5 Threatened species

5.1 Candidate species

5.1.1 Ecosystem credit species

The FBA 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 project footprint, the condition and patch size of vegetation. The FBA 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.

However, due to the lack of PCTs within the project footprint, no ecosystem credits species were predicted to occur.

5.1.2 Species credit species

Species credit species are typically predicted by the assessment tool based on the PCTs present within the project footprint, and a series of habitat and geographic location questions formulated by the assessment tool. Once the species credit species are identified, they undergo a second filtering step to determine whether they are filtered into the assessment for consideration as a species credit species.

However, no species credit species were identified from the tool, and therefore no species credit species were considered for further assessment.

5.1.3 Final candidate species

No candidate species were initially predicted by the tool. However, some species have habitat requirements that cannot be predicted by PCTs, and therefore cannot be predicted by the assessment tool. Particularly those species that can utilise man-made or exotic environments. As such, a conservative list of final candidate species was developed (Table 5.1).

This list is based on the species likelihood of occurrence (Annexure A), which was informed from database searches, previous studies, and specific habitat features present within the project footprint. The list of final candidate species is then used to determine whether or not the species requires further assessment in the tool and whether targeted surveys are required. It is noted that this list (Table 5.1) contains both species and ecosystem credit species, and targeted survey was completed for all species, despite the assessment tool not requiring targeted survey for ecosystem credit species.

Furthermore, it is noted that a candidate species is typically not considered present by the FBA where:

- The habitat is substantially degraded
- An expert report states that the species is unlikely to be present
- The species is a vagrant and is unlikely to frequently use habitat in the project footprint
- Records of the species are at least 20 years old or have doubtful authenticity.

Table 5.1: List of candidate species credit species and their initial likelihood of occurrence (Annexure A)

Species	Species or ecosystem credit species	Likelihood of occurrence	Habitat assessment	Targeted survey
Grey-headed Flying-fox *(Pteropus poliocephalus)*	Species (breeding camps) and ecosystem (foraging)	High	Potential feed trees scattered across the study area. However, these are limited in number and may occur as individual trees. Records exist in close proximity to the site and are common in the locality.	No – assumed presence for foraging
Little Bentwing-bat *(Miniopterus australis)*	Species (breeding sites) and ecosystem (foraging)	Low	Utilises caves, hollows and man-made structures as roost sites. Only one record exists for this species within the locality. This record is within 100 metres of Iron Cove bridge and over 20 years old. The record is noted as being dubious within the NSW Wildlife Atlas, as the record is well outside the species known range.	Yes
Eastern Bentwing-bat *(Miniopterus schreibersii oceanensis)*	Species (breeding sites) and ecosystem (foraging)	Moderate	Utilises caves, hollows and man-made structures as roost sites. A number of records exists for this species within the locality. This closest record is over 20 years old from an old Balmain power station. It occurs within 100 metres of Iron Cove bridge. Other records are from Goat Island (ten years old), 2.5 km north of the site within Sydney Harbour.	Yes
Eastern Freetail-bat *(Mormopterus norfolkensis)*	Ecosystem	Moderate	Primarily uses hollows as roost sites, but can also use man-made structures. Nearest record is ten years old from Goat Island, 2.5 km north of the site in Sydney Harbour.	Yes
Southern Myotis *(Myotis macropus)*	Species (breeding sites) and ecosystem (foraging)	Low	Species has specific roost requirements, which primarily include tree hollows within riparian zones. Nearest record (ten years old) is from Goat Island, 2.5 km north of the site in Sydney Harbour).	Yes
Yellow-bellied Sheathtail-bat *(Saccolaimus flaviventris)*	Ecosystem	Low	Primarily uses hollows as roost sites. No records for this species exist within the locality.	Yes

5.2 Threatened species survey

5.2.1 Terrestrial flora surveys

No threatened flora were considered as having the potential to occur within the project footprint, or were recorded opportunistically during the vegetation and fauna surveys. The project footprint is representative of a highly disturbed and degraded environment, dominated by exotic vegetation or disturbance tolerant species.

5.2.2 Terrestrial fauna surveys

All fauna surveys were conducted in accordance with the SEARs and were consistent with the FBA and NSW and Commonwealth guidelines (Table 5.2). Where survey methods differed, an explanation was provided. A summary of the field survey effort for each species is provided in Table 5.3 and a map showing survey locations in Figure 5.1.

Fauna habitat assessments were initially conducted to identify potential habitat, including marking of habitat features, such as hollow-bearing trees, rock habitats, known food trees and

foraging substrates, presence of termite mounds, and evidence of fauna usage, for example diggings, chewed plant cones and scats. This habitat assessment was used to inform the requirement for targeted threatened fauna surveys, survey effort and survey location.

Table 5.2: Minimum requirements for candidate fauna species

Species	Minimum survey requirements and survey timing
Microbats	*FBA Tool* = Surveys should be conducted between October and March. *NSW* = Echolocation call survey (such as Anabat recorders) for a minimum of four hours. While not specified as a minimum requirement, it is recommended the recorders operate for the entire night (DEC 2004). *Commonwealth* = Species are not listed under the EPBC Act.
Grey-headed Flying-fox	*FBA* = Surveys are to be conducted between September and May. *NSW* = Spotlight searches combined with listening for audible calls and movements in trees, focussing on fruiting or flowering food trees and known roost sites or camps. For targeted survey near likely food resources, survey effort should involve 2 x 1 hour spotlighting sessions over two nights (DEC 2004). *Commonwealth* = This species occupies most areas in its distribution in highly irregular patterns, and therefore surveys based on animal sightings are unlikely to be reliable. A more effective survey method is to search appropriate databases and other sources for the locations of camps, and to conduct vegetation surveys to identify feeding habitat (DEWHA 2010b).

5.2.3 Summary of fauna survey effort

The fauna surveys for this assessment were conducted over multiple nights between August and October 2016 (Table 5.3). Surveys were only conducted at the Rozelle Rail Yards as potential habitat for these species were not considered to be present at other sites. Survey effort was prioritised according to the habitat features present within the rail yards (Figure 5.1).

Table 5.3 Summary of survey effort

Species	Survey effort	Dates	Survey method
Microbats	102 hours of recording	21/09/16, 22/09/16, 27/09/16, 12/10/16, 14/10/16 & 24/10/16	Four echolocation recording devices were set at separate locations over two consecutive nights (see Figure 5.1). A time delay was programmed into each device such that the calls were recorded from 5:30pm to 6am. Opportunistic follow-up Anabat surveys were conducted on 27 September and 24 October to supplement initial surveys. During these surveys, the Anabat was set for an hour following sunset. Bat calls for the initial Anabat surveys were analysed by Rodney Armistead and assigned to four levels of confidence as per Mills et al. (1996) (refer to Annexure E). An inspection (internal and external) of the Ports Authority building east of the bridge was conducted on 12 October for potential roost sites. An inspection of the cavities of the northern span of Victoria Road bridge was conducted on 14 October, using a burrow-scope and elevated work platform.

