biodiversity development assessment report) for details of the accredited assessors who undertook the assessment.

Assessment requirements	Where addressed
5. In accordance with section 9.1 and 9.2 of the BAM the BDAR must assess all direct and indirect impacts of the project on native vegetation, threatened ecological communities and threatened species habitat based on current records.	Impacts of the project on native vegetation, threatened ecological communities and threatened species habitat is included in section 12.3 , section 12.4 and Appendix H (Biodiversity development assessment report).
6. The biodiversity assessment must consider impacts on: a) wetland vegetation communities over the entire alignment of the tunnel; and b) wetland fauna habitat.	Impacts on wetland vegetation communities and fauna habitat are discussed in section 12.3 , section 12.4 and Appendix H (Biodiversity development assessment report).
7. The biodiversity assessment must assess cumulative impacts with current road projects such as additional impacts, prolongment of biodiversity impacts, and deferment of habitat rehabilitation works.	Cumulative impacts with current roads projects are discussed in section 12.4.6 and Appendix H (Biodiversity development assessment report).
8. Impacts on biodiversity values that cannot be assessed using the BAM must also be otherwise assessed. The values include: a) impacts on fish habitats and nurseries within and adjoining the project area; and b) matters of national significance listed under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .	Impacts on aquatic biodiversity are discussed in section 12.3.3 , 12.4.3 and Appendix H (Biodiversity development assessment report). Impacts on matters of national significance are discussed in section 12.3.6 , 12.4.4 and Appendix H (Biodiversity development assessment report). Impacts on Groundwater Dependent Ecosystems (GDEs) are discussed in section 12.3.4 , 12.4.3 and Appendix H (Biodiversity development assessment report).
9. The assessment of aquatic habitats must identify mitigation and management measures to minimise construction impacts including the spread of aquatic weeds.	Impacts on aquatic habitats are discussed in section 12.3.3 , 12.4.3 and Appendix H (Biodiversity development assessment report), and measures proposed to minimise construction impacts are discussed in section 12.6 and Appendix H (Biodiversity development assessment report).
10. The EIS must include design opportunities for improvement of the Rockdale Wetlands including measures to reduce the potential for de-oxygenation of and increased nutrient inputs to waters.	Opportunities for improvement of the Rockdale Wetlands will be investigated; including management measures to maintain more consistent dissolved oxygen conditions (refer to Chapter 18 (Surface water and flooding)). A surface water and groundwater monitoring regime will be undertaken to inform the investigation.
11. Where waterbodies are to be reconstructed, the design should be consistent with the current guidelines.	Waterbodies would be constructed in accordance with current guidelines. Refer to Chapter 13 (Landscape and visual impacts).

12.1 Assessment approach

The key components of the biodiversity assessment included:

- Desktop analysis to describe the existing environment and landscape features of the study area and to identify threatened terrestrial and aquatic values potentially affected by the project
- Field surveys to identify the biodiversity values within the construction boundary and to determine the likelihood of threatened species and their habitats occurring in the construction boundary or being affected by the project
- Qualitative assessment of potential impacts of the project on biodiversity values, including threatened species.

A summary of the tasks undertaken to inform the Biodiversity Development Assessment Report (BDAR) is included in this section.

The biodiversity assessment for the permanent power supply connection was not completed as part of the BDAR for the main project as it is expected to have negligible biodiversity impacts compared to the main project. The assessment consisted of desktop analysis to describe the existing environment of the indicative construction route and a qualitative assessment of potential impacts on biodiversity values.

12.1.1 Relevant guidelines and policies

The BDAR has been prepared to assess the impacts of the project in accordance with relevant legislation as described in **Table 12-2**.

Table 12-2 Legislation relevant to the biodiversity assessment of the project

Name	Relevance to the project
Commonwealth	
<i>Environmental Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	Under the EPBC Act, an action includes a project, undertaking, development, activity, and series of activities or alteration. An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is a 'controlled action' and may not be undertaken without approval from the Australian Government Minister for the Environment. The project would not have a significant impact upon any Matters of National Environmental Significance (MNES) and therefore does not require approval from the Australian Government Minister for the Environment as outlined in section 12.3 and section 12.4 .
State	
<i>Biodiversity Conservation Act 2016</i> (BC Act)	<p>The project is a major project and requires submission of a Biodiversity Development Assessment Report under the BC Act.</p> <p>The BC Act provides for listing of 'threatened species, populations and ecological communities', 'Key Threatening Processes', and the preparation and implementation of Recovery Plans and Threat Abatement Plans.</p> <p>The biodiversity assessment was undertaken by accredited assessors, in accordance with the requirements of the Biodiversity Assessment Method Order 2017. The BDAR includes information in the form detailed in the Biodiversity Conservation Act 2016 (s. 6.12), Biodiversity Conservation Regulation 2017 (s 6.8) and Biodiversity Assessment Method (BAM).</p> <p>Annexure E of Appendix H (Biodiversity development assessment report) outlines where the requirements of the BAM are addressed in the Biodiversity development assessment report.</p> <p>As detailed in section 12.3 and section 12.4, the project is not expected to have a significant impact on any species or communities listed under the BC Act.</p>
<i>Fisheries Management Act 1994</i> (FM Act)	<p>The FM Act aims to conserve, develop and share the fishery resources of the state. It provides listings of 'threatened species, populations and ecological communities', 'Key Threatening Processes', and the preparation and implementation of Recovery Plans and Threat Abatement Plans. The FM Act has been considered for the purpose of this assessment with regard to aquatic biodiversity (including listed protected and threatened species and populations) and Key Threatening Processes.</p> <p>Sections 201, 205 and 219 of the FM Act require permits to be obtained for dredging or reclamation work (including any excavation of land submerged by water), harming marine vegetation and blocking of fish passage respectively. However, permits under the FM Act are not required for approved State significant infrastructure (in accordance with section 5.23 of the Environmental Planning and Assessment Act 1979 (NSW) (EP&A Act).</p> <p>In accordance with Section 199 of the FM Act, notification to the NSW Department of Primary Industries (Fisheries) (DPI-Fisheries) is required if dredging or reclamation works are required in water land classed as key fish habitat. Following detailed design, DPI-Fisheries would be notified regarding construction works at Cooks River and Rockdale Wetlands and its response would be considered (refer to Chapter 2 (Assessment process)).</p>
<i>Water Management Act 2000</i> (WM Act)	An assessment of the potential impacts to groundwater dependent ecosystems (GDEs) was carried out as part of the BDAR and is summarised in section 12.3.4 and section 12.4.4 .

Name	Relevance to the project
<i>State Environmental Planning Policy (Coastal Management) 2018</i> (Coastal Management SEPP)	<p>The Coastal Management SEPP establishes a new, strategic land use planning framework for coastal management. It identifies the wetland within Rockdale Bicentennial Park and Scarborough Park North, as well as other wetlands within the vicinity of the project, as "coastal wetlands". There are also areas surrounding Rockdale Bicentennial Park and Scarborough Park North which are identified as a "proximity area for coastal wetlands".</p> <p>Clause 10(1) of the Coastal Management SEPP states that development on land identified as "coastal wetlands" may only be carried out with development consent.</p> <p>Clause 11(1) of the Coastal Management SEPP states that development consent on land identified as "proximity area for coastal wetlands" must not be granted unless the consent authority is satisfied that the proposed development will not significantly impact on:</p> <ol style="list-style-type: none"> the biophysical, hydrological or ecological integrity of the adjacent coastal wetland or littoral rainforest, or the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland or littoral rainforest. <p>The project is State significant infrastructure and is permissible without consent; therefore Clause 10(1) and Clause 11(1) do not apply once it is approved by the Minister for Planning.</p>

Policy and guidelines

The BDAR has been prepared to assess the impacts of the project on biodiversity values in accordance with the requirements of the NSW Biodiversity Offsets Scheme¹ and the Biodiversity Assessment Method (BAM).

The BAM contains the assessment methodology to quantify and describe the biodiversity values within the construction boundary, and the methodology to assess the biodiversity offsets required for any unavoidable impacts. The BDAR for the project has assessed impacts to all MNES using the significant impact criteria and guidelines established by the Commonwealth.

The BAM applies predominantly to terrestrial impacts. The assessment of impacts of the project on aquatic environments and biodiversity has been undertaken in accordance with the *Policy and Guidelines for Fish Habitat Conservation and Management* (update 2013)² which incorporates *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*³.

The BDAR has also considered the following guidelines:

- *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (NSW DPI 2012)
- *NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft November 2004* (NSW DEC 2004)
- *NSW Threatened species survey and assessment guidelines: field survey methods for fauna (Amphibians)* (NSW DECC 2009)
- *NSW Sustainable Design Guidelines Version 3.0* (TfNSW 2013)
- *Aquatic Ecology in Environmental Impact Assessment – EIA Guideline* (Marcus Lincoln Smith 2003)
- *Commonwealth Survey Guidelines for Australia's Threatened Frogs* (DEWHA 2010)
- *Commonwealth Survey Guidelines for Australia's Threatened Bats* (DEWHA 2010)
- *Matters of National Environmental Significance Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth 2013)
- *Referral guideline for management actions in Grey-Headed and Spectacled Flying-fox camps* (Commonwealth 2015).

¹ NSW Office of Environment and Heritage (OEH) (2017). *Biodiversity Offsets Scheme*.

² NSW Department of Primary Industries (DPI) (2013). *Policy and Guidelines for Fish Habitat Conservation and Management (update 2013)*.

³ Fairfull and Witheridge (2003). *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*.

Study area

A study area for matters covered by the BAM as well as matters of national environmental significance (MNES) has been defined as the land within the construction boundary and within 500 metres of the construction boundary. The construction boundary and study area is shown in **Figure 12-1**.

The study area assessed for groundwater dependant ecosystems (GDEs) and riparian ecosystems included a 500 metre buffer of the construction boundary (including the full length of the tunnels underground), as shown in **Figure 12-6**. Riparian ecosystems are those associated with (and often located adjacent or close to) waterbodies, or dependent on surface or subsurface drainage. GDEs are defined and discussed in further detail in **section 12.2.5**.

Some desktop assessment tools for biodiversity have a minimum search area of a 10 kilometre radius. This area is referred to as ‘the locality’ in this chapter.

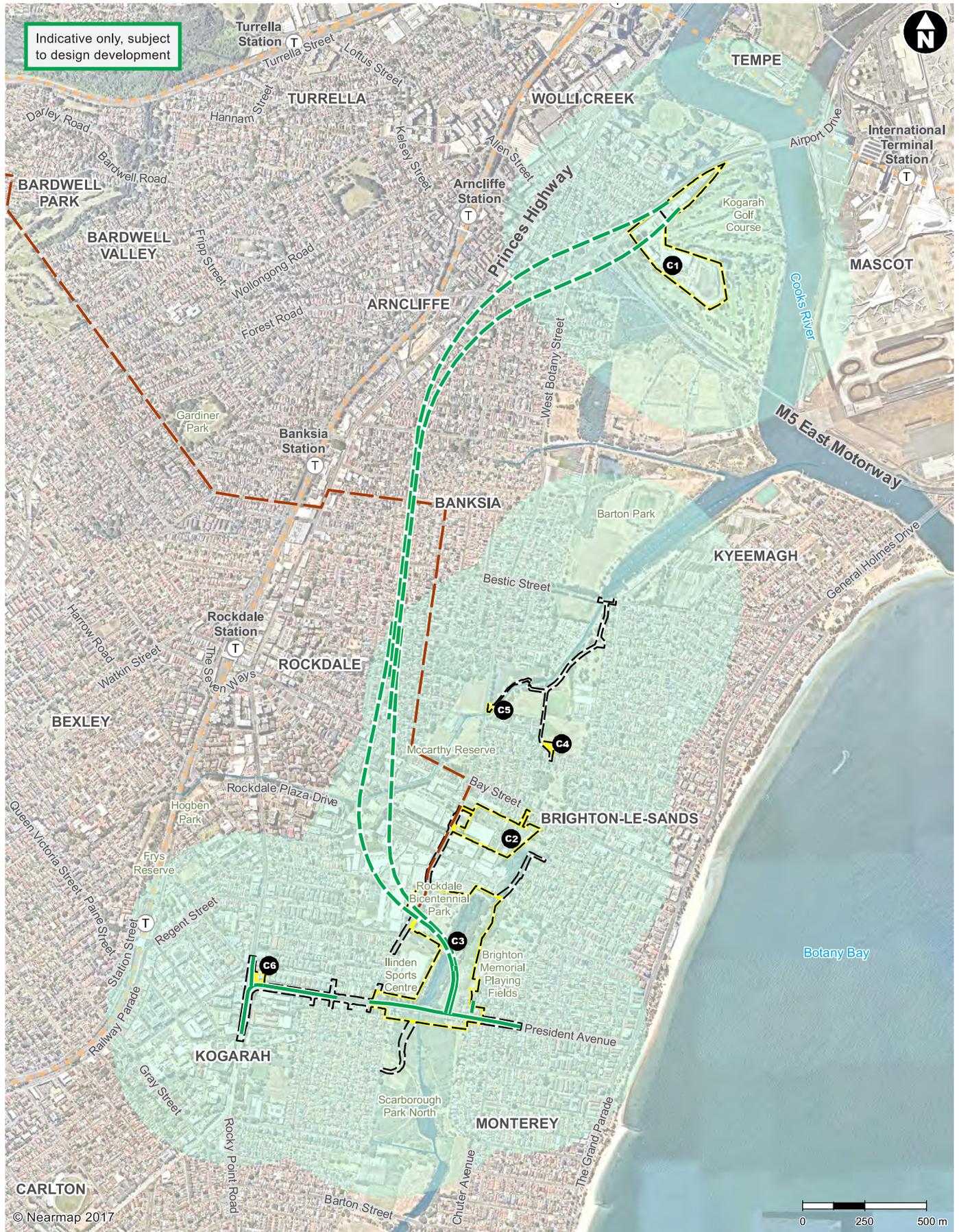


Figure 12-1 Biodiversity assessment study area

12.1.2 Desktop assessment

A desktop review was undertaken to identify the potential presence of threatened species, populations or ecological communities listed under the BC Act and FM Act, as well as MNES listed under the EPBC Act within the study area. The desktop review included a review of the following databases and aerial photography:

- Visual information system online Vegetation Classification database (OEH 2017)
- Atlas of NSW Wildlife (5 kilometre radius search) (OEH 2017)
- Threatened Biodiversity Data Collection (OEH 2017)
- Directory of Important Wetlands Australia (Commonwealth DEE 2017)
- State Environmental Planning Policy (Coastal Management) 2018 Interactive maps
- Sydney Metropolitan Catchment Management Authority Vegetation Mapping v 3.0 (OEH 2016)
- Soil Landscapes of the Sydney 1:100,000 Sheet (Chapman and Murphy 1989)
- EPBC Act Protected Matters Search Tool (5 kilometre radius search) (Commonwealth DEE 2017)
- NSW Fisheries Marine Vegetation Map (Botany Bay and Cooks River) (NSW DPI 2000)
- National Atlas of Groundwater Dependent Ecosystems, accessed January 2018 (<http://www.bom.gov.au/water/groundwater/gde/>)
- Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011
- Threatened Biodiversity Data Collection (OEH 2017)
- Fisheries threatened and protected species records viewer (NSW DPI 2017)
- *Fisheries Management Act* -listed protected and threatened species and populations, including species profiles, 'Primefact' publications and expected distribution maps (Riches et al. 2016)
- Online Zoological Collections of Australian Museums (OZCAM).