5.2.4 Fauna survey conditions

The fauna surveys were conducted during variable temperatures and generally after suitable rainfall (Table 5.4).

Table 5.4: Weather observations during fauna field survey

Date	Temperature °C (Min)	Temperature °C (Max)	Wind Speed km/h (at 9am)	Rainfall (mm) previous 48 hours
21/09/2016	14.0	22.3	15	11.0
22/09/2016	12.8	19.7	20	1.0
27/09/2016	10.6	23.3	28	9.8
12/10/2016	9.7	23.3	22	3.6
14/10/2016	8.4	20.3	11	6.2
24/10/2016	9.9	18.7	20	16.2

*Note: Data taken from Sydney Airport automatic weather station, 066037 (BOM 2016).

5.3 Threatened species results

Two threatened fauna species, the Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat were recorded during the targeted surveys (Table 5.5), within the Rozelle area. Furthermore, the Grey-headed Flying-fox was assumed to be present across the project footprint based on the presence of suitable foraging trees, and known records in close proximity to the Rozelle Rail Yards site.

Table 5.5: Threatened species survey results

Species	Ecosystem or species credit species?	Identification method	Can the species withstand further loss?	Habitat feature/ component	Impact
Grey-headed Flying-fox *(Pteropus poliocephalus)*	Ecosystem (foraging habitat)	Assumed	Not applicable for ecosystem credit	Planted and landscaped foraging trees within and adjacent to the site	Limited feed trees within the 4.49 hectares mapped as urban exotic and native cover
Eastern Bentwing-bat* *(Miniopterus schreibersii oceanensis)*	Species (breeding sites)* and ecosystem (foraging)	Recorded (Anabat surveys)	Yes	Non-native foraging habitat and potential roosting cavities under Victoria Road bridge (ecosystem credit components)	Up to 3.78 hectares foraging habitat (mapped urban exotic and native cover at construction sites; C5, C6 & C7) and direct impacts on potential roost sites
Yellow-bellied Sheathtail-bat *(Saccolaimus flaviventris)*	Ecosystem	Recorded (possible call, Anabat survey)	Not applicable for ecosystem credit	Non-native foraging habitat (ecosystem credit component)	Up to 3.78 hectares foraging habitat (mapped urban exotic and native cover)

* No maternity colonies for the Eastern Bentwing-bat are known within the Sydney Metro CMA Area (OEH 2016a). It breeds at maternal roosting sites within karst (limestone) caves (in areas such as the Blue Mountains some distance from the study area) and migrates to Sydney and other areas in the winter, returning to the maternal roost in summer.

Figure 5.1: Threatened species survey locations for the Rozelle Rail Yards site management works (ELA 2016)

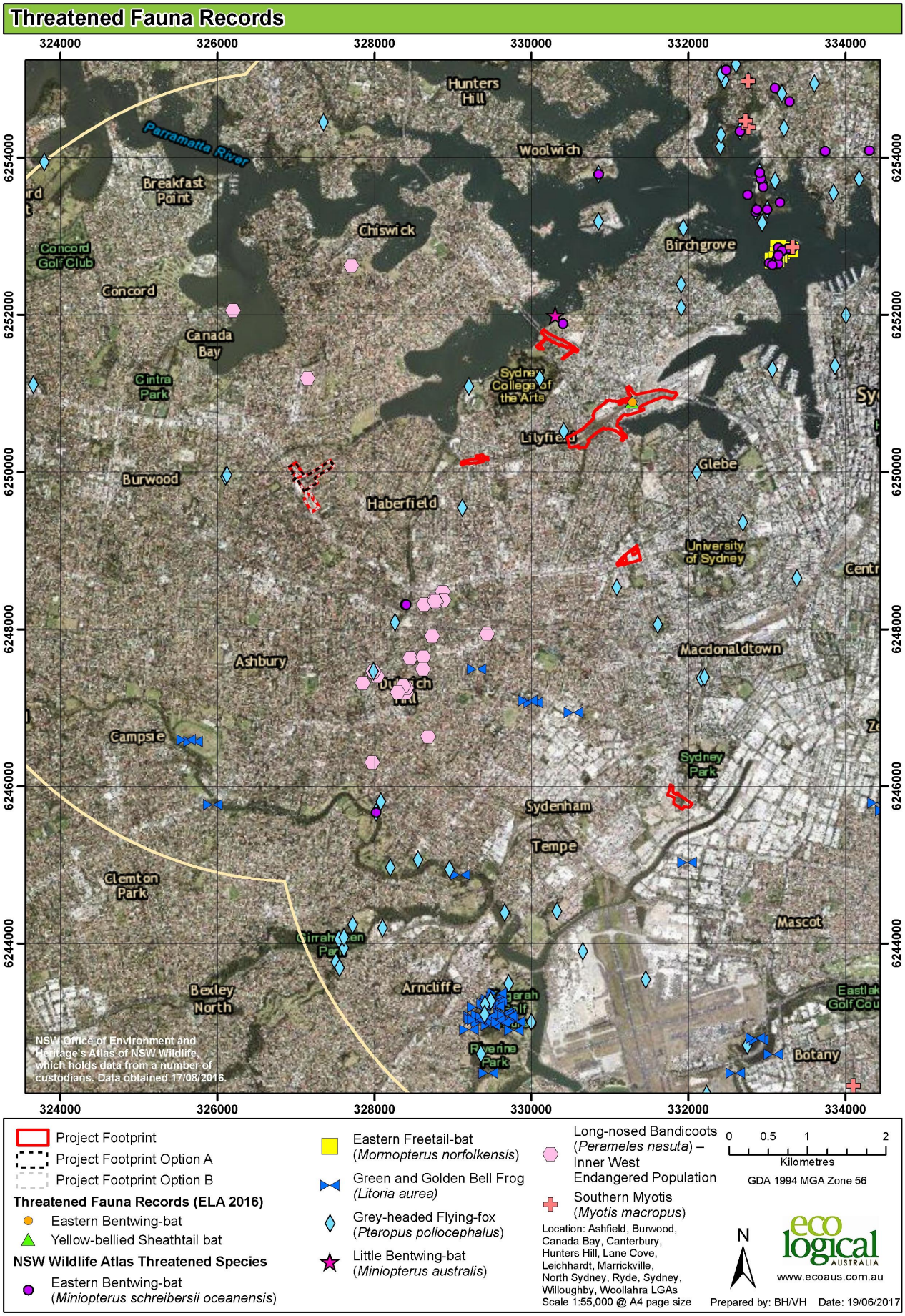

Figure 5.2: Recorded threatened species (database and survey records)

5.4 Aquatic habitat and threatened species

The aquatic marine environment includes the intertidal and subtidal ecosystem of the harbour and its estuarine tributaries.

5.4.1 Aquatic assessment methodology

A desktop review of threatened species considers a broad context for mobile aquatic species in estuarine waters. Traditionally a 10 kilometre radius search is used, however, a larger search area is suitable where connectivity is possible (eg water or vegetation corridors) or when flora/fauna surveys are historically limited or difficult (eg underwater). The following databases and online researches were searched for an area encompassing all of Sydney Harbour, its major tidal rivers and within 10 kilometre of the shore:

- EPBC Act – Protected Matters Search Tool
- TSC Act – Threatened Species Search Tool (BioNet)
- FM 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)
- The Sydney Harbour – Foreshores and Waterways Area Development Control Plan: Ecological Communities and Landscape Characters' Map and Wetlands Protection Map.

This desktop assessment determines the likelihood of occurrence for listed species, populations and communities. Strictly terrestrial species were filtered from the results, with focus given to fish, sharks, rays, aquatic mammals, aquatic reptiles, shorebirds, wetland birds, migratory birds and pelagic birds. Other populations filtered out are those with defined geographic boundaries outside of the study area.

Following the desktop assessment, a site visit was conducted of Whites Creek and its confluence with Rozelle Bay on 26 September 2016 and 30 May 2017. Other sites were considered in the desktop assessment but were not visited as part of the aquatic methodology: Iron Cove bridge abutment (reclaimed land with seawall); Iron Cove at Haberfield (footprint beyond riparian buffer); Hawthorne Canal at Darling Road (footprint beyond riparian buffer); Johnstons Creek at Camperdown (footprint beyond riparian buffer); and Alexandra Canal at St Peters (footprint beyond riparian buffer).

5.4.2 Aquatic results

Desktop assessment

The results of the desktop assessment are shown in Figure 5.3.

Threatened fish are either unlikely to occur because there is no suitable habitat (eg freshwater for Macquarie Perch) and no records of occurrence in the catchment (eg Australian Grayling), and no specific habitat is available (eg caves and crevices for Black Rock cod).

Threatened sharks and rays may opportunistically pass through the estuary while exploring or chasing prey, but they would not depend on Whites Creek, or Rozelle Bay, Iron Cove Bay, Alexandra Canal or any other waterway near the sites for habitat. Regular boat traffic may deter large fauna from regularly using the study area.

Threatened aquatic mammals (whales, dolphins, dugongs and seals) are known to occur in the harbour and/or along the coast. Large mammals are unlikely to depend on shallow areas. Dugongs forage on seagrass beds, but there are no records in the harbour, suggesting they prefer more expansive beds such as in Botany Bay. Seals may follow prey into shallow water or explore the adjacent area. It is likely most aquatic mammals avoid human activities, especially in high boat traffic areas.

Threatened aquatic reptiles (turtles) are more common along coastal waters than in the harbour. It is possible they explore the greater area, but would not depend on the project footprint and its immediate surrounds for habitat.

Threatened birds such as shore birds, wetland birds, migratory birds and pelagic birds are unlikely to occur given the minimal/steep intertidal area created by the channel and rock revetment walls. They would also avoid areas with concentrated human activities.

Threatened flora and vegetation communities/populations (saltmarsh and *Posidonia* (Seagrass)) do not occur on or near the project footprint.

Other protected fauna listed under the FM Act are assessed for likelihood of occurrence. Listed marine or estuarine species include one shark, six fishes and a taxonomic order of Syngnathiformes (seahorses, sea dragons, pipefish, pipe horses, ghost pipefish and sea moths):

- The Herbst's Nurse Shark only occurs in deep water (150-600 metres), unlike the shallow study area
- Most listed fishes are known to occur around rocky coastal reefs, which are absent in the study area. One fish (Estuary Cod) occurs in a range of habitats, from turbid shallow estuary waters (juveniles) to the base of drop offs and deeper water (adults). Sydney is the southern extent of Estuary Cod, with no records in the harbour or similar habitats nearby
- Syngnathiformes occur in the harbour, and are known to use a variety of habitats, such as macroalgae, seagrass beds and unvegetated shallows. These species are unlikely to occur in the project footprint due to unsuitable habitat.

It is considered unlikely that there is valuable or specific aquatic habitat for threatened aquatic/estuarine species, populations or communities listed under the FM Act, TSC Act and EPBC Act within the project footprint. It is possible some species may opportunistically pass near the project footprint in estuarine bays given the connectivity to the broader harbour and coastal habitats, but they are unlikely to depend on the habitat within the project footprint.

Existing environment

The foreshore of Rozelle Bay near Whites Creek consists of reclaimed land, vertical seawalls, jetty structures, riprap embankment and gentle sloping intertidal land. At the lower end of Whites Creek, the marine environment is highly modified, consisting of a nine-metre wide concrete lined channel with vertical walls (historic Sydney Water channel). On The Crescent, the existing crossing is a low bridge, 46 metres wide by nine metres long. Sydney Water has a plan to naturalise sections of Whites Creek further upstream of the crossing, which provides an opportunity for the project to extend the Sydney Water naturalisation works to the confluence with Rozelle Bay.

Sessile marine organism have adapted to the concrete walls of Whites Creek, especially *Saccostrea commercialis* (Sydney Rock Oyster) and *Chamaesipho tasmanica* (Honeycomb Barnacle). A low horizontal intertidal zone prevents establishment of mangroves and saltmarsh. The concrete substrate is covered with a thin layer of sediment and debris, but does not support seagrass or marine macroalgae. Woody debris and leaf litter has accumulated in the bay at the discharge point immediately east of the road crossing. No seagrass occurs near the outlet, and no marine alga is attached to the gabion wall. Riparian vegetation upstream is comprised of a row of planted *Casuarina glauca* (Swamp Oak) and *Phoenix canariensis* (Canary Island Date Palm).

The 'Sydney Harbour – Foreshores and Waterways Area Development Control Plan: Ecological Communities and Landscape Characters' map does not identify the site as any notable Aquatic Ecology Community, besides 'Rivers and Creeks' and 'Water'. Likewise, the area is not identified for "Wetland Protection'. The state-wide mapping of estuarine macrophytes (mangrove, saltmarsh and seagrass) by DPI Fisheries, identifies a patch of seagrass (*Halophila*) in the shallow subtidal zone at the opposite end of Rozelle Bay, around

two kilometres north-east near Ewenton Park – Balmain; and a small patch of mangroves 800 metres east in Rozelle Bay (Creese et al 2009). A small mangrove/saltmarsh restoration zone is located 250 metres east in Bicentennial Park, Glebe.

Whites Creek is concrete lined and, therefore, is not considered KFH and does not receive a waterway crossing classification for fish passage (see classification system in Fairfull 2013).

Photos of the existing environment at Whites Creek are shown in Figure 5.4 to Figure 5.7.