Documents which were also reviewed to assist with identifying biodiversity values within the study area included:

- WestConnex New M5 EIS – Biodiversity Assessment Report (EcoLogical 2015)
- Rockdale Biodiversity Strategy 2014 – A Strategy for the Natural Assets of the City of Rockdale (Rockdale City Council 2014).

Likelihood of occurrence assessment

Based on the desktop assessment, further assessment was undertaken to determine how likely a particular species is to occur within the study area. A likelihood ranking was then assigned to each species, according to whether the species was 'known', 'likely', 'possible', 'unlikely' or 'absent'. The likelihood of occurrence assessment was used to guide and inform the field surveys that were undertaken for the project. Refer to Annexure A of **Appendix H** (Biodiversity development assessment report) for the likelihood of occurrence assessment and description of likelihood rankings.

12.1.3 Field surveys

Flora

The existing vegetation community mapping⁴ within the study area was verified to confirm the presence or absence of native vegetation communities, including presence of any threatened ecological communities (TECs). Vegetation communities were identified from a combination of floristic surveys and transect traverses conducted in September 2017, and checked to see if a plant community type (PCT) could be assigned, by comparing the dominant canopy species, the general description of location, soil type and other attributes as described in the NSW OEH BioNet Vegetation classification⁵. If a PCT could not be assigned, it was identified as non-native vegetation.

Targeted threatened species surveys were conducted for *Syzygium paniculatum* (Magenta Lilly Pilly) as this species was initially considered to have the potential to occur within the construction boundary. Magenta Lilly Pilly is listed as endangered under the BC Act.

Four full floristic vegetation plots and four vegetation integrity plots were surveyed within the 'project footprint' or 'development footprint' (referred to as the construction boundary in this chapter) in accordance with the BAM. All field data collected at full-floristic and vegetation integrity plots are included in Annexure 2 of **Appendix H** (Biodiversity development assessment report).

Where vegetation was present but it could not be classified as any particular PCT, it was combined into the vegetation type 'Urban Exotic and Native Cover' (see **section 12.2.2**).

Fauna

Fauna surveys were carried out over several days between October 2017 and March 2018 at Rockdale Bicentennial Park and surrounds and in the vicinity of the Arncliffe construction ancillary facility, as these areas were considered the only potential habitat for species within the construction boundary. Details of the field surveys, survey extents and survey conditions are provided in **Appendix H** (Biodiversity development assessment report). In summary, these surveys included:

- Fauna habitat assessments to identify potential habitat for threatened fauna species (such as hollow-bearing trees, rock habitats, roosting habitat for the *Pteropus poliocephalus* (Grey-headed Flying-fox), known food trees and evidence of fauna usage)
- Targeted threatened species surveys were conducted for *Myotis macropus* (Southern Myotis) as they are considered to have the potential to occur in the study area
- Targeted threatened species surveys were conducted for *Litoria aurea* (Green and Golden Bell frog) in accordance with the *Survey guidelines for Australia's threatened frogs*⁶. These surveys took place in February and March 2018.
- Targeted surveys for 'species credit species' (detailed in **Appendix H** (Biodiversity development assessment report))
- Surveys for migratory birds at dawn for two hours per session, over three months to account for temporal and tidal variation.

An assessment of the aquatic habitat was also undertaken in the wetland within Rockdale Bicentennial Park through Rockdale Wetlands, the wetland entering Scarborough Park North, Muddy Creek upstream of Bestic Street and the Cooks River near Kogarah Golf Course.

⁴ NSW OEH (2016). Sydney Metropolitan Catchment Management Authority Vegetation Mapping v 3.0.

⁵ NSW OEH (2017). Visual information system online Vegetation Classification database.

⁶ Commonwealth of Australia (2010) *Survey guidelines for Australia's threatened frogs*.

12.2 Existing Environment

12.2.1 Landscape features

The landscape features of the study area have been determined in accordance with the requirements of the BAM. Landscape features contribute to the overall biodiversity value of the study area and are used to inform appropriateness of offsets where required. **Table 12-3** summarises the biodiversity landscape features of the study area. Figures showing landscape features of the study area are included in **Appendix H** (Biodiversity development assessment report).

Table 12-3 Biodiversity landscape features of the study area

Landscape feature	Description
Interim Biogeographic Regionalisation for Australia (IBRA) region and subregion	The study area is located entirely within the Sydney Basin Bioregion, which extends north to the Hunter Valley, west to Mudgee and south to Batemans Bay, and is within the Pittwater IBRA subregion. The study area occurs within a highly urbanised setting surrounded by extensive areas of established urban development.
Mitchell landscapes	The majority of the study area occurs within the Mitchell landscapes of Sydney–Newcastle Barriers and Beaches landscape and the Woronora Plateau landscape.
Rivers and streams	<p>The study area intersects three waterways, including:</p> <ul style="list-style-type: none"> • Cooks River (near Kogarah Golf Course) – 4th order stream • Muddy Creek (upstream of Bestic Street) - 1st order stream • Wetlands within Rockdale Bicentennial Park through Rockdale Wetlands and south of President Ave (within Scarborough Park North) – 1st order stream <p>Cooks River is mapped as key fish habitat, as defined in the <i>Fisheries Policy and Guidelines for Fish Habitat Conservation and Management update 2013</i>⁷.</p> <p>Muddy Creek is also mapped as key fish habitat, north of Bestic Street (tidal portion).</p> <p>A riparian area of around 40 metres exists either side of Cooks River. A riparian area of around 10 metres exists either side of Muddy Creek and the wetland within Rockdale Bicentennial Park.</p> <p>The permanent power supply connection also crosses Muddy Creek, Bardwell Creek and Wollli Creek.</p>
Wetlands	<p>Five wetlands (listed under the Directory of Nationally Important Wetlands) are located within the study area (refer to Figure 12-5), including:</p> <ul style="list-style-type: none"> • Eve Street Wetland (Nationally important) • Marsh Street Wetland (Locally important) • Landing Lights Wetland (Locally important) • Spring Street Wetland (Locally important) • Scarborough Park North Wetland (Locally important) <p>The Eve Street Wetland is located around 500 metres from the project and the Landing Lights, Marsh Street, and Spring Street wetlands are within the 500 metre buffer area but do not fall within the construction boundary. A small section of the Scarborough Park North wetland is within the construction boundary.</p> <p>The Coastal Management SEPP identifies the wetlands within Rockdale Bicentennial Park and Scarborough Park North, as well as other wetlands within the vicinity of the project, as “coastal wetlands”. There are also areas surrounding Rockdale Bicentennial Park and Scarborough Park North which are identified as a “proximity area for coastal wetlands”.</p>

⁷ Fairfull and Witheridge (2003). *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*.

Landscape feature	Description
State or regionally significant biodiversity links (connectivity)	The study area does not contain any connectivity features. However, there is a corridor of land extending south from Brighton-Le-Sands to Ramsgate that is primarily open space and is a local wildlife corridor. This corridor forms part of the existing F6 reserved corridor. The open space and minor areas of native vegetation do not connect large patches of intact native vegetation or habitat. However this is likely to function as 'stepping stones' between habitats for relatively common urban wildlife.
Vegetation cover	The assessment for the study area (500 metres from the construction boundary) in accordance with the BAM) recorded around 21.45 hectares of native vegetation cover. This represents around 35 per cent native vegetation cover.
Patch size or vegetation	Patch size for the native vegetation identified in the study area was calculated using vegetation mapping for all patches of intact native vegetation on and adjoining the construction boundary. Patch size is calculated for each patch of vegetation that occurs on or adjoins the construction boundary where there is a gap, and the vegetation is intact. The patch size for use in the tool was 15.4 hectares. Vegetation within the remainder of the study area comprises patches of urban native and exotic vegetation and is surrounded by extensively urbanised areas.

12.2.2 Terrestrial flora

Native vegetation communities

The BAM requires the extent of native vegetation within the 'project area' (defined in this assessment as the construction boundary) to be mapped. This native vegetation was classified using PCTs defined in the BioNet Vegetation Classification database.

The project is located in a highly urbanised environment and much of the area is entirely modified and disturbed, and contains exotic species, weeds and planted native or non-indigenous species. It is characterised by urban parks, landscaped road verges, compacted soils, introduced fill, existing dwellings, industrial areas and other infrastructure.

Previous mapping identified the following vegetation communities within the construction boundary:

- Estuarine Reedland
- Estuarine Swamp Oak Forest
- Coastal Flats Swamp Mahogany Forest
- Urban Native and Exotic Cover.

A total of three native vegetation types corresponding with three PCTs were identified within the construction boundary during field surveys (see **Table 12-4**). The three PCTs are listed as Endangered under the BC Act.

Table 12-4 Plant community types within the construction boundary

PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Area
1232	Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Coastal Swamp Forest	Forested Wetlands	0.47
1795	Swamp Mahogany / Cabbage Tree Palm – Cheese Tree – Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Coastal Swamp Forest	Forested Wetlands	0.30
1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	Coastal Freshwater Lagoons	Freshwater Wetlands	0.77

Vegetation types that are saline, such as saltmarsh or mangrove forest are not quantified or assessed as per the BAM. These are addressed and described in **section 12.2.4**.

One of the Swamp Oak floodplain swamp forest communities is located within Rockdale Bicentennial Park, along the drainage line (see **Figure 12-2**). This community is in a disturbed condition, with a high occurrence of weeds and exotic species in the understorey. Much of the community is landscaped and there is regular human traffic through the area. To the south of President Avenue, this PCT is present as a treeless vegetation type, along the edges of the drainage line south of President Avenue. The community is also in a disturbed condition with a high occurrence of weeds. This PCT includes areas where the canopy may be absent due to inundation and hydrological cycles.

The Swamp Mahogany/Cabbage Tree Palm community is likely to have been reconstructed and planted as part of bush regeneration works in Rockdale Bicentennial Park (see **Figure 12-2**). The canopy is dominated by native vegetation communities such as *Eucalyptus robusta* (Swamp Mahogany). The understorey is predominantly planted native herbs and grasses with a few exotic species. The species present reflect a subset of the species likely to be found in this PCT plus other species that would be native to coastal alluvial flats.

The Common Reed plant community was present as a treeless vegetation type, along the edges of the drainage line south of President Avenue. The community was in a disturbed condition with a high occurrence of weeds, such as *Rubus fruticosus* (Blackberry) and *Lantana camara* (Lantana). The reedlands were dominated by *Phragmites australis* (Common Reed). A canopy layer was very sparse and consisted of the occasional low growing *Casuarina glauca* (She Oak) on the banks of the drainage line. Like the Swamp Oak floodplain community, this PCT includes areas where the canopy may be absent due to inundation and hydrological cycles.

A fourth vegetation type was identified within the construction boundary, but could not be classified into a PCT. This vegetation is mapped as Urban Exotic and Native Cover (4.80 hectares) which consists of planted, non-indigenous native and exotic species within local parklands. These areas often contain large expanses of exotic grasses and other weeds and generally occur where the soil profile has been extensively modified. Some areas only contain large established trees (native and exotic) over exotic grasses, with no shrub layer or evidence of regenerating over storey species.

A typical area within the Rockdale Bicentennial Park contains exotic vegetation and weeds, planted indigenous or non-indigenous and disturbance tolerant species across all vegetation layers.

The Arncliffe construction ancillary facility (C1) would be located within an existing construction site for the New M5 Motorway project. The direct biodiversity impacts of the New M5 Motorway project (including the clearing of the land within C1) were assessed using the Framework for Biodiversity Assessment methodology in the WestConnex New M5 EIS – Biodiversity Assessment Report⁸, and offsets have already been provided under the approval for that project.

The remainder of surface works (including at the Rockdale (C2), President Avenue (C3), shared cycle and pedestrian pathways east (C4) and west (C5) construction ancillary facilities), and President Avenue construction ancillary facility (C6) are located in areas generally characterised by urban parks, road infrastructure, landscaped road verges, introduced fill, industrial areas, existing dwellings and other infrastructure. These areas are considered to be in a poor ecological condition, with little ecological value, and are unlikely to have any native resilience or recovery potential.

The existing ecological conditions along the route of the permanent power supply connection can be largely characterised as heavily modified by urban and residential development. The permanent power supply would be either installed underground or, where the power line crosses waterways or railways, installed in a conduit attached to an existing crossing or underbored to avoid impacts. The power line would be located within the existing road reserve with the exception of where it would cross Bardwell Valley Golf Club, Bardwell Creek, run along the edge of Silver Jubilee Park and go under the T4 Eastern Suburbs and Illawarra Line. The power line would be constructed via trenching, or where required, under-boring (for example to avoid impacts to vegetation).

A desktop review of the Protected Matters Search Tool revealed numerous native vegetation communities within 10 kilometres of the permanent power supply construction route (refer to **Figure 7-11**). Given the highly urbanised and developed nature of the proposed works area, most of these native vegetation communities have been heavily disturbed and modified, and it is noted that there has been widespread incursion of weeds and exotic species. Native vegetation is either remnant or regrowth and the habitat conservation value of most vegetation is low.

⁸ Eco Logical Australia (2015). WestConnex New M5 EIS – Biodiversity Assessment Report.

Bardwell Creek is steeply incised and comprises of introduced fill and weeds. Vegetation within Bardwell Valley Golf Club comprises of sparsely distributing mature trees. There are no significant vegetation communities in tact in the vicinity of the proposed route and the area has been subject to a high level of previous disturbance due to ongoing maintenance of the Golf Club.

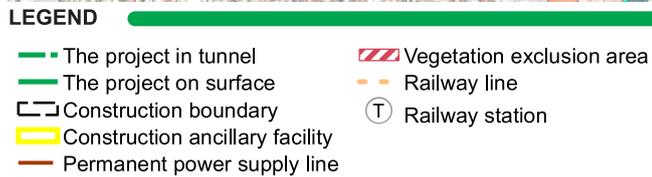
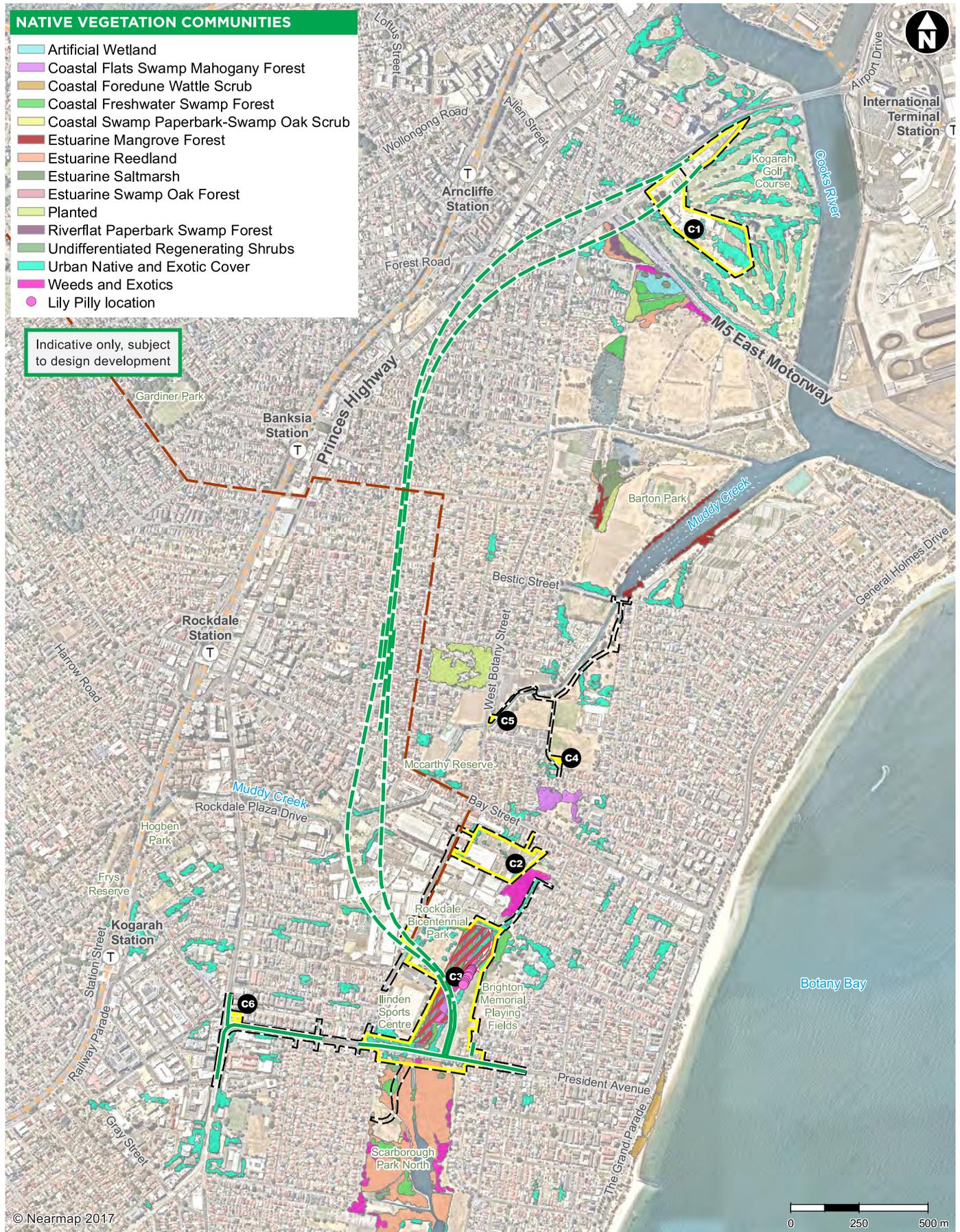


Figure 12-2 Native vegetation communities within the study area

Threatened ecological communities

Of the three PCTs identified within the study area, two threatened ecological communities were present (see **Table 12-5**). Both are listed under the BC Act and neither are listed under the EPBC Act.

Table 12-5 TECs identified within the construction boundary

PCT ID	PCT Names	Threatened ecological community name	BC Act listing	EPBC Act listing	Area
(a) 1232 (b) 1808	(a) Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion (b) Common Reed on the margins of estuaries and brackish lagoons along the NSW South Wales coastline	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	Endangered	Not listed	(a) 0.47 hectares (b) 0.77 hectares Total: 1.24 hectares
1795	Swamp Mahogany / Cabbage Tree Palm – Cheese Tree – Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	Endangered	Not listed	0.30 hectares

A vegetation integrity assessment using the Credit Calculator (BAMC) was undertaken to identify ecosystem credit species (species that can be reliably predicted based on the PCT), and ‘species credit species’ (species that require credits/offsets). The results are outlined in **Table 12-6**. The identification of ecosystem credit species is required based on the PCT, IBRA subregion of the study area and the condition and patch size of vegetation to be impacted (see **Table 12-3**).

Table 12-6 Vegetation integrity

Veg Zone	PCT ID	Condition	Area (ha)	Composition Condition Score	Structure Condition Score	Function Condition Score	Current vegetation integrity score
1	1232	Moderate – Good	0.47	24.7	27.5	48	32
2	1795	Moderate – Good	0.30	78	58	78.2	70.7
3	1808	Moderate – Good	0.77	25.6	15.4	-	19.9

There is one threatened ecological community listed under the BC Act located within 100 metres of the permanent power supply construction route. It is a community of Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions, located within Girrahween Park around 20 metres west of the proposed alignment along Hartill-Law Avenue. No TECs were located within the proposed alignment of the power supply connection.

Threatened flora

During the field surveys, planted *Syzygium paniculatum* (Magenta Lilly Pilly) was found within the construction boundary. Around 20 adult individuals were recorded within Rockdale Bicentennial Park as landscape plantings, which were not fruiting or flowering. The area where Magenta Lilly Pilly was recorded is not a known population for this species, as identified in the Recovery Plan.

Ecosystem credit species

The BAM requires that a list of threatened species that can be reliably predicted by habitat surrogates are identified. These species are called ecosystem credit species and they are automatically generated based on the PCT, the IBRA subregion of the construction boundary, the cover and patch size of vegetation. The BAM allows an assessor to determine whether any of the habitat components for the predicted threatened species are present or not. If they are not present, an assessor does not need to identify the ecosystem credit species present in the vegetation zone.

Where the assessor determines that none of the habitat components are present in a vegetation zone for a threatened species predicted for assessment, the species is considered unlikely to occur and no further assessment is required for that species in that vegetation zone. The assessor must record in the BDAR the reasons for determining that a predicted species is unlikely to occur in the vegetation zone.

Where the assessor determines that none of the habitat components are present on the entire subject land for the threatened species predicted for assessment, the species is considered unlikely to occur and no further assessment is required for that species. The assessor must record in the BDAR the reasons for determining that a predicted species is unlikely to occur on the subject land.

If the species is a vagrant in the IBRA subregion, the species is considered unlikely to occur and no further assessment is required. The assessor must record in the BDAR the reasons for determining that the species is unlikely to occur on the subject land.

In total 29 ecosystem credit species are predicted to occur in the construction boundary, including *Pteropus poliocephalus* (Grey-headed Flying-fox). A full list of ecosystem credit species is provided in section 5 of **Appendix H** (Biodiversity development assessment report), along with their associated habitat constraints, geographic limitations and sensitivity to gain class.

Species credit species

In accordance with the BAM requirements, a list of species credit species (species that require species credits) is generated based on the PCTs present, an assessment of the IBRA sub region, past records and habitat elements. Some 33 species credit species are predicted to occur within the construction boundary, including *Myotis macropus* (Southern Myotis), *Pteropus poliocephalus* (Grey-headed Flying-fox) and *Litoria aurea* (Green and Golden Bell Frog).

A full list of species credit species is provided in section 5 of **Appendix H** (Biodiversity development assessment report), along with their associated habitat constraints, geographic limitations and sensitivity to gain class.

A search of the OEH BioNet Atlas in August 2018 identified around 10 threatened flora species listed under the BC Act that have been recorded within 100 metres of the permanent power supply construction route. No records were found within the proposed alignment of the route.

Weeds

Weeds are common throughout the study area with some areas supporting weed infestations, particularly within Rockdale Bicentennial Park. Weeds identified in the study area during the field surveys are summarised in **Table 12-7**. The table identifies which species are listed on the Commonwealth DEE Weeds of National Significance (WoNS) list, and if they are identified as a high threat exotic species by the BAM. High threat exotic species are considered a high threat if they are not controlled and will outcompete native plants. These species would be controlled as part of the mitigation measures for the project (refer to **section 12.6**).

Table 12-7 Weeds recorded in the study area

Scientific name	Common name	Weeds of National Significance (WoNS)	High threat exotic
<i>Anredera cordifolia</i>	Madeira Vine	Yes	Yes
<i>Araujia sericifera</i>	Moth Vine	No	Yes
<i>Bidens pilosa</i>	Cobbler's Pegs	No	Yes
<i>Cestrum parqui</i>	Green Cestrum	No	Yes
<i>Chrysanthemoides monilifera</i> subsp. <i>Rotundata</i>	Bitou Bush	Yes	Yes
<i>Cinnamomum camphora</i>	Camphor Laurel	No	Yes
<i>Conyza bonariensis</i>	Fleabane	No	No
<i>Ehrharta erecta</i>	Panic Veldt Grass	No	Yes
<i>Erythrina crista-galli</i>	Cockspur Coral	No	Yes
<i>Foeniculum vulgare</i>	Fennel	No	No
<i>Hydrocotyle bonariensis</i>	N/A	No	No
<i>Ipomoea alba</i>	A Morning Glory	No	Yes
<i>Lantana camara</i>	Lantana	Yes	Yes
<i>Ochna serrulata</i>	Mickey Mouse Bush	No	Yes
<i>Parietaria Judaica</i>	Asthma Weed	No	No
<i>Paronychia brasiliiana</i>	N/A	No	No
<i>Pennisetum clandestinum</i>	Kikuyu	No	No
<i>Ricinus communis</i>	Castor Oil Plant	No	Yes
<i>Rubus fruticosus</i> sp. agg.	Blackberry	Yes	Yes
<i>Rumex crispus</i>	A Dock	No	No
<i>Tradescantia fluminensis</i>	Trad	No	Yes

12.2.3 Terrestrial fauna

Threatened fauna and habitat

The EPBC Act PMST⁹ and the Atlas of NSW Wildlife identified 90 threatened fauna species (or their habitat) listed under the BC Act or EPBC Act as potentially occurring within 10 kilometres of the project. A full list of these species is provided in Annexure A of **Appendix H** (Biodiversity development assessment report).

In accordance with the BAM, 33 candidate species were predicted to occur within the construction boundary.

The list of candidate species is based on each species' likelihood of occurrence, which was informed by database searches, previous studies and specific habitat features present within the study area. The likelihood of occurrence assessment is detailed in Annexure A of **Appendix H** (Biodiversity development assessment report). The list of final candidate species was then used to determine whether or not the species requires further assessment in the form of targeted surveys.

Targeted threatened species surveys were conducted for Green and Golden Bell Frogs and Southern Myotis as these 'species credit species' (species that require species credits/offsets) were considered to have the potential to occur in the project area. Grey-headed Flying-fox was also considered likely to use some of the study area for foraging habitat and is listed as vulnerable under the BC Act.

⁹ Commonwealth Department of Environment and Energy 2017. EPBC Act Protected Matters Search Tool.

A search of the OEH BioNet Atlas in August 2018 identified around five threatened fauna species listed under the BC Act that have been recorded within 100 metres of the permanent power supply construction route. No records were found within the proposed alignment of the route.

Grey-headed Flying-fox

The Grey-headed Flying-fox (*Pteropus poliocephalus*), listed as vulnerable under the BC Act and EPBC Act, is considered likely to occur within the study area and has been recorded foraging adjacent to the construction boundary.

The construction boundary contains potential foraging habitat for the Grey-headed Flying-fox (refer to **Figure 12-3**). This habitat is located within Rockdale Bicentennial Park where there are numerous planted *Ficus hillii*, *Eucalyptus robusta* and *Eucalyptus botryoides* x *salign*, among other potential food sources.

No roosting sites or breeding camps occur within the study area, however there is a large camp at Turella, which is within close proximity of the project (3 kilometres north-west).

Green and Golden Bell Frog

The Green and Golden Bell Frog is listed as Vulnerable under the EPBC Act and Endangered under the BC Act.

The Arncliffe population of Green and Golden Bell Frogs, prior to the construction of the M5 East Motorway, was centred on the Marsh Street Wetland. With the construction of the M5 East Motorway, impacts to the Marsh Street Wetland precipitated the construction of two 'RTA Ponds'. The 'RTA Ponds' were purpose built breeding ponds for the Green and Golden Bell Frog and were constructed along Marsh Street, adjacent to the Southern and Western Sydney Ocean Outfall System (SWSOOS) and the Kogarah Golf Course. The Green and Golden Bell Frog population in and at the RTA Ponds and Kogarah Golf Course was monitored annually from 2003 and 2015¹⁰.

The population was considered stable up to April 2015, after which the Arncliffe population (across Kogarah Golf Course, RTA Ponds, Barton Park and Riverine Park (refer to **Figure 12-4** for Green and Golden Bell Frog records and potential habitat)) has appeared to be in decline. The decline has been attributed to predation, poor climatic conditions and potentially due to disturbances from nearby road construction activities.

In 2016, the New M5 Motorway was approved for construction, which included the Arncliffe construction ancillary facility, adjacent to the RTA Ponds. The approval for the New M5 Motorway included the development of management plans and the requirement to establish new habitat and a breeding population of Green and Golden Bell Frog in captivity. Eighteen adult frogs were captured between 2016 and 2017 and transferred to the captive breeding facility.

New habitat ponds are currently being established for the reintroduction of frogs at Marsh Street to mitigate impacts of the New M5 Motorway project on this population.

Targeted surveys for Green and Golden Bell Frogs were conducted in February 2018, following 50 millimetres of rainfall at the Sydney Airport, in accordance with Commonwealth guidelines¹¹. No frogs were found during the field surveys for the project. During the survey period 2017/2018 (October to March) in the Arncliffe area, only one adult was recorded at around 400 metres south-east of C1. No frogs were detected in the RTA Ponds or within the areas of habitat immediately adjacent to C1.

Southern Myotis

No Southern Myotis were recorded during the field surveys. However, President Avenue crosses over a culvert which conveys a waterway running from the north (Rockdale Bicentennial Park) to the south (Scarborough Park North). This culvert may be potential habitat for *Myotis macropus* (Southern Myotis), a threatened bat which is listed as vulnerable under the BC Act.

¹⁰ Biosphere Environmental Consulting 2000-2017. Biosphere Environmental Consultants 2000-2017. Various monitoring reports on Green and Golden Bell Frog at Arncliffe. Reports to NSW Roads and Maritime Services.

¹¹ Commonwealth of Australia (2010) *Survey guidelines for Australia's threatened frogs*.