The foreshore of Rozelle Bay near Whites Creek is highly modified. Banks are either rock revetment batters with twin pipe culverts, gabion baskets, weed-invaded fill or dilapidated seawalls. Two *Casuarina glauca* saplings have colonised the artificial batters, but do not qualify as any native vegetation community. This landscape prevents saltmarsh and mangrove establishment. The exotic *Lampranthus tegans* (Little Noon-flower) occurs at the top of the batter but does not qualify as a saltmarsh community. Few marine molluscs and oysters occupy the intertidal base of the batter. The subtidal substrate is silty-sand covered with organic matter (leaves and branches) discharged from Whites Creek. Decomposition of detritus may result in anoxic conditions close to the sediment, and is unlikely to be suitable for benthic infauna. No seagrass or macroalgae occur within 50 metres of the bank. This area is classed as Type 3 Key Fish Habitat (minimal sensitivity) (Table 1 in Fairfull 2013).

Photos of the existing environment at Rozelle Bay near Whites Creek are shown in Figure 5.8 to Figure 5.13.

Johnstons Creek also flows to Rozelle Bay, and like Whites Creek (Figure 5.3), it is concrete lined and does not have any valuable aquatic habitat mapped by DPI Fisheries and the Sydney in the Sydney Harbour – Foreshores and Waterways Area Development Control Plan: Ecological Communities and Landscape Characters'.

Iron Cove Creek and Hawthorne Canal are 1st Order tributaries of Iron Cove estuary (Figure 5.3). Both waterways are concrete lined channels, transitioning from freshwater to estuarine where they are mapped as KFH. These provide limited value aquatic habitat with limited opportunities for water quality improvement before water reached the bay. The 'Sydney Harbour – Foreshores and Waterways Area Development Control Plan: Ecological Communities and Landscape Characters' map does not identify the creeks near the sites as having any notable Aquatic Ecology Community, besides 'Rivers and Creeks'.

Iron Cove estuary is a narrow arm of Sydney Harbour. The foreshore is heavily developed with extensive areas of habitat lost to reclamation and seawalls. The 'Sydney Harbour – Foreshores and Waterways Area Development Control Plan: Ecological Communities and Landscape Characters' map identifies the area beneath Victoria Road at Iron Cove Bridge as 'Grassland', 'Mixed Rock Intertidal and Mudflats', 'Water' and 'Area not mapped – site specific investigations required'. Mapping by DPI-Fisheries (Creese et al 2009) shows a narrow band of Zostera/Halophila seagrasses 400 metres to the west, and a small patch of Zostera 500 metres to the east.

Alexandra Canal is a realigned waterway flowing to Botany Bay. The channel has limited habitat variety, with similar depth, width, stone lined banks and poor riparian vegetation. It is mapped as KFH, which would provide optional open water habitat for fish navigating Wolli Creek and Cooks River. This canal does not provide habitat for threatened aquatic species. The nearest seagrass beds are several kilometres downstream in Botany Bay.

5.4.3 Riparian vegetation

The riparian vegetation in the project footprint is mapped as urban exotic and native cover, and represents planted and landscaped native and exotic species, such as *Casuarina glauca, Lomandra longifolia* and Palm trees.

The parts of the Whites Creek and Hawthorne Canal riparian corridor that occur in the project footprint are highly modified environments, consisting of a concrete channel with vertical walls and concrete base. These channels for the purposes of the *Water Management Act 2000*, do not meet the definition of a river. Furthermore, the riparian vegetation does not contribute to the ecological functioning of the creek. The vegetation provides low ecological value, and is of limited habitat for fauna species.

However, it is noted that Sydney Water has a plan to naturalise sections of Whites Creek further upstream of the crossing at The Crescent. This provides an opportunity for the project to integrate and build on the Sydney Water naturalisation plan, and continue the naturalisation of the riparian corridor through to the confluence with Rozelle Bay.