Migratory species

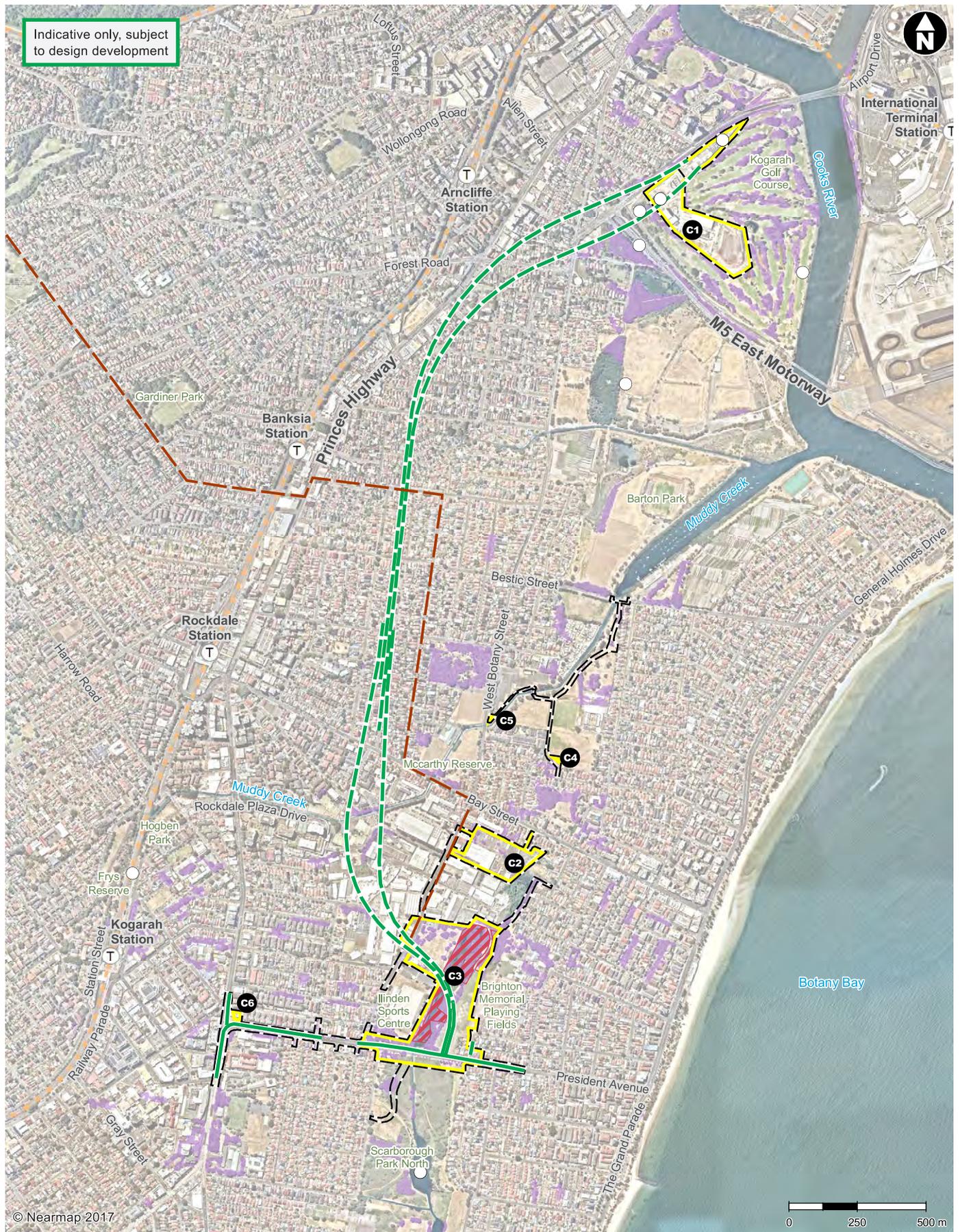
The Landing Lights wetland (within 500 metres of the project) is known to provide habitat for the following migratory species listed under the EPBC Act:

- *Calidris acuminata* (Sharptailed Sandpiper)
- *Calidris ferruginea* (Curlew sandpiper)
- *Limosa limosa* (Black-tailed Godwit)
- *Xenus cinereus* (Terek Sandpiper).

These species do not breed in Australia. They migrate south for the southern summer, using wetlands, shores and exposed mudflats for foraging. Surveys conducted between October and December 2017 did not record any migratory species listed under the EPBC Act.

Publicly available data from Bayside Council¹² also revealed that between April 2016 and June 2017, no EPBC Act migratory species were recorded from the wetland.

¹² Bayside Council (2018) Bird monitoring data for Landing Lights wetland April 2016 – July 2017. Available at <https://www.rockdale.nsw.gov.au/Pages/pdf/LLWBM-AprJul.pdf>



LEGEND

- The project in tunnel
- The project on surface
- Construction boundary
- Construction ancillary facility
- Permanent power supply line
- Vegetation exclusion zone
- Grey-headed Flying-fox
- Potential Grey-headed Flying Fox habitat
- Railway line
- Railway station

Figure 12-3 Grey-headed Flying Fox records and potential habitat



LEGEND					
	The project in tunnel		Vegetation exclusion zone		Railway line
	The project on surface		Green and Golden Bell Frog		Railway station
	Construction boundary		Green and Golden Bell Frog Habitat		
	Construction ancillary facility				
	Permanent power supply line				

Figure 12-4 Green and Golden Bell Frog records and potential habitat

12.2.4 Aquatic biodiversity

The desktop assessment returned a result of 108 threatened species, populations and ecological communities related to freshwater or estuarine habitat that have the potential to occur within the study area. This included fish, sharks, rays, turtles, marine mammals, frogs, saltmarsh and seagrass. Frogs, and wetland, shore and migratory birds are discussed in the terrestrial chapters of this report. A refined review of known locations, expected distribution maps and habitat requirements narrowed this list further in preparation for the field survey.

The field survey was conducted on 23 January 2018 and targeted five distinct habitat types and locations which have the potential to be impacted by the construction or operation of the project, including Rockdale Bicentennial Park, Scarborough Park North, Muddy Creek, the Cooks River and Wollie Creek. These five habitats are described in **Table 12-8** and shown in **Figure 12-5**.

Other protected flora and fauna listed under the FM Act were assessed for their likelihood of occurrence, such as marine vegetation (macroalgae, seagrass, mangroves and saltmarsh) and fish (certain sharks, finfish and seahorses) (refer to Annexure A of **Appendix H** (Biodiversity development assessment report)).

Table 12-8 Description of aquatic habitats within in the vicinity of the project

Aquatic habitat	Description
Wetland within Rockdale Bicentennial Park through Rockdale Wetlands	<ul style="list-style-type: none"> • A 30 metre wide artificial pond extended 500 metres north of President Ave within the Rockdale Wetlands • The wetland receives stormwater discharge from several large pipe culverts and the water level is regulated by a small weir at President Avenue • Riparian vegetation is a dense cover of native trees with scattered shrubs and groundcovers. Dense weeds, such as <i>Lantana camara</i> (Lantana) and <i>Erythrina crista-galli</i> (Cockspur Coral Tree) occur in patches, and there was evidence of recent weed control during the field surveys • The banks of the pond are steep with exposed soil, rocky rubble and building waste (e.g. bricks) • Water quality is variable, possibly influenced by algal growth and waterbird activity. For example, water quality is poorer near the central footbridge where people feed the waterbirds • Dissolved oxygen was observed to rapidly drop at night in the wetland, which would generally indicate the wetland does not provide habitat for fish. However, the presence of piscivorous bird species (fish eaters) suggests fish were present • Anecdotal evidence suggests that the wetland provides habitat for Eastern Long-necked Turtle and other aquatic reptiles • This habitat is not mapped as Key Fish Habitat (KFH) by DPI Fisheries.
Wetland entering Scarborough Park North	<ul style="list-style-type: none"> • A narrow (10 metre) wetland directly downstream of President Avenue located within the Scarborough Park North Wetland, which receives water which has spilled over the Bicentennial Park weir. The wetland extends south for around 2 kilometres before entering a stormwater culvert beneath Ramsgate • The channel is extremely shallow with a thick sediment deposition. A dense reedland of <i>Typha orientalis</i> (Typha) and <i>Phragmites australis</i> (Common Reed) extends westward of the channel, whilst the eastern bank supports scattered <i>Casuarina glauca</i> (She Oak) trees • Dissolved oxygen concentration was observed to be poor and unlikely to support fish life • Salinity was observed to be high, indicating saline input from groundwater (no tidal influence was observed). The southern portion of the wetland (from around 800 metres south of President Avenue) is mapped as Key Fish Habitat by DPI Fisheries.

Aquatic habitat	Description
Muddy Creek upstream of Bestic Street	<ul style="list-style-type: none"> • A 14 metre wide concrete-lined channel. The northern portion is tidal and the southern half towards West Botany Street is freshwater, with occasional tidal influence • The channel is concrete lined for two kilometres upstream of West Botany Street and natural downstream of Bestic Street. The downstream portion was observed to have a narrow band of mangroves and modified embankments • A school of juvenile <i>Mugil cephalus</i> (Sea Mullet) was observed in the freshwater reach. High impact weeds, including <i>Juncus acutus</i> (Sharp Rush), occur at the southern extent of the saltmarsh • Two small drainage lines enter the channel from the south • The tidal portion of this concrete channel is mapped as Key Fish Habitat by DPI Fisheries, starting around 250 metres south of Bestic Street.
Cooks River near Kogarah Golf Course	<ul style="list-style-type: none"> • Around 145 metre wide River with seawalls on both banks • Common marine molluscs inhabited the sloping stone seawall. An underwater survey found rock rubble, oysters, coarse sand/gravel and fine woody debris in the subtidal zone. • Four small stormwater culverts flow into the river within the study area • No marine vegetation (e.g. seagrass, mangroves, saltmarsh) occurs in the area • A sewage outfall is located near a utility bridge (over the M5 East tunnel), which was flowing at the time of survey. With the exception of material released from the outfall, the river had reasonable water clarity, indicating good tidal flushing. A large number of <i>Girella tricuspidata</i> (Luderick) were active near the sewer outlet during the survey • This river is mapped as Key Fish Habitat by DPI Fisheries.

One threatened aquatic ecological community occurred along Muddy Creek, where Coastal Saltmarsh has established above the concrete-lined drain. A narrow (1-2 metres) sandy flat supports several saltmarsh species, such as *Atriplex* sp., *Sarcocornia quinqueflora* (Samphire), *Suaeda australis* (Austral seablite) and *Tetragonia tetragonioides* (Native spinach).

No threatened aquatic species or populations were observed at the other three locations, and none were considered likely to depend on the habitat for survival. At the Cooks River, it is possible some species may opportunistically pass through the area given the connectivity to the broader bay and coastal habitats, but they are unlikely to depend on habitat within the site for their survival.

Protected aquatic flora listed under the FM Act was observed at Muddy Creek outside of the study area, with saltmarsh and *Avicennia marina* (Grey Mangrove) growing in the intertidal zone. However, protected aquatic fauna listed under the FM Act are unlikely to occur within the study area, due to lack of suitable habitat, such as rocky reefs, deep water and dense seagrass or macroalgae. No marine vegetation was observed at Cooks River within five metres of the waterline.

Muddy Creek, Bardwell Creek and Wolli Creek are three watercourses which are intersected along the alignment of the permanent power supply connection route. Wolli Creek is mapped as Key Fish Habitat by DPI Fisheries.

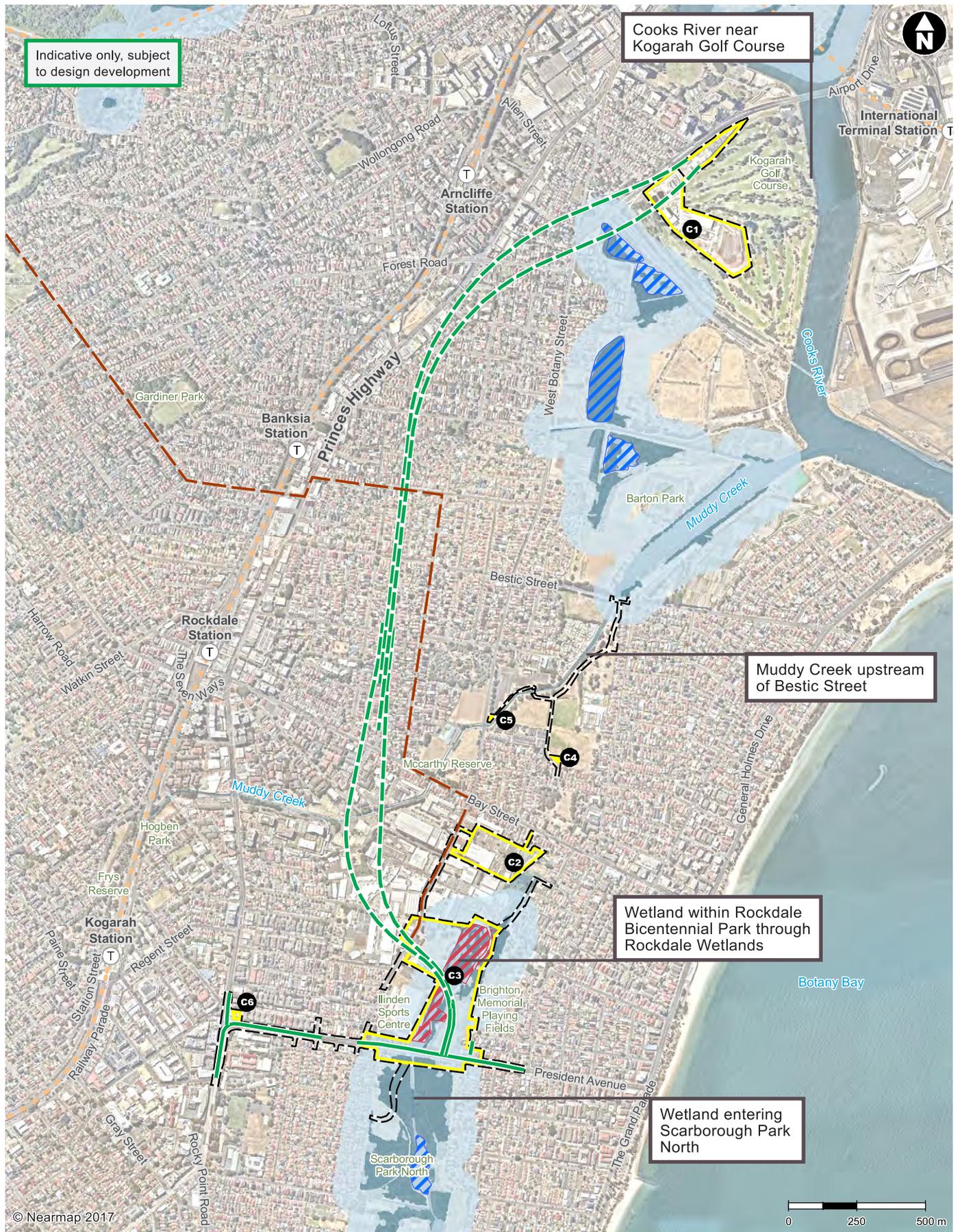


Figure 12-5 Aquatic habitat and wetlands in the vicinity of the construction boundary

12.2.5 Groundwater dependent ecosystems

GDEs are defined as ecosystems whose current species composition, structure and function are reliant on a supply of groundwater, as opposed to surface water supplies from overland flow paths. Most wetland communities and many river systems have some degree of dependence on groundwater.

The most likely GDE types in the Sydney region are terrestrial vegetation communities with deep roots that use groundwater, wetlands, and river base flow systems.

The GDE Atlas¹³ and *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* were reviewed to identify groundwater dependent ecosystems (including those of high priority in *Water Sharing Plan*).

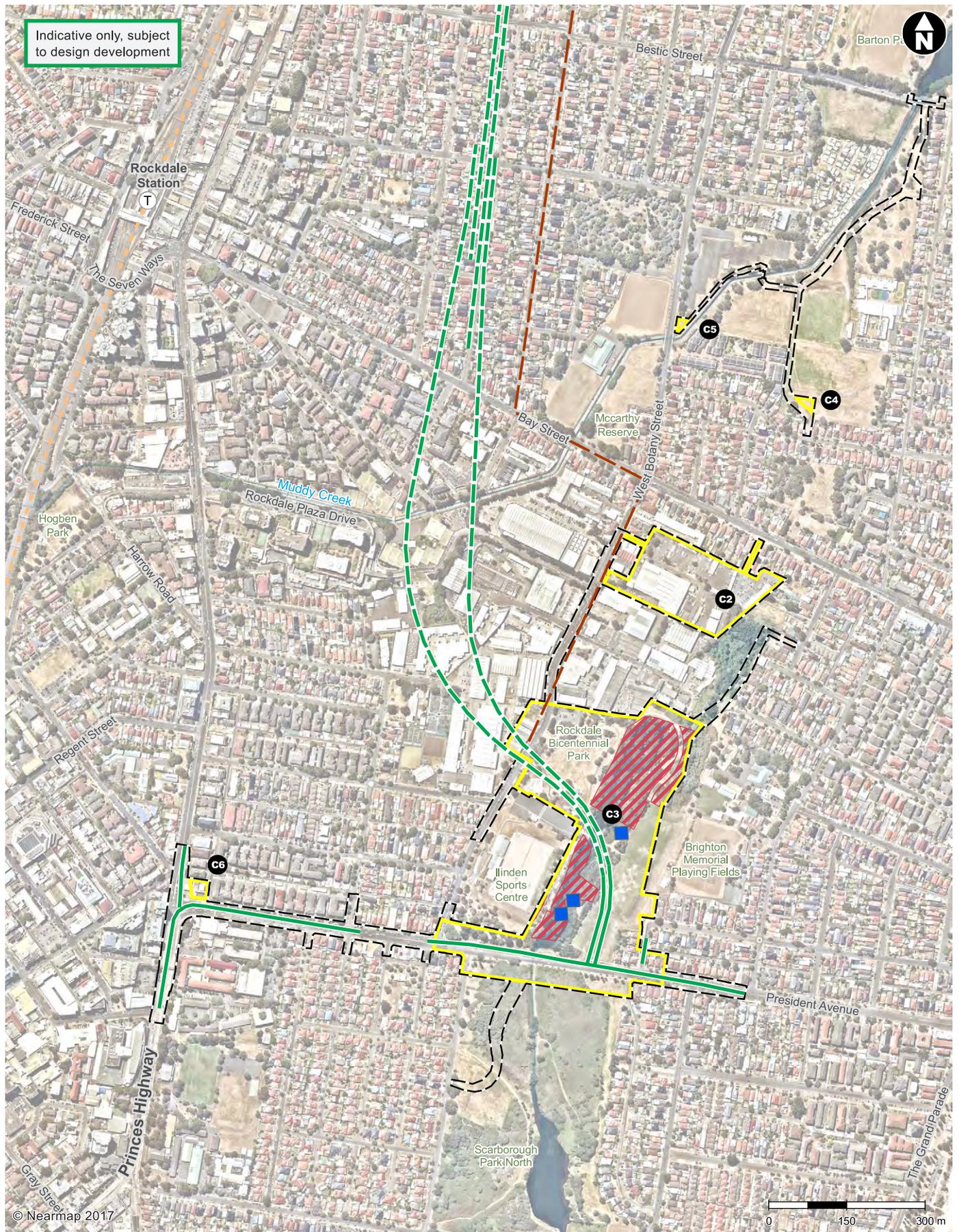
The *Water Sharing Plan* did not identify any GDEs occurring within the study area. The closest high priority GDEs are the Botany Wetlands and Lachlan Swamps within the Botany Sands, located in Centennial Park around eight kilometres north-east of the project.

A search of the GDE Atlas indicated that there are several areas within the study area that have a moderate potential to be dependent on groundwater (refer to **Figure 12-6**).

There are areas of vegetation mapped as highly likely to be groundwater dependent at Kogarah Golf Course. This vegetation could be affected if the water table is lowered to a point beyond the rooting depth.

There are some small patches of mapped Swamp Oak floodplain swamp forest and Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin. These PCTs have a moderate potential to be reliant on the subsurface connections to groundwater.

¹³ Bureau of Meteorology (2018). National Atlas of Groundwater Dependent Ecosystems, accessed January 2018 (<http://www.bom.gov.au/water/groundwater/gde/>)



LEGEND	
	The project in tunnel
	The project on surface
	Construction boundary
	Construction ancillary facility
	Vegetation exclusion zone
	Groundwater dependent ecosystems
	Railway line
	Permanent power supply line
	Railway station

Figure 12-6 Groundwater dependent ecosystems in the vicinity of the construction boundary

12.3 Potential impacts – construction

12.3.1 Terrestrial flora

Loss of native vegetation

The project would involve the removal of native vegetation, as outlined in **Table 12-9**.

Around 237 native trees (or small groups of trees) were assessed within the construction boundary and would require removal to facilitate the project. Based on the current concept design for the project, it is unlikely these trees could be retained. Of these trees, around 41 have been identified as having a high retention value in accordance with the Institute of Australian Consulting Arboriculturists Significance of a Tree, Assessment Rating System¹⁴ (refer to Attachment A of Annexure B (Landscape and visual assessment) of **Appendix C** (Place making and urban design)).

Trees to be retained would be protected in accordance with Australian Standard (AS) 4970-2009 Protection of trees on development sites and suitable ground protection measures to protect the tree protection zone. Tree removal would be carried out by a suitably qualified arborist and in accordance with AS 4373-2007 Pruning of Amenity Trees and the NSW WorkCover Code of Practice for the Amenity Tree Industry (1998).

This assessment has been based on the current construction boundary and concept design for the project. Impacts to trees would be minimised wherever practicable and further opportunities to retain trees may emerge during detailed design. Where removal of trees is unavoidable, trees would be replaced in accordance with the tree management strategy for the project, which would be prepared in consultation with relevant stakeholders (including local councils). The strategy would be used to guide the management of trees that need to be removed and to consider options for their replacement (refer to section 13.9 of **Chapter 13** (Landscape and visual)). The replacement of trees would include a net increase in the number of replacement trees.

Table 12-9 Direct impacts to native vegetation

PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Extent of vegetation removal (ha) (direct impact)
1232	Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Coastal Swamp Forest	Forested Wetlands	0.47
1795	Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Coastal Swamp Forest	Forested Wetlands	0.30
1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	Coastal Freshwater Lagoons	Freshwater Wetlands	0.77

¹⁴ IACA 2010. IACA Significance of a Tree, Assessment Rating System (STARS), Institute of Australian Consulting Arboriculturists, Australia, www.iaca.org.au.

Removal of threatened flora communities

The project would involve the removal of two communities of threatened flora listed under the BC Act, as outlined in **Table 12-10**.

Table 12-10 Direct impacts on threatened ecological communities

PCT ID	PCT Names	Threatened ecological community name	BC Act listing	EPBC Act	Extent of vegetation removal for the project (ha)
(a) 1232 (b) 1808	(a) Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion (b) Common Reed on the margins of estuaries and brackish lagoons along the NSW South Wales coastline	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	Endangered	Not listed	(a) 0.47 hectares (b) 0.77 hectares Total: 1.24 hectares
1795	Swamp Mahogany / Cabbage Tree Palm – Cheese Tree – Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	Endangered	Not listed	0.30

Removal of threatened flora species

The Magenta Lilly Pilly within the construction boundary, are not known as a population for this species as identified in the Recovery Plan. There are 20 adult Magenta Lilly Pillies planted in lines within landscape plantings at the Rockdale Bicentennial Park. These plants would be cleared for the project however they would not be offset in accordance with BAM as they are not part of a known naturally occurring population.

Spread of weeds

Some weeds would be removed during the vegetation clearing required for the project. The BDAR is not required to assess the direct impacts of weed removal, in accordance with the BAM.

Given the presence of weeds in the study area (refer to **Table 12-7**), there is potential for disturbance of vegetation to lead to the spread and/or intensification of weeds. If not appropriately managed, this may indirectly affect native flora and fauna in adjoining areas by further reducing habitat quality, altering the structure and composition of vegetation and increasing competition for resources.

The implementation of management measures outlined in **section 12.6** would minimise the potential for the spread of weeds from construction activities.

Non-native vegetation and human made structures

Around 21 non-native trees (or small groups of trees) would require removal to facilitate the project. The non-native vegetation includes exotic managed grassland, planted mature trees and shrubs located in parks. Based on the current concept design for the project, it is unlikely these trees could be retained. One tree (*Araucaria heterophylla* (Norfolk Island pine)) has been identified as having a high retention value in accordance with the Institute of Australian Consulting Arboriculturists Significance of a Tree, Assessment Rating System¹⁵ (refer to Attachment A of Annexure B (Landscape and visual assessment) of **Appendix C** (Place making and urban design)).

¹⁵ IACA 2010. IACA Significance of a Tree, Assessment Rating System (STARS), Institute of Australian Consulting Arboriculturists, Australia, www.iaca.org.au.

Trees to be retained would be protected in accordance with Australian Standard (AS) 4970-2009 *Protection of trees on development sites*, and suitable ground protection measures (including the establishment of tree protection zones) would be implemented. Tree removal would be carried out by a suitably qualified arborist and in accordance with AS 4373-2007 *Pruning of Amenity Trees* and the NSW WorkCover Code of Practice for the Amenity Tree Industry (1998).

This assessment has been based on the current concept design for the project. Further opportunities to retain trees may emerge during detailed design. All opportunities for retaining additional trees through tree sensitive design and construction methods would be considered. Where removal of trees is unavoidable, trees would be replaced in accordance with the tree management strategy for the project.

Vegetation to be impacted at the President Avenue construction ancillary facility (C3) has been identified as potential foraging habitat for the Grey-headed Flying-fox, and the existing culvert and pipe underneath President Avenue is potential *Myotis macropus* (Southern Myotis) habitat. Prescribed impacts associated with the removal of non-native vegetation at C3 and the culvert underneath President Avenue are detailed in **Table 12-11**.

Prescribed impacts include impacts on biodiversity values in addition to, or instead of clearing native vegetation or loss of habitat. For example, the removal of non-native vegetation and human-made structures, or impacts on the movement of threatened species that maintains their life cycle.

Table 12-11 Prescribed impacts associated with the removal of non-native vegetation at the President Avenue construction ancillary facility (C3)

Species or ecological community affected	<i>Pteropus poliocephalus</i> (Grey-headed Flying-fox)	<i>Myotis macropus</i> (Southern Myotis)
Non native vegetation or human made structure with potential to be habitat	Parkland trees at C3	Culvert and pipe within C3
Nature, extent and duration of long and short term impacts due to removal of non-native vegetation	<p>The vegetation would be removed during construction.</p> <p>Vegetation removal would be a temporary impact as it is proposed to plant species suitable for foraging habitat following construction.</p>	<p>The pipe and culvert would be disturbed by construction noise, dust, light and vibration.</p> <p>Light, dust and vibration would be a short term impact during construction only. Noise would continue during operation due to increased traffic movements close to the pipe and culvert.</p>
Importance within the bioregion of the habitat of these species	<p>The national Recovery Plan for this species states that important habitat includes any foraging habitat within 50 km of a camp that has sustained more than 30,000 individuals.</p> <p>The area subject to the proposed action is around 10 km south-west of a long-term camp at Centennial Park.</p> <p>The total area impacted by the project would be around 4.45 hectares. This is a small proportion of the 3,620,000 hectares of habitat in the bioregion. There is around 41.9 hectares of foraging habitat within the study area.</p>	<p>This species is known to occupy a range of resources in the Sydney region. A study by Gonsalves and Law (2017) showed that in Port Jackson, it was widely distributed, being present at about 93% of the 56 sites sampled. While it was present in a large number of sites, feeding was concentrated around a few key locations. Most of the sites where the species was present were associated with mangrove and seagrass cover and good water quality.</p> <p>The culvert and surrounding habitat at the Rockdale Bicentennial Park are of low quality, have high turbidity with neither seagrass nor mangrove plants present. Given this, the culvert is unlikely to be a key habitat for this species in the bioregion.</p>
Consequence of the impacts for the local and bioregional persistence	<p>The species exists as a dynamic single population which utilises a range of habitats along the Australian east coast.</p> <p>During construction vegetation would be removed to allow for the proposed cut and cover tunnel and associated activities. While there would be an opportunity to rehabilitate the cut and cover areas following construction, there would be a lag in the time before planted vegetation reaches maturity.</p> <p>The impacts of removal of non-native vegetation are anticipated to be minor relative to the habitat for this species.</p> <p>Vegetation removal is not likely to result in the long term decrease in species numbers in the local area (considered to include the camp at Turrella) or within the bioregion.</p>	<p>Replacement on the culvert at President Avenue is unlikely to be of great consequence to the species bioregional persistence, given the low quality of the habitat and the presence of the species in Port Jackson and other coastal lagoon locations.</p> <p>Locally, there are several culverts at Princes Highway, Bay Street, West Botany Street and Bestic Street, all conveying water along Muddy Creek. South from the project lie culverts under Barton Street, Ramsgate Road and Ferry Street. The Gonsalves and Law (2017) study showed that roosting fidelity was high for one area (west of Sydney Harbour). Where urbanisation was high, activity levels were low. It is expected given the high urbanisation, and number of culverts near the project, the consequences of impacts on this culvert would not be high.</p> <p>Appropriate mitigation measures would be applied to reduce potential impacts on this species.</p>

Change in vegetation integrity

The change in vegetation integrity, measures the variation between the current and future condition scores, based on the plots in each vegetation zone. The results are outlined in **Table 12-12**. For vegetation that would be completely removed, the future integrity score is zero.

Table 12-12 Change in vegetation integrity

Veg Zone	PCT ID	Condition	Area (ha)	Current vegetation integrity score ¹⁶	Future vegetation integrity score	Change in vegetation integrity
1	1232	Moderate – Good	0.47	32	0	32
2	1795	Moderate – Good	0.30	70.7	0	70.7
3	1808	Moderate – Good	0.77	19.9	0	19.9

Permanent power supply route

The proposed alignment of the power supply route is considered unlikely to impact on the threatened species located within 100 metres of the alignment. No threatened species are located within the alignment. The power line would be constructed via under-boring in some locations, for example to avoid impacts to vegetation. While the removal of street trees would be avoided wherever possible, the trenching works may impact on root zones at some locations. The critical root zone of street trees would be avoided and where this is not possible, due care would be taken to avoid physical damage to the trees and their root system.

The alignment would be installed as a conduit to an existing crossings in the vicinity of the threatened ecological community identified within Girrahween Park around 20 metres west of the proposed alignment along Hartill-Law Avenue.

12.3.2 Terrestrial fauna

Edge effects

With regard to biodiversity, edge effects are changes in population or community structures that occur at the edge of two habitats.

Edge effects on native vegetation are considered likely to occur as a result of the works. At C3, there would be native vegetation remaining south of President Avenue in an area dominated by Common Reedlands (PCT1808).

The reedlands retained would be potentially subject to increased light and weed invasion because of the project. Only a small area of reedlands is proposed to be cleared (around 0.77 hectares) and around 10 hectares would remain. Indirect impacts would be limited through the implementation of mitigation measures (refer to **section 12.6**).

Habitat for native species includes non-remnant vegetation (such as planted street trees and exotic species), which was recorded adjacent to the site. Edge effects on these areas are also likely to occur, but would be limited through the implementation of relevant mitigation measures.

Fauna injury and mortality of fauna

Fauna injury or mortality could occur during construction of the project, as a result of direct collision with vehicles and equipment within the construction boundary. Mobile species (such as birds) may be able to move away quickly and easily, but other less mobile species, or those with high fidelity within their home range, may be slower to move away or may not relocate at all, potentially resulting in injury or mortality of the individual.

Although there is potential for some injury or mortality of fauna species, the project is unlikely to result in a large number of fauna injury or mortality incidents, as the majority of the project would be constructed underground. Where temporary and permanent ancillary facilities and infrastructure occur, the surrounding land is highly urbanised.

¹⁶ Vegetation integrity scores are based on both the extent, composition and condition of vegetation communities.