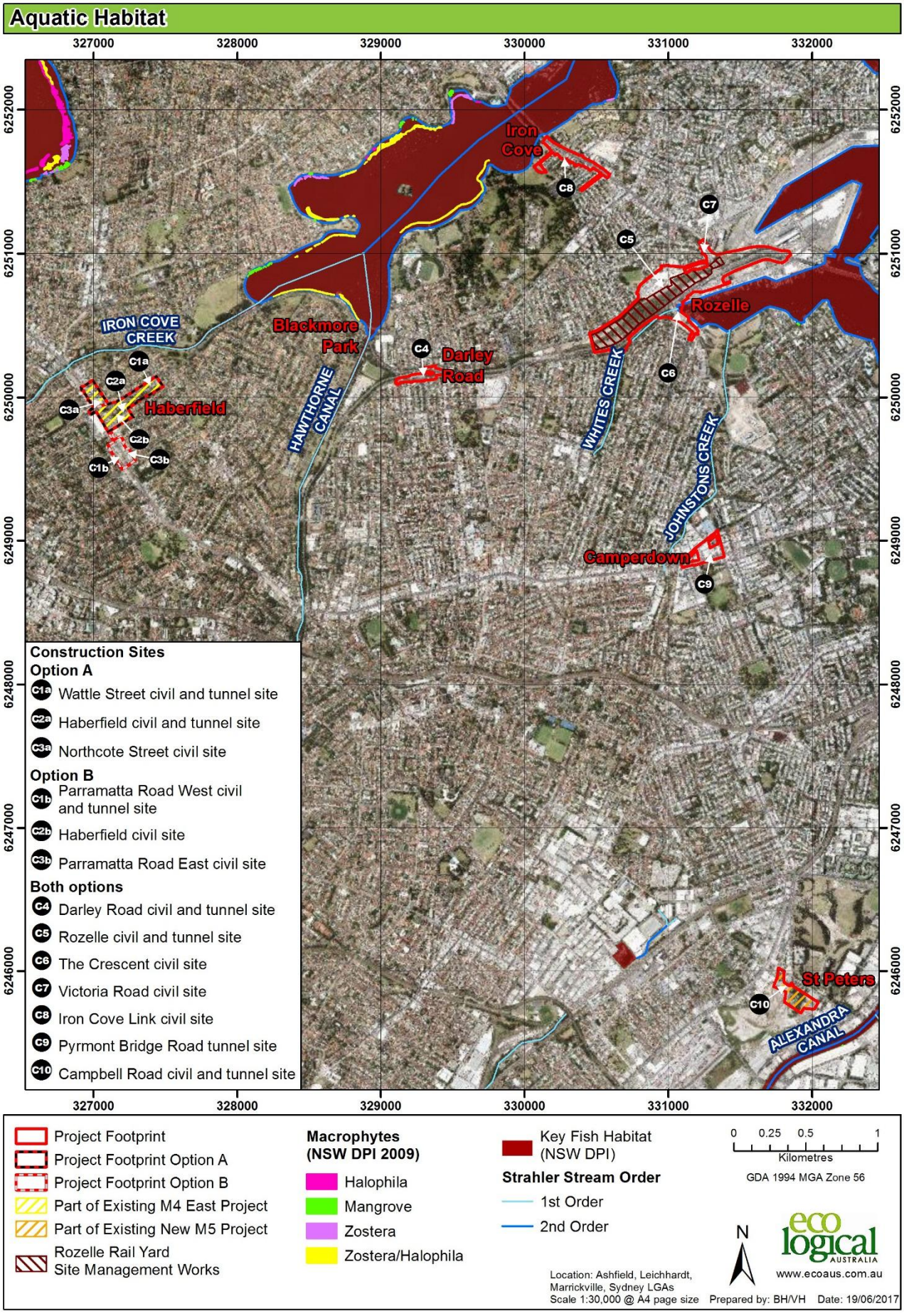

Figure 5.3: Aquatic values and key fish habitat

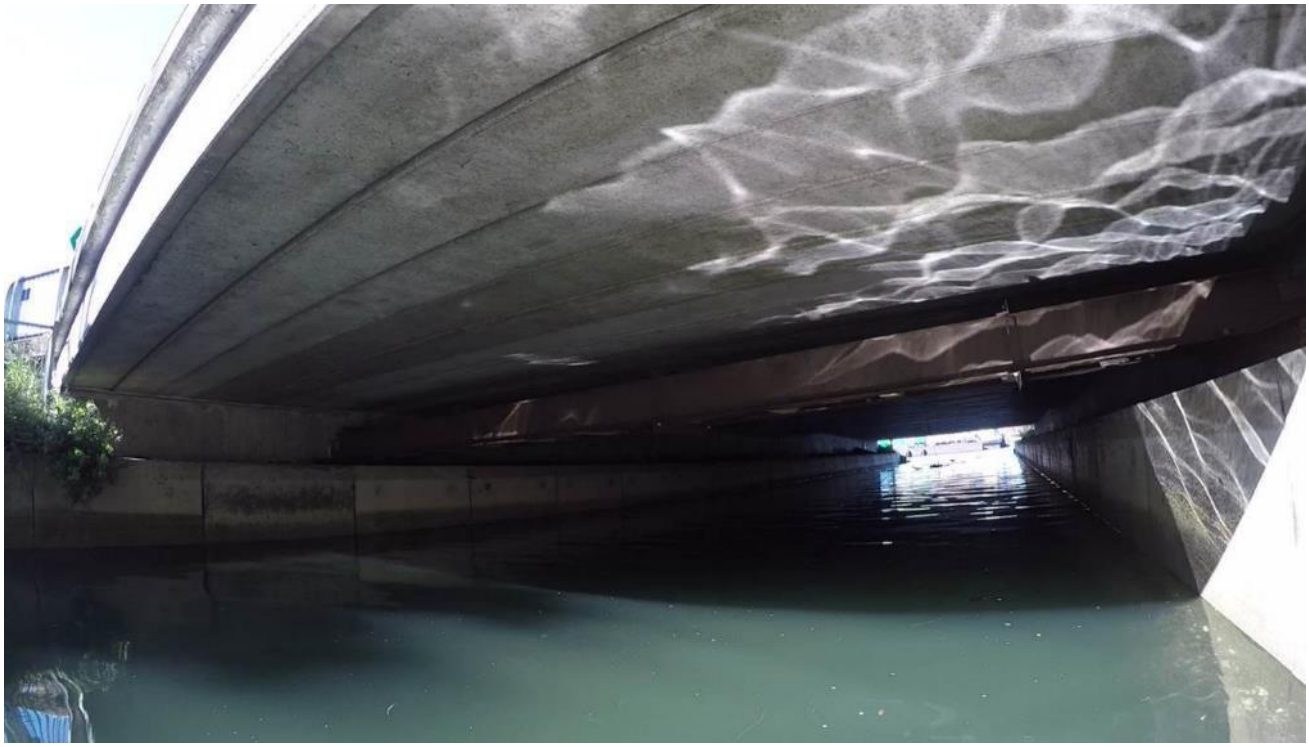

Figure 5.4: The Crescent bridge over Whites Creek; taken from western side facing downstream

Figure 5.5: Whites Creek 50 metres upstream of The Crescent bridge

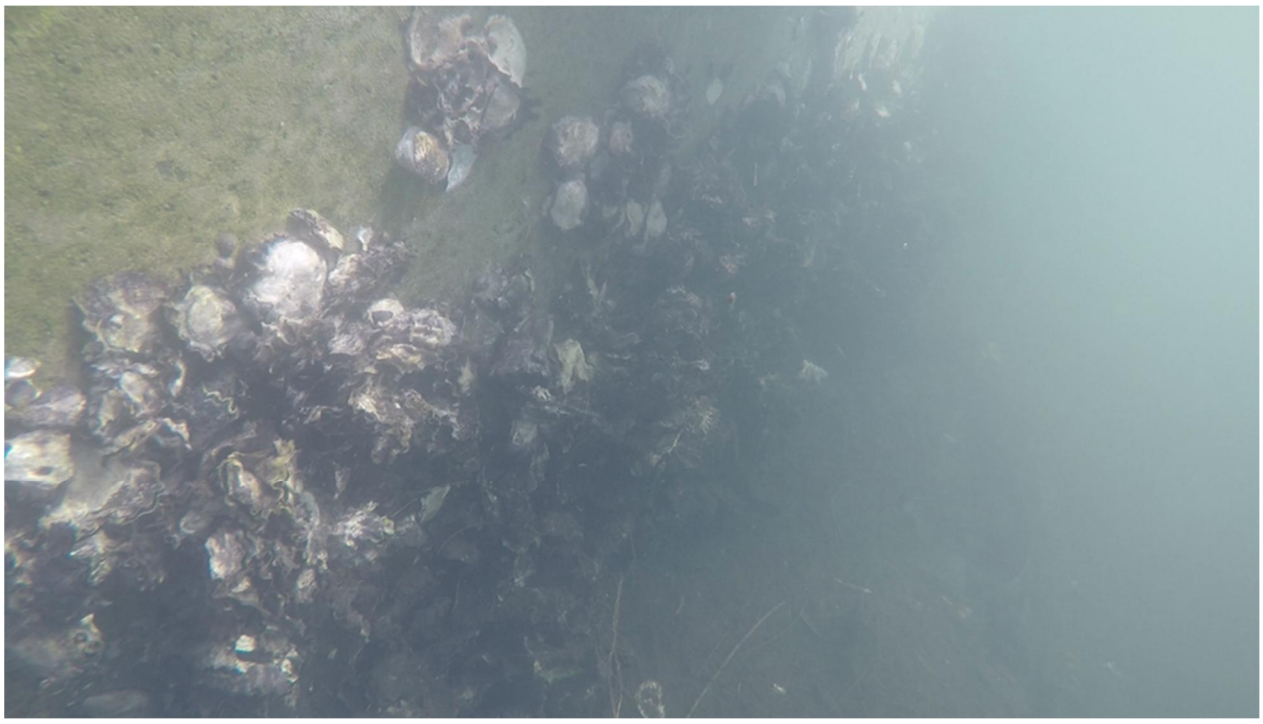

Figure 5.6: Oysters attached to concrete channel walls in Whites Creek

Figure 5.7: Large woody debris and a thin layer of detritus at the outlet of Whites Creek into Rozelle Bay