During construction works at C3, there is a possibility that Grey-headed Flying-fox may be injured or stressed due to disturbances associated with noise, dust or light. Direct mortality is unlikely. Individuals are likely to actively avoid the area during works and therefore risk to fauna would be low.

Implementation of management measures outlined in **section 12.6** would reduce the chances of injury or mortality of fauna. Measures to manage potential impacts on bats would be included in the Construction Flora and Fauna Management Plan.

Actions such as fauna rescue and relocation during dewatering and bunding of the wetland within C3 would reduce potential injury to aquatic fauna (e.g. Eastern Long-necked Turtle). Mortality of fish and turtles are expected to be minimised through standard rescue and release protocols.

Impact on migratory species

For migratory birds, the impacts are unlikely to be significant during construction. Migratory species occasionally visit the Landing Lights Wetland (nearby the project, but not within the construction boundary), preferring to use the resources at Towra Point wetland and Shell Point Botany Bay.

While the species do occasionally occur close to the project, the species have not been observed to occur within the construction boundary. Indirect impacts that may potentially impact these species include hydrological changes, such as a reduction in groundwater supply to wetlands that supply habitat for a species.

Threatened fauna and loss of habitat

Grey-headed Flying-fox

The project would result in the loss of around 4.45 hectares of potential foraging habitat for the Grey-headed Flying-fox, which is listed as Vulnerable under the BC Act and EPBC At. However, no Grey-headed Flying-fox roosting sites or camps occur within the study area, and therefore it was concluded that the species would not be impacted by the works.

Of the 4.45 hectares to be removed for the project, an area of about one hectare of native vegetation likely to be Grey-headed Flying-fox foraging habitat would be offset through the ecosystem credits required for impacts on this native vegetation. An additional area of planted urban native trees may also be foraging habitat for this species.

Indirect impacts of the project also have the potential to disturb the Grey-headed Flying-fox. Noise and vibration would be generated by the construction activities within the construction boundary, and lighting would be required during standard construction hours and during out-of-hours (night) works. These types of indirect impacts are already widespread within the highly urbanised study area, and any exacerbation of these impacts would be managed and minimised by the implementation of mitigation measures outlined in **section 12.6**.

Green and Golden Bell Frog

Intensive monitoring indicates that the local Green and Golden Bell Frog population at Arncliffe has appeared to be in decline since 2016 likely due to predation and poor climatic conditions (A White, pers. comm. 2017).

During the field surveys for the project, no frogs were found. During the survey period 2017/2018 (October to March) in the Arncliffe area, only one adult was recorded at around 400 metres south-east of C1. No frogs were detected in the RTA Ponds or within the areas of habitat immediately adjacent to C1.

Green and Golden Bell Frog habitat would not be directly affected by the construction of the project. This is because the project would use the existing Arncliffe construction ancillary facility currently being used for the construction of the New M5 Motorway project. Offsets have already been provided under the approval for that project. The construction of the project would however delay the habitat reinstatement of the Arncliffe construction ancillary facility following the construction of the New M5 Motorway project. Given the low occurrence of Green and Golden Bell Frogs in the vicinity of C1, the impact of this delay on the population is not expected to be significant.

Roads and Maritime has instigated, as part of the Green and Golden Bell Frog Management Plan for the New M5 Motorway project, a program of captive breeding and new habitat creation at Marsh Street. Animals are in captive husbandry and have not yet been introduced into their new habitat which is currently under construction. The construction of the project would not impact on the new habitat at Marsh Street (which is located on the other side of the M5 East Motorway). Any decision to introduce frogs into Marsh Street or the two RTA ponds as part of the New M5 Motorway mitigation measures would consider any indirect impacts arising from this project along with an assessment of the ongoing viability and suitability of the RTA ponds to provide habitat for this species.

The construction of the project is likely to result in the prolongation of indirect impacts on the Green and Golden Bell Frog, currently arising from the use of the area at C1 for construction of the New M5 Motorway. Impacts would include disturbance due to noise, dust and vibration for the duration of construction works at C1. These impacts would be temporary and are not expected to significantly impact the Green and Golden Bell Frog population, therefore no biodiversity credits are proposed to be retired to offset these indirect impacts.

Following completion of construction works for the New M5 Motorway project at C1, the project would ensure that a number of biodiversity management measures including maintaining frog fencing, implementation of hygiene protocols and an unexpected finds procedure would remain in place during construction of the project. In addition, noise and vibration management measures (refer to **Chapter 11** (Noise and vibration)), dust management (refer to **Chapter 9** (Air quality)) and lighting management measures (refer to **Chapter 13** (Landscape and visual)) would be implemented and help minimise impacts to fauna such as the Green and Golden Bell Frog.

Southern Myotis

Potential *Myotis macropus* (Southern Myotis) habitat would be directly affected by the construction of the President Avenue intersection and upgrade works. President Avenue crosses over a culvert which conveys a waterway running from north (Rockdale Bicentennial Park) to the south (Scarborough Park North). The culvert may be potential habitat for this threatened bat, listed as vulnerable under the BC Act. Given the high urbanisation and number of culverts in the vicinity of the project, the consequences of the replacement of this culvert are not expected to be significant for this species.

Impacts to threatened fauna are not expected during construction due to the limited number of threatened species records in the vicinity of the project, and the lack of suitable habitat along the majority of the proposed power line alignment. The management measures for the project would include an unexpected finds procedure for both flora and fauna during construction.

12.3.3 Loss of aquatic biodiversity

Appendix L (Surface water technical report) states that potential impacts to surface water quality, hydrology and geomorphology during construction of the project, associated with discharges of surface water and construction wastewater and disturbances to waterways are considered to be manageable. Potential impacts would be confined to the construction boundary with application of the proposed management measures outlined in **Chapter 18** (Surface water and flooding).

Overall, impacts to aquatic habitat would be relatively minor, considering existing conditions, scale and recovery potential. Specific impacts to each unique habitat type is summarised in **Table 12-13**.

Table 12-13 Potential impacts during construction to aquatic habitats across the study area

Aquatic habitat	Description
Wetland within Rockdale Bicentennial Park through Rockdale Wetlands	<ul style="list-style-type: none"> • This pond is required to be diverted during cut and cover construction. This would result in a temporary and direct loss of around 0.2 hectares of aquatic and riparian habitat, and would obstruct local fish passage. It would also temporarily reduce water circulation (e.g. wind and inflow movement) • Aquatic and semi-aquatic fauna dependant on this pond would be segregated into two populations, occupying a one hectare northern pool and one hectare southern pool. The survival of any population is unlikely to be impacted given the size of refuge pools available and the nature of the excavation. The riparian vegetation would be restored after the reinstatement of the wetland and Rockdale Bicentennial Park following construction. Also, species currently inhabiting the pond are likely to be those tolerant of urban pressures, such as poor water quality • The temporary haulage route within C3 at Rockdale Bicentennial Park runs through the local non-Aboriginal heritage listed item 'Kings Wetland'. The 'Kings Wetland' in the area of the haulage route is modified with minimal native vegetation and impacted by stormwater runoff and other urban pollution. Impacts to the 'Kings Wetland' aquatic biodiversity values are therefore not expected to be significant. • Other impacts during construction include disturbance or physical impact to aquatic fauna due to noise and vibration. For example, excessive noise or vibration could cause fish mortality due to the interruption of underwater communication. • There would be a temporary loss of habitat and shading provided by the existing mature trees. This would recover over time with the reinstatement of vegetation and the temporary impacts are not expected to be significant.
Wetland entering Scarborough Park North	<ul style="list-style-type: none"> • Infilling of the northern boundary of this habitat would result from the raising of President Avenue (increased embankment). A small area of reeds and aquatic habitat would be removed for the project. This small area (<10 metre channel length) is currently in poor condition and would not significantly alter the ecological value of this wetland • Replacement culverts beneath the road and any minor channel works to tie in the modified road corridor would disturb soft benthic sediment, creating sediment plumes downstream if not contained. Any dredged material would be tested for acid sulfate soil potential and treated accordingly • Infilling of the northern boundary of this habitat would result from the raising of President Avenue (increased embankment). A small area of reeds and aquatic habitat (currently in poor condition) would be lost, however this would not significantly alter the ecological value of this reach • Physical disturbance and mixing of substrate that potentially contains heavy metals may release the metals more rapidly than natural processes, resulting in dissolved metals moving downstream during high rainfall events.
Muddy Creek upstream of Bestic Street	<ul style="list-style-type: none"> • The proposed shared cycle and pedestrian pathways would not require clearing of mangroves or saltmarsh (i.e. no harm to marine vegetation), and earthworks would not affect the concrete channel or banks • There would be no obstruction of fish passage • The project adjacent to Muddy Creek is mapped as Key Fish Habitat (Muddy Creek north of Bestic Street), but there would be no harm to marine vegetation or loss of other fish habitat. Therefore, fish habitat offsets are not required • There would be potential for minor indirect impacts to surface flows due to a small increase in impervious surface area.
Cooks River near Kogarah Golf Course	<ul style="list-style-type: none"> • The Cooks River would be directly impacted by the project as the water treatment plant at Arncliffe would discharge to the Cooks River. One of the existing four culverts would be used to discharge to the river, avoiding direct bank disturbance during construction.

Protected aquatic flora listed under the FM Act was observed at Muddy Creek in the vicinity of C5. However the marine vegetation was growing under disturbed conditions forming a patchy and narrow strip. Although these types of marine vegetation provide important functions in an estuary, their value and potential to expand on site is reduced by past development, concrete-lined channels and seawalls. Therefore, the project is considered unlikely to impact protected aquatic flora or fauna, and no marine vegetation would be harmed.

Eve Street Wetland (Nationally important), and Spring Street Wetland, Landing Lights Wetland and Marsh Street Wetland (Locally important) are not expected to be impacted by the project.

Permanent power supply route

The permanent power supply connection would be installed within the roadway or in a conduit attached to an existing crossing where the connection crosses Muddy Creek, Bardwell Creek and Wolli Creek. This would avoid direct bank disturbance and impacts to aquatic biodiversity within these waterways. **Chapter 18** (Surface water and flooding) outlines the proposed management measures for surface water quality during construction of the project.

Acidification

The project has the potential to result in impacts on biodiversity from acid sulfate soils during construction. It is assumed that a large portion of the excavation for the cut and cover and trough structures within C3 would be through acid sulfate soils.

Management of acid sulfate soil would be consistent with the *Acid Sulfate Soil Manual*¹⁷. The preference would be to treat acid sulfate soils (and any groundwater) on-site prior to reuse on-site or disposal off-site. For the project, the majority of excavated material would be disposed off-site. Water affected by acid sulfate soils would be collected and treated prior to disposal.

Implementation of mitigation measures would limit the potential indirect impacts to biodiversity through exposure to acid sulfate soils.

¹⁷ Stone et al (1998). *Acid Sulfate Soil Manual*.

12.3.4 Impact on groundwater dependent ecosystems

The NSW Aquifer Interference Policy states that predicted drawdowns of greater than 10% of natural variation will require adaptive management for high priority GDEs (e.g. monitoring and mitigation/remediation during operation), should the project be approved. Natural seasonal variation in monitoring data is in the order of one metre, therefore the drawdown threshold for predicted impact reporting has been taken as 0.1 metres.

None of the GDEs identified within the study area are of high priority. The closest high priority GDEs are the Botany Wetlands and Lachlan Swamps within the Botany Sands, located in Centennial Park around eight kilometres north-east of the project. These wetlands are at a sufficient distance from the project to not be impacted by the project during construction and operation.

The GDEs at Rockdale Bicentennial Park are highly modified and consist of remnant and planted vegetation on the banks of the wetland. The wetland is fed from surface flows and stormwater runoff. These potential GDEs are likely to have a moderate reliance on groundwater. Further modification of these GDEs would be required to enable temporary diversion of the wetlands during construction of the diaphragm walls at the President Avenue intersection. The wetlands would be reinstated and remediated after construction.

Groundwater modelling has predicted that the long term surface water drawdown within Rockdale Wetlands ranges from 0.28 metres to 0.32 metres (refer to **Chapter 17** (Groundwater and geology)). However the wetlands are not classified as a high priority GDE and the wetlands are highly modified to act as flood mitigation basins. Consequently the projected groundwater drawdown is likely to be mediated by the inflow from stormwater.

At Scarborough Park North, the GDE is fed by both surface flows (including stormwater from the wetland and associated water) and a weak tidal influence from Botany Bay. The potential GDE is present as reedlands and is fed by stormwater inflows from the wetland and associated water as well as a weak tidal influence. This potential GDE has a moderate reliance on subsurface water. A potential drawdown of between 0.11 and 0.12 metres is likely to be mediated by the inflow of water from stormwater.

Potential impacts to GDEs in the vicinity of Kogarah Golf Course and the Cooks River were assessed as being low as a result of groundwater level decline during the construction of the project.

Elsewhere within the study area, wetlands have limited groundwater dependence and are therefore unlikely to be adversely impacted by groundwater level decline associated with the construction phase of the project.

Overall, the project is not expected to significantly affect or change groundwater flows, providing impacts to possible groundwater interactions at or near drainage lines is kept to a minimum and the mitigation measures outlined in **section 12.6** are implemented.

12.3.5 Introduction and spread of exotic species

Animal pests

Given the study area is disturbed and within a highly urbanised setting, it is highly likely that animal pests would be present within the study area. The following species were recorded during field surveys:

- European Red Fox (*Vulpes vulpes*)
- European Rabbit (*Oryctolagus cuniculus*)
- Common Myna (*Acridotheres tristis*).

'Predation by the European Red Fox' and 'Competition and grazing by the feral European Rabbit' are key threatening processes listed under the EPBC and BC Act.

The project is not likely to exacerbate the impacts of the European Red Fox or European Rabbit on native fauna, given they already live in the study area, the highly urban context and the lack of native fauna present (as well as degraded condition of native fauna habitat).

The project is also considered unlikely to exacerbate the impacts of the Common Myna on bird assemblages in the study area.

Feral cats were not recorded during the field survey. However they are likely to forage the study area given the surrounding urban development. 'Predation by the feral cat' is a key threatening process listed under the EPBC and BC Act. The project is unlikely to increase the abundance of cats, introduce them into new areas (given the abundance of cats in the study area), or increase predation pressure on native fauna.

Pathogens

A number of pathogens are of concern in NSW that have the potential to impact on native flora and fauna. Activities that involve movement of equipment over large areas are of particular concern given the high potential for pathogen spread over large areas. Although no sign of pathogen infection was identified during the field survey or desktop assessment, it is important to assess the potential impacts of these pathogens and mitigate against their spread.

The main pathogens of concern are:

- Myrtle Rust (*Uredo rangelli*)
- Chytrid Fungus (*Batrachochytrium dendrobatidis*)
- Phytophthora (*Phytophthora cinnamomi*).

The 'Infection of frogs by amphibian chytrid fungus causing the disease Chytridiomycosis' and 'Dieback caused by Phytophthora' are listed as key threatening processes under both the EPBC Act and the BC Act.

The 'Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae' is a listed key threatening process under the BC Act.

Given the highly urban context and lack of existing remnant native vegetation within the study area, it is unlikely that Phytophthora is present. Myrtle rust, if present, would be limited to any landscaped or planted Eucalypts. It is possible that the Chytrid fungus could be present at the Arncliffe tunnel site, where frog habitat occurs adjacent to the site.

The implementation of appropriate mitigation measures listed in **section 12.6** would reduce the potential for introduction of Myrtle rust, Chytrid fungus and Phytophthora into the study area during construction of the project. Where required, these pathogens would be managed through the implementation of the management measures detailed in **section 12.6**.

12.3.6 Impact on matters of national environmental significance

An assessment in accordance with criterion under the Commonwealth *Matter of National Environmental Significance Significant Impact Guidelines*¹⁸ was undertaken and is provided in Annexure E of **Appendix H** (Biodiversity development assessment report). The assessment outlined below concluded that a significant impact on the Green and Golden Bell Frog, Magenta Lilly Pilly and Grey-headed Flying-fox is unlikely to occur as a result of the project and therefore no species offsets are required.

Grey-headed Flying-fox

The project would result in the loss of around 4.45 hectares of potential foraging habitat (such as Fig trees and winter flowering street trees) for the Grey-headed Flying-fox, which is listed as Vulnerable under the BC Act and EPBC Act. It may also result in indirect impacts such as disturbance from construction noise, vibration and lighting. However, no Grey-headed Flying-fox roosting sites or camps occur within the study area.

An assessment in accordance with the Commonwealth Significant Impact Guidelines was undertaken for the Grey-headed Flying-fox. The assessment concluded that the project would not have a significant impact on this species, and as such, a referral to the Commonwealth was not required. Furthermore, the Grey-headed Flying-fox, is an ecosystem credit species (species that can be reliably predicted to occur based on an identified PCT). Given the absence of PCTs within the study area, this species does not require an offset, in accordance with the BAM.

¹⁸ Commonwealth of Australia (2013). *Matter of National Environmental Significance Significant Impact Guidelines*.

Green and Golden Bell Frog

Impacts to the Green and Golden Bell Frog have also been considered in relation to Commonwealth Significant Impact Criteria and the specific *Significant impact guidelines for the vulnerable green and golden bell frog (Litoria aurea) Nationally threatened species and ecological communities EPBC Act policy statement 3.19*.

During the survey period 2017/2018 (October to March) in the Arncliffe area, only one adult was recorded at around 400 metres south-east of C1 (refer to **section 12.3.2** for details on population trends). No frogs were detected in the RTA Ponds or within the areas of habitat immediately adjacent to C1.

Green and Golden Bell Frog habitat would not be directly affected by the construction of the project. This is because the project would use the existing Arncliffe construction ancillary facility, currently in use for the construction of the New M5 Motorway project. Offsets have already been provided under the approval for that project. The construction of the project would however delay the habitat reinstatement of the Arncliffe construction ancillary facility following the construction of the New M5 Motorway project. Given the low occurrence of Green and Golden Bell Frogs in the vicinity of C1, the impact of this delay on the population is not expected to be significant.

The construction of the project is likely to result in the prolongation of indirect impacts (such as noise, dust and vibration impacts) on the Green and Golden Bell Frog, currently arising from the use of the area at C1 for construction of the New M5 Motorway. These impacts would be temporary and are not expected to significantly impact the Green and Golden Bell Frog population given the implementation of management measures identified in **section 12.6, Chapter 11** (Noise and vibration), **Chapter 9** (Air quality) and **Chapter 13** (Landscape and visual).

Therefore, the assessment concluded that the project would not have a significant impact on this species, and as such, a referral to the Commonwealth is not required.

Magenta Lilly Pilly

An assessment in accordance with the Commonwealth Significant Impact Guidelines¹⁹ was undertaken for the Magenta Lilly Pilly. The project contains a number of Magenta Lilly Pilly adults. Around 20 adult individuals were recorded at Rockdale Bicentennial Park in landscape plantings. These adult plants were not fruiting or flowering and their origins are unknown, although they are likely to have been planted as part of the park landscaping. The assessment concluded that the project would not have a significant impact on this species.

All impacts to MNES have been avoided as far as practicable and all impacts have been assessed in accordance with Commonwealth guidelines. Environmental management measures would be implemented to manage potential impacts to MNES.

As no significant impact would occur on any MNES, a referral to the Commonwealth Department of the Environment and Energy is not required and the EPBC Act assessment bilateral agreement has not been triggered for the project. Further detail is provided in **Chapter 2** (Assessment process).

12.3.7 Impacts on relevant key threatening processes

The project has the potential to contribute to key threatening processes as defined by the EPBC Act, BC Act and FM Act in relation to threatened species, communities, populations and their habitats. These are summarised in **Table 12-14**. With the implementation of appropriate mitigation measures, the risk of exacerbating these key threatening processes is considered to be low.

¹⁹ Commonwealth of Australia (2013). *Matter of National Environmental Significance Significant Impact Guidelines*.

Table 12-14 Potential impacts of key threatening processes on biodiversity

Key threatening process	Statutory listing	Relevance to the project	Potential or known impact
Clearing of native vegetation	BC Act and EPBC Act	The project would involve the removal of native vegetation, including threatened species, and potential foraging habitat for the Grey-headed Flying-fox.	Known
Removal of dead wood and dead trees	BC Act	The project would involve the removal of native vegetation.	Known
Invasion and establishment of exotic vines and scramblers	BC Act	The project would involve indirect impacts (e.g. noise, light and dust) on native vegetation and habitat.	Potential
Invasion, establishment and spread of <i>Lantana camara</i>	BC Act and EPBC Act	The project would involve indirect impacts (e.g. noise, light and dust) on native vegetation and habitat.	Potential
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	EPBC Act	The project would involve indirect impacts (e.g. noise, light and dust) on native vegetation and habitat.	Potential
Predation by Plague Minnow or Mosquito Fish (<i>Gambusia holbrooki</i>)	BC Act and EPBC Act	The project would involve indirect impacts (e.g. noise, light and dust) on native vegetation the Green and Golden Bell Frog potentially exacerbating predation by Plague Minnow or Mosquito Fish, if the indirect impacts are not managed appropriately.	Known
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	BC Act and EPBC Act	Movement of vehicles, equipment and people during construction carries a risk of introduction and spread of Myrtle rust. Presence of Myrtle rust within the study area is unknown, but would likely be limited to any landscaped or planted Eucalypts.	Potential
Infection of frogs by amphibian chytrid fungus causing the disease Chytridiomycosis	BC Act and EPBC Act	Chytrid fungus is spread by cross contamination of water bodies and improper handling of frogs. It is possible that the Chytrid fungus could be present at the Arncliffe tunnel site, where frog habitat occurs adjacent to the site, if management measures are not applied appropriately.	Potential
Dieback caused by the root-rot fungus* <i>Phytophthora cinnamomi</i>	BC Act and EPBC Act	Spores can be spread over large areas by water, vehicle and machinery movement as well as human and animal movement.	Potential
Human-caused climate change	BC Act, EPBC Act and FM Act	During construction, machinery and production and transport of materials would emit carbon-dioxide into the atmosphere, which is known to increase greenhouse gases responsible for climate change.	Known

*Note: It is now understood that *P. cinnamomi* is not a fungus. This was the name of the key threatening process when it was registered under the EPBC Act.

12.4 Potential impacts – operation

12.4.1 Terrestrial flora

Where the removal of trees is unavoidable during construction, trees would be replaced in accordance with the tree management strategy for the project, which would be prepared in consultation with relevant stakeholders (including local councils). The strategy would be used to guide consideration of options for their replacement (refer to section 13.9 of **Chapter 13** (Landscape and visual)).

The replacement of trees would be in accordance with a number of general principles, including a net increase in the number of replacement trees. The plan would also include species recommendations for the landscape design to consider, including foraging trees for the Grey-headed Flying-fox. Native vegetation would be re-established in accordance with *Guide 3: Re-establishment of native vegetation* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011)²⁰.

12.4.2 Terrestrial fauna

Threatened fauna and habitat

There would be potential indirect impacts on the Green and Golden Bell Frog during operation at the Arncliffe motorway operations complex, including noise and light spill. However, these impacts are not expected to be significant given the implementation of the management measures outlines in **section 12.6**.

Lighting would be provided along the shared cycle and pedestrian pathways, including the President Avenue shared cycle and pedestrian bridge. The lighting would be downward facing to minimise light spill, therefore reducing disturbance to the Grey-headed Flying-fox.

Impact on migratory species

For migratory birds, the impacts are unlikely to be significant during operation. The migratory species occasionally visit the Landing Lights Wetland (which are not within the construction boundary), preferring to use the resources at Towra Point wetland and Shell Point Botany Bay.

Only indirect impacts may potentially affect these species via possible hydrological changes, such as groundwater drawdown and barriers to flow, resulting in a reduction in groundwater supply to wetlands which provide habitat for migratory species.

Fauna injury and mortality of fauna

Fencing or other appropriate separation mechanisms would be used during the operation of the project. Fencing or other mechanisms would minimise terrestrial fauna from entering the motorway, however no one measure would completely eliminate the risk of vehicle strike during operation.

Threatened fauna and loss of habitat

Green and Golden Bell Frog

Following construction of the project, there would be an increase in the permanent take of land (that is potential Green and Golden Bell Frog Habitat) for this project above what was approved for the New M5 Motorway. The area of permanent take would have consisted of fairways, rough and small unmanaged ponds (water hazards) at Kogarah Golf Course.

While there would be less area able to be reinstated to golf course if this project were approved, the impact on the population of Green and Golden Bell Frog is not likely to be significant. The area of permanent take is not likely to sever any habitat corridor or prevent frogs from dispersing across the golf course. The area of permanent take was included in the biodiversity offsets sought for the New M5 Motorway project.

²⁰ RTA (2011). *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects*.

12.4.3 Loss of aquatic biodiversity

Appendix L (Surface water technical report) states that potential impacts to surface water quality during operation of the project, associated with treated tunnel water discharges, stormwater discharges and spills are considered able to be mitigated by the proposed design and with application of the proposed management measures outlined in **Chapter 18** (Surface water and flooding).

Residual impacts to surface water flows and water levels during dry conditions and after frequent rainfall events in Scarborough Ponds, Muddy Creek and the Cooks River are considered to be negligible during the operation of the project. Potential scour impacts at discharge locations would be controlled through implementation of dissipation and scour protection measures. Monitoring would be undertaken after the restoration of the Bicentennial Park Pond to certify that Bicentennial Park Pond restoration works are undertaken appropriately.

An overview of the potential impacts during operation to specific aquatic habitats is outlined in **Table 12-15**.

Table 12-15 Potential impacts during operation to aquatic habitats across the study area

Aquatic habitat	Description
Wetland within Rockdale Bicentennial Park through Rockdale Wetlands	<ul style="list-style-type: none"> There would be a temporary loss of habitat and shading from the existing mature trees. This would recover over time with the reinstatement of vegetation and riparian habitat above the cut and cover structure within Rockdale Bicentennial Park. Opportunities to incorporate improvement measures to the Bicentennial Park Pond to provide additional treatment of surface water and shallow groundwater would be investigated in consultation with Bayside Council and other relevant stakeholders.
Wetland entering Scarborough Park North	<ul style="list-style-type: none"> Opportunities would be investigated for improving water quality flows into the Scarborough Ponds at Scarborough Park North, within the project boundary during detailed design (refer to Chapter 18 (Surface water and flooding)).
Muddy Creek upstream of Bestic Street	<ul style="list-style-type: none"> Potential impacts on Muddy Creek and associated drainage lines are expected to be minor A small increase in impervious surface area would result from the installation of the shared cycle and pedestrian pathways, which can lead to faster surface runoff and warmer water. However, given the majority of the catchment is impervious, a small addition is likely to be insignificant Infilling or shading of <i>Phragmites australis</i> (Common Reed) may be required around stormwater channels leading to Muddy Creek. These small stands currently help filter water by trapping sediment and pollutants before they enter the main channel, and their removal or shading would reduce this process. However, existing grass swales and a mangrove channel also contribute to this function, and the protection or enhancement of those elements may balance the process.
Cooks River near Kogarah Golf Course	<ul style="list-style-type: none"> During operation, the Cooks River would be directly impacted by the project, as the water treatment plant at Arncliffe would discharge to Cooks River near the Giovanni Brunetti bridge The addition of the small discharge outlet is unlikely to significantly alter the hydrological character of the Cooks River, a large tidal river The quality of discharged water is expected to meet 80% species protection guidelines (refer to Appendix L (Surface water technical report)). Given the largely modified nature of the entire catchment, this discharge quality is unlikely to significantly alter the marine ecology.

No impacts to Muddy Creek, Bardwell Creek and Wollie Creek are expected to occur during operation of the project as a result of the permanent power supply connection.

12.4.4 Impact on groundwater dependent ecosystems

For the Rockdale Wetlands area, groundwater modelling predicts the long term surface water drawdown as being between 0.28 metres and 0.32 meters. However, as described in **section 12.3.4** the wetlands are not classified as high priority and are highly modified to act as flood mitigation basins. Consequently the predicted groundwater drawdown would be less than anticipated because of the continual inflow of stormwater and floodwaters.

Long term dewatering caused by tunnel drainage is predicted to lower the water table and water pressure levels within the Hawkesbury Sandstone, reducing the amount of groundwater available for some shallow rooted plants. The minimum depth of the water table underlying the majority of the construction boundary is on average one metre below ground surface. Areas where the water table is shallow, such as along the Rockdale Wetlands corridor, are typically subjected to flood inundation which would provide water periodically for shallow rooted plants that may have some groundwater dependence. At other more elevated topographic areas, such as parts of Arncliffe, the water table is much deeper below ground surface and consequently flora is unlikely to be dependent on groundwater.

Following the completion of tunnel construction, groundwater would be available for partially groundwater dependent flora, as the unsaturated soil zone would not be affected by the project and would continue to receive rain infiltration. Shallow perched water (water located at an elevation higher than the local water table) is expected to be present irregularly along the alignment and could partially sustain surface ecosystems. However, partially groundwater dependent flora would primarily be dependent upon rainfall recharge and moisture within the unsaturated soil zone. In low lying areas, the project is not expected to substantially change the availability of water for plants due to the low permeability of fine soils in combination with frequent rainfall events and higher recharge compared to elevated sites.

Potential impacts to the potential GDEs were assessed as being low as a result of groundwater level decline during the operation of the project (refer to **Chapter 17** (Groundwater and geology)).

Drawdown in excess of the seasonal variation of 0.05 metres is predicted at Landing Lights, Eve Street, Spring Street, King Street and Marsh Street Wetlands, with long term drawdown predicted to vary from 0.28 metres at Landing Lights Wetland to 0.47 metres at the Marsh Street Wetland (refer to **Chapter 17** (Groundwater and geology)). These predicted drawdowns are not considered to be of concern because the wetlands are not dependent on groundwater.

The mainline tunnels for the project have been designed to minimise high groundwater inflows into the tunnels. Potential impacts associated with groundwater inflows such as groundwater level decline and potential impacts to GDEs have therefore been minimised in the design of the mainline tunnels.

12.4.5 Impact on matters of national environmental significance

Following the desktop assessment and field surveys, three MNES was identified as potentially occurring within the study area and could be adversely affected by the project. These were:

- Grey-headed Flying-fox
- Green and Golden Bell Frog
- Magenta Lilly Pilly.

Grey-headed Flying-fox

An assessment in accordance with the Commonwealth Significant Impact Guidelines²¹ was undertaken for the Grey-headed Flying-fox (refer to Annexure D of **Appendix H** (Biodiversity development assessment report)).