Figure 5.8: Whites Creek outlet and banks of Rozelle Bay proposed for modification

Figure 5.9: Northern side of Whites Creek outlet where new culverts would discharge across a rock spillway

Figure 5.10: Proposed site of new pipe and box culvert outlet (red line shows approximate disturbance)

Figure 5.11: Location of proposed bank stabilisation works south of Whites Creek outlet (red line shows approximate disturbance)

Figure 5.12: Subtidal benthic habitat in Rozelle Bay near Whites Creek outlet covered with fine woody debris

Figure 5.13: Subtidal benthic habitat in Rozelle Bay comprised of silty sand with no bioturbation from infauna and no marine vegetation (seagrass, macroalgae)

6 Matters of national environmental significance

The following MNES protected under the EPBC Act were considered for their relevance in regards to the project:

- World Heritage Properties (sections 12 and 12A)
- National Heritage Places (sections 15B and 15C)
- wetlands of international importance (sections 16 and 17B)
- listed threatened species and communities (sections 18 and 18A)
- listed migratory species (sections 20 and 20A)
- Commonwealth land (for actions outside Commonwealth Land that may impact on the environment on Commonwealth Land) (section 26 and 27A).

Of these, only listed threatened and migratory species were considered relevant for this report.

6.1 Threatened species

One MNES (threatened species) was presumed to be present within the study area, being the Grey-headed Flying Fox, which is listed as vulnerable under the EPBC Act.

A habitat assessment and likelihood of occurrence (Annexure A) indicated that this species was considered likely to forage on a limited number of feed trees (within the 4.49 hectares of the mapped urban exotic and native cover) within the study area and potentially be impacted by the project. This species was not recorded during the field surveys for the project. However, known records exist for the species within the locality and in close proximity to the project footprint. Further details including level of impacts, project specific mitigation measures and required offsets are discussed in Chapter 9.

An assessment in accordance with the Commonwealth Significant Impact Guidelines (Commonwealth of Australia 2013) for the Grey-headed Flying-fox is provided in Annexure E. This assessment concluded that a significant impact on the Grey-headed Flying-fox is unlikely to occur as a result of the works. Consequently, an EPBC Act referral is not required and the EPBC Act bilateral agreement relating to environmental assessment (2015) does not apply.

Consequently, an assessment in accordance with the Commonwealth Significant Impact Guidelines or referral to the Commonwealth was not required.

6.2 Migratory species

Forty migratory species listed under the EPBC Act were assessed for their likelihood of occurrence, including a number of predominantly marine species (Annexure A). The assessment considered it was unlikely for any species to occur within the project footprint, primarily due to the lack of suitable habitat and the highly urbanised environment of the site.

7 Summary of biodiversity values

7.1 Biodiversity values assessed under the FBA

This section provides a summary of the biodiversity values that occur in the project footprint, and have been assessed under the FBA (Table 7.1). This includes threatened species, populations and communities listed under the TSC Act and EPBC Act.

Table 7.1: Summary of biodiversity values assessed under the FBA

Biodiversity value	Ecosystem or species credit species	Identification method	Area/individuals within project footprint	Assessed in FBA for offsets
Eastern Bentwing-bat	Ecosystem credit species (foraging and roosting habitat)*	Recorded (echolocation recording device). Potential roosting site under Victoria Road bridge.	Potential roosting sites and up to 3.78 hectares of foraging habitat	Not required, as there are no ecosystem credits present and there is no direct impact on species credit species component (breeding habitat)
Grey-headed Flying-fox	Ecosystem credit species (foraging habitat)	Assumed to be present. Known to occur within the locality and in close proximity to the site	Limited feed trees within the 4.49 hectares (mapped as urban exotic and native cover)	Not required, as there are no ecosystem credits present and there is no direct impact on species credit species component (breeding camps)
Yellow-bellied Sheathtail-bat	Ecosystem credit species (foraging and roosting habitat)	Recorded (echolocation recording device)	Up to 3.78 hectares foraging habitat (mapped urban exotic and native cover)	Not required, as there are no ecosystem credits present and there is no direct impact on species credit species component (breeding habitat)

* Ecosystem credit was not assessed under the FBA, as no PCTs present within site. See section 7.2.

7.2 Biodiversity values outside the FBA

All biodiversity values in the project footprint were assessed under the FBA (Table 7.1). There were no matters outside of the FBA methodology unassessed within the project footprint. Therefore, no species, populations or communities listed under the FM Act, migratory species listed under the EPBC Act or groundwater dependent ecosystems were considered to occur, or be impacted by the project.

8 Avoid and minimise impacts

8.1 Avoidance and minimisation

Stage Two of the FBA requires a demonstration of efforts to avoid and minimise impacts on biodiversity, followed by an assessment of direct and indirect impacts and proposed onsite mitigation measures.

This chapter is consistent with Section 8 of the FBA and describes how biodiversity values identified in the study area (Table 7.1), have been avoided and impacts minimised, using reasonable onsite measures.

A detailed description on avoidance, alternate locations and route alignments are provided in the main EIS document. This description incorporates constraints and considerations from all factors such as social, economic, transport, and engineering.

8.1.1 Avoidance

Avoidance measures for biodiversity values were incorporated into the project in order to reduce ecological impacts, and primarily involved:

- Examining alternate locations for surface area works
- Examining route alignment and placement of construction compounds.

The project occurs within a highly urban context, where biodiversity values are limited and restricted in extent. Furthermore, the project is a linking tunnel for the M4 East and New M5 projects, and is therefore predominantly underground. This reduces the overall project footprint and minimises impacts to terrestrial biodiversity values by limiting vegetation clearance and impacts to terrestrial fauna habitats.

The combination of the factors above has resulted in the selection of a project footprint that has avoided all impacts to native vegetation, avoided threatened flora and avoided threatened fauna breeding habitat.

8.1.2 Alternate locations and route alignment

Alternatives to the project to reduce impacts on biodiversity values were considered by Roads and Maritime based on the extent to which they could meet the project objectives and how well they performed with reference to other transport, environmental, engineering, social and economic factors.

The following options were considered:

- ‘Do nothing / do minimum’
- Improvements to the freight rail network
- Public and active transport enhancements
- Demand management
- Optimising the performance of existing infrastructure
- The construction of a new motorway (the project).

Alternative locations initially considered for the project include surface works at Blackmore Oval in Leichhardt, Easton Park in Lilyfield and Bicentennial Park in Annandale. Whilst native vegetation (as defined by the FBA) were not present within the proposed footprints at these locations, they did provide a greater potential to provide for threatened fauna habitat than their alternative locations at Leichhardt (C4) and Rozelle (C5, C6 and C7).

9 Impact assessment

9.1 Areas requiring assessment

In accordance with the FBA, areas not requiring assessment must be identified in the BAR, including land without native vegetation (as per the definition under the *Native Vegetation Act 2003*), unless the area of land requires assessment under the SEARs.

Other areas not requiring offsets and further assessment in the BAR include:

- Impacts on PCTs that:
  - Have a site value score <17, or
  - Are not identified as critically endangered ecological communities (CEECs) or endangered ecological communities (EECs)
- Impacts on PCTs that are not associated with threatened species habitat and are not identified as CEECs/EECs
- Impacts on non-threatened species and populations that do not form part of a CEEC or EEC
- Impacts on threatened species habitat associated with a PCT within a vegetation zone with a site value score <17.

These areas cover the project footprint and are mapped as cleared land (associated with tracks, roads, buildings and other infrastructure) and urban exotic and native vegetation within the project footprint (Figure 9.1).

9.1.1 Removal of native vegetation

No areas of native vegetation (ie PCTs under the FBA) were mapped within the project footprint.

9.1.2 Removal of threatened fauna species habitat and habitat features

Direct and indirect impacts are associated with potential foraging habitat of the Grey-headed Flying-fox, Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat. These species are classified as ecosystem credit species in relation to foraging habitat. However, due to the absence of native vegetation (PCTs) within the project footprint, these areas of foraging habitat do not require further assessment or offsets.

Direct impacts are also associated with potential microbat roosting sites (non-breeding / maternal roost), located under Victoria Road bridge. However, no bats were observed within the cavities under the bridge during visual inspections, but were recorded flying around the bridge during the echolocation surveys.

However, these roost sites are not classified as part of the species credit component (breeding / maternal) and therefore, under the FBA they are assessed as part of the ecosystem credits. No maternity colonies for the Eastern Bentwing-bat are known within the Sydney Metropolitan Catchment Management Authority Area (OEH 2016a). This species breeds at maternal roosting sites within karst (limestone) caves and migrates to Sydney and other areas in the winter, returning to the maternal roost in summer. Indirect impacts would include noise, dust and light. A description of these impacts is provided in section 9.4.

9.1.3 Removal of threatened plants

No threatened flora were identified during field surveys, or are considered has having a potential to occur.

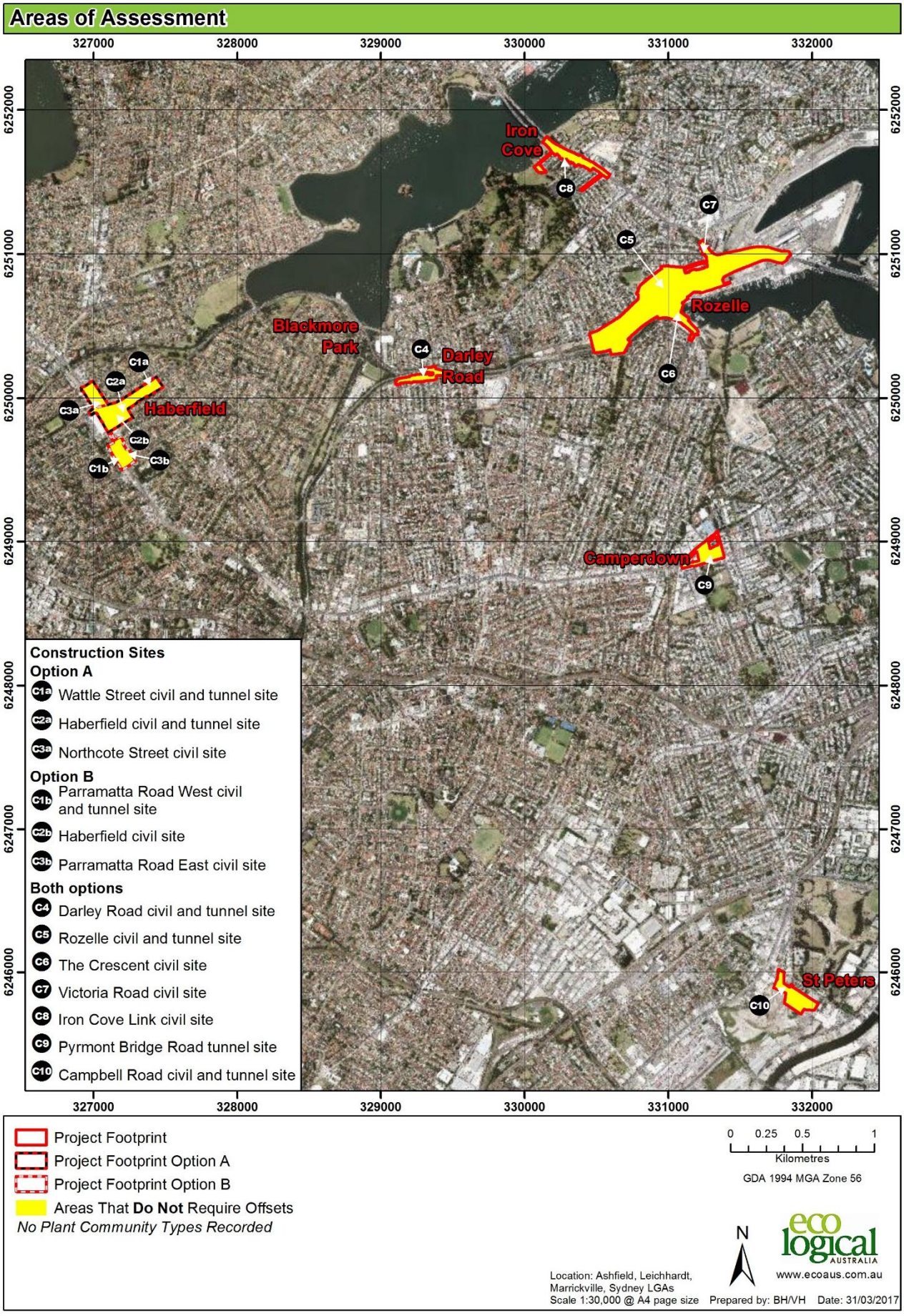

Figure 9.1: Areas not requiring assessment

9.2 Matters for further consideration

No matters for further consideration were provided by OEH or included in the SEARs, and thus no additional matters are required to be assessed.

9.2.1 Landscape features

Landscape features that are matters for further consideration include:

- Impacts that will substantially reduce the width of vegetation in the riparian buffer zone bordering rivers and streams fourth order or greater
- Impacts in state biodiversity links
- Impacts on important wetlands and their buffers
- Impacts in the buffer zone along estuaries.

No matters for further consideration relating to landscape features were present within the study area.