Lighting would be provided along the shared cycle and pedestrian pathways, including the President Avenue shared cycle and pedestrian bridge. The lighting would be downward facing to minimise light spill, therefore reducing disturbance to the Grey-headed Flying-fox.

²¹ Commonwealth of Australia (2013). *Matter of National Environmental Significance Significant Impact Guidelines*.

The assessment concluded that the project would not have a significant impact on this species during operation, and as such, a referral to the Commonwealth is not required. Furthermore, offsets for this species are not required (according to BAM), as impacts are associated with an ecosystem credit species.

Green and Golden Bell Frog

An assessment in accordance with the Commonwealth Significant Impact Guidelines and the specific *Significant impact guidelines for the vulnerable green and golden bell frog (Litoria aurea) Nationally threatened species and ecological communities EPBC Act policy statement 3.19*. was undertaken for the Green and Golden Bell Frog (refer to Annexure D of **Appendix H** (Biodiversity development assessment report)).

During operation, there would be an increase in the permanent take of land (that is potential Green and Golden Bell Frog Habitat) for this project above what was approved for the New M5 Motorway. The area of permanent take would comprise fairways, rough and small unmanaged ponds (water hazards) on the golf course.

While a smaller area would be reinstated to golf course if this project were approved, the impact on the population of Green and Golden Bell Frog is not likely to be significant. The area of permanent take is not likely to sever any habitat corridor or prevent frogs from dispersing across the golf course. The area of permanent take was included in the biodiversity offsets sought for the New M5 Motorway project.

Roads and Maritime has instigated, as part of the Green and Golden Bell Frog Management Plan for the New M5 Motorway project, a program of captive breeding and new habitat creation at Marsh Street. Animals are currently in captive husbandry and have not yet been introduced into their new habitat which is currently under construction. The project would not impact on the new habitat at Marsh Street. Any decision to introduce frogs into the RTA ponds as part of the New M5 Motorway mitigation measures would consider indirect impacts arising from this project along with an assessment of the ongoing viability and suitability of the RTA ponds to provide habitat for this species.

The assessment concluded that the project would not have a significant impact on this species during operation, and as such, a referral to the Commonwealth is not required.

Magenta Lilly Pilly

An assessment in accordance with the Commonwealth Significant Impact Guidelines was undertaken for the Magenta Lilly Pilly (refer to Annexure D of **Appendix H** (Biodiversity development assessment report)). The construction boundary contains 20 adult individuals recorded at Rockdale Bicentennial Park in landscape plantings. These plants would be cleared during construction of the project (as outlined in **section 12.3.6**), however no impacts to this species is anticipated during operation of the project. As such, a referral to the Commonwealth is not required.

Mitigation strategies have been put into place to manage potential impacts to MNES.

As no significant impact would occur to any MNES during operation, biodiversity offset and a referral to the Commonwealth Department of the Environment and Energy is not required and the EPBC Act assessment bilateral agreement has not been triggered for the project.

12.4.6 Impacts on relevant key threatened processes

The project has the potential to contribute to a key threatening process during operation as defined by the EPBC Act, BC Act and FM Act in relation to threatened species, communities, populations and their habitats. This process is summarised in **Table 12-16**.

Table 12-16 Potential impacts of key threatening processes on biodiversity

Key threatening process	Statutory listing	Relevance to the project	Potential or known
Human-caused climate change	BC Act, EPBC Act and FM Act	The results of the greenhouse gas assessment for the project demonstrates the benefits of road tunnel usage in urban areas, where travel along a more direct route at higher average speeds results in fewer greenhouse gas emissions being generated by road users, as reduced congestion and stop-start driving reduces the fuel used by vehicles. Further detail is provided in Chapter 22 (Climate change and risk adaptation).	Known

12.4.7 Cumulative impacts

Other Roads and Maritime projects

New M5 Motorway

The New M5 Motorway project involves construction and operation of a new, tolled multi-lane road link between the existing M5 East Motorway, east of King Georges Road, and St Peters, an intersection at St Peters and connections to the existing road network. The project would utilise some of the area used by the New M5 Motorway project at Kogarah Golf Course (the Arncliffe construction ancillary facility).

The New M5 Motorway project was assessed using the Framework for Biodiversity Assessment, which differs from the assessment methodology for the project. The assessment is summarised in section 4.1.2.1 of **Appendix H** (Biodiversity development assessment report).

The New M5 Motorway directly impacted 3.31 hectares of native vegetation. Accordingly, the project Biodiversity Assessment Report assessed the type and number of credits using the Framework for Biodiversity Assessment. These calculations identified the following offset requirements for the project:

- A total of 58 ecosystem credits consisting of 31 Broad-leaved Ironbark – *Melaleuca decora* shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 725) credits and 27 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT 1046) credits
- A total of 203 credits for Green and Golden Bell Frog.

In addition to the above impacts, 10.80 hectares of planted native and exotic vegetation have been affected by New M5 Motorway works, which represented potential foraging habitat for the Grey-headed Flying-fox.

The project overlaps with the New M5 Motorway project at the Arncliffe tunnel stubs, with the project utilising part of the existing New M5 Motorway construction ancillary site at Arncliffe. The project would require the deferment of the New M5 Motorway's habitat reinstatement requirements at the Arncliffe construction ancillary facility (C1).

The use of C1 by the project would prevent around 7.6 hectares of land being reinstated at the conclusion of the New M5 Motorway project. The operational footprint at Arncliffe would also expand as part of the project to include the water treatment plant and substation, meaning less land would be reinstated following the commencement of construction for the project.

The continued use of this site is unlikely to significantly affect Green and Golden Bell Frog. This is because the species is not likely to be present due to a decline in the population, and the removal of adult frogs for the captive breeding program (as part the of the New M5 Motorway project).

Management measures proposed for the project for biodiversity values are consistent with those adopted for the New M5 Motorway project.

The project would require the removal of a small amount of foraging habitat (suitable feed trees; up to 4.45 hectares) for the Grey-headed Flying-fox in the form of planted native or exotic vegetation, contributing to a minor cumulative impact on this species.

Marsh Street Widening

Roads and Maritime proposes to widen Marsh Street, Arncliffe to provide three continuous westbound lanes between the Giovanni Brunetti Bridge and the M5 Motorway intersection. That project is located adjacent to the Kogarah Golf Course and the RTA Ponds at Arncliffe.

The Marsh Street widening project was assessed as a Part 5 activity under the EP&A Act and the Review of Environmental Factors for the project concluded that about 2.02 hectares of vegetation would be removed including 0.1 hectares of 'Swamp Oak Forest'. The project included an area of steep batters to the north of the RTA Ponds and widening Marsh Street at this location.

The Marsh Street widening project impacted Green and Golden Bell Frog habitat. Mitigation measures provided in the project REF for this species included:

- Delineation of Green and Golden Bell Frog habitat from the construction zone by a frog-proof fence
- Pre-clearance survey for this species

- Direction of surface water runoff away from the RTA Ponds
- Maintenance of the water supply to the RTA Ponds.

No offsets were proposed for the Marsh Street widening project.

The project abuts the Marsh Street widening project. The Marsh Street project commenced in April 2016 and all major work has recently been completed (early 2018). The two projects, along with the New M5 Motorway project, would impact the area close to the RTA Ponds continuously for several years, should this project be approved. While the project would not intensify activity at the Arncliffe construction ancillary facility, it would prolong noise, light, dust and vibration indirect impacts.

Other projects

Residential development at Cooks Cove, Wolli Creek, Arncliffe, Banksia and Turrella

The Department of Planning and Environment and Bayside Council have prepared a Land Use and Infrastructure Strategy for the Bayside West Precincts²². These precincts include parts of the suburbs of Arncliffe and Banksia. The strategy identifies that parts of these precincts could be subject to further development, especially for housing.

Development and land use change in these areas is subject to further assessment. However the strategy signals intent to explore intensification of land use, which would include in areas containing biodiversity values, such as in the Kogarah Golf Course, adjacent to the RTA Ponds and in surrounding Green and Golden Bell Frog habitat such as at the Marsh Street Green and Golden Bell Frog habitat site. The strategy suggests that any future development in this precinct 'maximises the existing heritage elements...this encompasses ecological, [and] environmental elements' (DPE 2016). Future planning proposals for this area would need to consider potential cumulative impacts on Green and Golden Bell Frog habitat. The land on which the permanent facilities for the project are located on would be prevented from being returned to Green and Golden Bell Frog habitat.

12.5 Biodiversity offsets

Consistent with the *Biodiversity Conservation Act 2016* and the SEARs for the project, a biodiversity offset strategy has been developed to compensate for the unavoidable loss of ecological values as a result of the project.

The Biodiversity Offset Scheme requires the purchase and retirement of biodiversity credits calculated in accordance with the BAM. Roads and Maritime would consult with the vendor/s of the biodiversity credits detailed in **Appendix H** (Biodiversity development assessment report), and arrange to purchase and retire a total of 26 biodiversity credits appropriate to offset the impacts of the project.

²² Department of Planning and Environment, 2018. Bayside West Precincts 2036 – Arncliffe and Banksia.

This BDAR assessed the type and number of credits using BAM. The following PCTs require offsetting in accordance with the online credit calculator:

- Around 0.47 hectares of 1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion (8 credits)
- Around 0.30 hectares of 1795 Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin (10 credits)
- Around 0.77 hectares of 1808 Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline (8 credits).

It is noted that the Grey-headed Flying-fox is an ecosystem credit species under the BAM, however no breeding habitat for the Grey-headed Flying fox would be impacted by the project and therefore no separate species credits are required for this species.

An area of about one hectare of native vegetation likely to be Grey-headed Flying-fox foraging habitat would be directly affected by the project. It would be offset through the ecosystem credits required for impacts on this native vegetation.

12.6 Management of impacts

The mitigation measures to minimise direct and indirect ecological impacts would be implemented as part of the project in line with Roads and Maritime *Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority 2011). These measures would be detailed in the Construction Flora and Fauna Management Plan (CFFMP) for the project which would include: site-specific environmental induction; identification of clearing limits and protective fencing; vegetation clearance procedures; pre-clearance surveys; erosion and sediment controls; weed management and monitoring.

The New M5 Motorway project would continue to implement the New M5 Motorway Green and Golden Bell Frog Plan of Management, in line with the planning approval requirements for that project. For impacts created by the project, mitigation measures would be implemented consistently with that plan.

Opportunities would be investigated to improve the water quality within Rockdale Bicentennial Park and Scarborough Park North during detailed design, in consultation with Bayside Council and other relevant stakeholders. Water quality management measures are discussed further in **Chapter 18** (Surface water and flooding).

In addition to the implementation of the project in accordance with the above guideline, the project specific mitigation and management measures provided in **Table 12-17** would be implemented during construction and operation of the project to reduce or minimise the potential impacts discussed in **section 12.3** and **section 12.4**.

Table 12-17 Environmental management measures - Biodiversity

Impact	Reference	Environmental management measures	Timing
Removal of native vegetation and habitat, including threatened plants	B1	Detailed design will avoid or minimise the need for native vegetation and habitat removal for the construction of the project, where feasible. A plan for the rehabilitation of all areas directly affected by construction, including water bodies, would be included as part of the CFFMP (refer B4 below).	Detailed design
Indirect impacts on native vegetation and habitat	B2	Detailed design of the project will avoid or minimise artificial light impacts on biodiversity within and immediately adjacent to the operational project (e.g. downward-facing lighting along the shared cycle and pedestrian pathways)	Detailed design
Impacts to wetlands and riparian land	B3	Detailed design of the project will avoid or minimise disturbance to wetlands and riparian land during both construction and operation, as far as practical. This will include location of stockpiles outside of riparian corridors where reasonable and feasible.	Detailed design

Impact	Reference	Environmental management measures	Timing
Impacts to flora and fauna	B4	<p>A Construction Flora and Fauna Management Plan (CFFMP) will be prepared. The CFFMP would outline processes and responsibilities with regard to avoiding, managing and/or mitigating biodiversity impacts during construction.</p> <p>The plan will include:</p> <ul style="list-style-type: none"> • A process for pre-clearance surveys prior to vegetation clearing • A process for vegetation clearing including the establishment of exclusion zones at the limit of clearing to protect sensitive areas. Exclusion zones will be established in accordance with Guide 2 Exclusion Zones of Roads and Maritime's Biodiversity Guidelines²³ • An unexpected finds procedure for both flora and fauna • A procedure for managing inadvertent impacts to both flora and fauna • A process for identifying and managing priority and environmental weeds and other pests prior to, during, and after construction (including within vegetation exclusion zones) • A protocol to minimise the potential for the spread of pathogens such as Chytrid or Phytophthora fungus into and out of the site during construction • A process for dewatering and restoration of the Rockdale Wetland, including measures developed by an aquatic ecologist to handle and relocate aquatic fauna. <p>The processes and procedures will be prepared in accordance with relevant Roads and Maritime guidelines.</p>	Prior to construction
Impacts to Green and Golden Bell Frogs	B6	<p>All construction site inductions will contain a relevant section on identifying and managing potential risks to the Green and Golden Bell Frog. This will include identification of the frog and its habitat, a clear outline of the location of no-go zones for construction personnel, equipment and materials (including herbicides and pesticides), hygiene protocols and what to do in the event of an unexpected find.</p> <p>Frog exclusion fencing and sediment controls will be installed.</p> <p>Any Green and Golden Bell Frogs encountered within the construction boundary during construction are to be collected by a qualified and experienced herpetologist and relocated within the adjacent golf course by the herpetologist.</p> <p>Impacts to Green and Golden Bell Frog due to light spill will be mitigated with lighting directed to minimise construction night time light spill outside of all construction areas, particularly onto the RTA ponds and Kogarah Golf Course.</p> <p>The ground surface within the Arncliffe construction ancillary facility (excluding the operational footprint) will be reinstated to a condition the same or better than prior to the commencement of construction of the New M5 Motorway project in consultation with relevant stakeholders.</p>	Construction, and post- construction

²³ RTA, 2011, *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects*.

12.7 Environmental risk assessment

An environmental risk analysis was undertaken for biodiversity and is provided in **Table 12-18** below.

A level of assessment was undertaken commensurate with the potential degree of impact the project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised (for example, through design amendments). Where impacts could not be avoided, environmental management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation measures have been implemented. The methodology used for the environmental risk analysis is outlined in **Appendix O** (Methodologies).

Table 12-18 Environmental risk analysis – Biodiversity

Summary of impact	Construction/operation	Management and mitigation reference	Likelihood	Consequence	Residual risk
Vegetation clearing	Construction and operation	B1, B4	Certain	Minor	Medium
Deferral of Green and Golden Bell Frog habitat reinstatement	Construction	B6	Certain	Minor	Medium
Inadvertent impacts on adjacent habitat or vegetation	Construction	B3, B4	Unlikely	Minor	Low
Transport of weeds and pathogens from the site to adjacent vegetation	Construction	B3, B4	Unlikely	Moderate	Low
Sedimentation and contaminated and/or nutrient rich run-off to aquatic habitats	Construction and operation	B3, B4	Likely	Minor	Low
Noise, dust or light spill	Construction and operation	B3, B4	Likely	Minor	Low
Vehicle strike	Construction and operation	B3, B4	Unlikely	Moderate	Low
Trampling of threatened flora species	Construction and operation	B3, B4	Unlikely	Minor	Low
Disturbance to specialist breeding and foraging habitat for the Grey-headed Flying-fox	Construction and operation	B1, B4	Unlikely	Moderate	Low

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