9.2.2 Native vegetation

Native vegetation features that are matters for further consideration include:

- Any impact on a CEEC (unless specifically excluded in the SEARs) because it is likely to:
  - cause the extinction of the CEEC from the IBRA subregion, or
  - significantly reduce the viability of the CEEC
- Any impact on an EEC nominated in the SEARs because it is likely to:
  - cause the extinction of the EEC from the IBRA subregion, or
  - significantly reduce the viability of the EEC.

No matters for further consideration relating to native vegetation were present within the study area.

9.2.3 Species and populations

Species and populations that are matters for further consideration include:

- Impacts on areas of land that the NSW Minister for Environment has declared as critical habitat in accordance with section 46 of the TSC Act and which is listed on the Register of Critical Habitat in NSW
- Any impact on a critically endangered species (unless specifically excluded in the SEARs)
- Any impact on a threatened species or population nominated in the SEARs because it is likely to:
  - cause the extinction of a species or population from an IBRA subregion, or
  - significantly reduce the viability of a species or population
- Any impact on a threatened species or population that has not previously been recorded in the IBRA subregion according to records in the NSW Wildlife Atlas.

No matters for further consideration relating to species and populations were present within the study area.

9.2.4 Critical habitat

No impact of the project on areas of land that the NSW Minister for the Environment has declared ‘critical habitat’ in accordance with section 47 of the TSC Act and that are listed on the Register of Critical Habitat in NSW would occur.

9.3 Matters of national environmental significance

The only MNES that was considered likely to be impacted by the proposed works is the Grey-headed Flying-fox. This species was considered likely to forage on a limited number of feed trees within the project footprint (suitable feed trees within the 4.49 hectares of the mapped urban exotic and native cover) and others adjacent to the site. This species was not recorded during the field surveys. However, known records exist within close proximity to the project footprint. No impacts to a roosting site or camp will occur as a result of the project.

An assessment in accordance with the (Commonwealth of Australia 2013) for this species is provided in Annexure E. This assessment concluded that a significant impact on the Grey-headed Flying-fox is unlikely to occur as a result of the project. The Grey-headed Flying-fox is considered an ecosystem credit species under the FBA in relation to foraging habitat. Therefore, under the FBA and due to the absence of PCTs within the site, this species does not require an offset.

A summary of impacts relating to MNES are provided below in Table 9.1. Specific safeguards and mitigation measures for this species are provided below in Table 10.1 and Chapter 10.

Table 9.1: Summary of impacts relevant to MNES

Impact	MNES	Nature of impact	Scale of impact of proposed action	Intensity of impact of proposed action	Duration	Likely significance of impact	Confidence in assessment
Loss of foraging habitat	Grey-head Flying-fox *(Pteropus poliocephalus)*	Additional	Regional	Minor – the proposed action would remove a total of 4.49 hectares of foraging habitat. However, the loss of foraging habitat is considered negligible in the context of similar available habitat in the locality, and within the foraging range for this species.	Long term	Not significant	High – impacts are predictable.
Future urban growth	All MNES potentially present in Sydney's Inner West	Cumulative and facilitated	Regional	Minor – project increases capacity of existing regional road network and will support economic development across the Sydney region. It does not provide local road infrastructure.	Long term	Not significant	Moderate – impacts are unknown and unpredictable but confined to largely urban environments and the existing road corridor

9.4 Other impacts not covered by the FBA

9.4.1 Aquatic impacts

No impacts on aquatic biodiversity due to water quality are likely to occur as a result of the project. Appendix Q (Technical working paper: Surface water and flooding) of the EIS has concluded that no adverse cumulative surface water quality impacts are anticipated with implementation of appropriate management measures as part of the project and the residual risk to the environment would be low.

The project would not directly harm marine vegetation or habitat of threatened species, communities or populations. The works may require removal of planted riparian vegetation along the edges of the concrete channels for the upgrade of the intersection of The Crescent and City West Link. Following these works, the riparian corridor would be replanted as a continuation of the Sydney Water White's Creek naturalisation works, in consultation with Sydney Water (section 9.6.2).

The upgraded road will shade the aquatic habitat within the concrete channel, creating less favourable conditions for barnacles and oysters attached to the wall. This reduction in light is unlikely to change water temperature given the constant tidal movement in and out of the crossing. The increased bridge width is unlikely to act as a behavioural barrier to fish passage (as is the case with small dark culverts). The passage appears to have adequate clearance (two to three metres above water), depth (one to two metres) and width (nine metres) to encourage fish movement.

Indirect impacts to aquatic habitat may occur if mitigation measures are not in place and effective during construction. Indirect impacts during construction include turbid water, sediment deposition, and oil and pollutant spills. These impacts can reduce water quality, decrease light penetration through the water column, and smother benthic habitat with sediment. This may alter primary (plant) and secondary (animal) production that supports or regulates the aquatic food web.

Works would temporarily obstruct fish passage if a floating boom and silt curtain is placed near the creek outlet across the bay. This impact would be minimal given the poor creek habitat in Whites Creek and Rozelle Bay intertidal area. Fish passage would be restored during operation.

Upgrade of the Easton Park drain draining the Rozelle Rail Yards would result in the removal of around 27 metres of intertidal rock revetment wall to provide low and high-flow pipe/box culverts. Two large pipe culverts already exist in this location partially below the high tide mark. This intertidal habitat is in poor condition with limited aquatic value. Few oysters or marine molluscs inhabit this area. The adjacent subtidal zone is silty-sand with dense organic debris discharged from Whites Creek. No seagrass or macroalgae is present. As such, this area of Rozelle Bay is classed as Type 3 KFH (minimally sensitive) (from Table 1 in Fairfull 2013). A rock spillway and scour protection rock apron would replace the existing rock wall, providing a similar scale and type of intertidal habitat. There is no immediate occurrence of marine vegetation that could be affected by changes in salinity due to freshwater discharge. The nearest vegetation is 250 metres east (mangrove/saltmarsh rehabilitation in Bicentennial Park, Glebe), which is unlikely to be unaffected by changes in freshwater discharge due to its distance and mixing with tidal water. Therefore, the proposed works will not result in a net loss of KFH, as required by the Fisheries NSW Policy and guidelines for fish habitat conservation and management (Update 2013).

No direct impacts would occur to Dobroyd Canal (Iron Cove Creek), Hawthorne Canal, Iron Cove estuary, Johnstons Creek and Alexandra Canal as the project footprint either lies outside of the riparian buffer or is on developed land.

Indirect impacts to waterways could occur if adequate controls are not in place, specifically to address sediment runoff during construction, poor water discharged from tunnel dewatering, polluted road runoff during operation, and high velocity runoff/discharge. Uncontrolled runoff or discharge can influence the physico-chemical properties of waterways, such as water temperature, turbidity, pH, salinity and alkalinity. However, the receiving waterways are currently highly disturbed ecosystems, which cannot feasibly be returned to a 'slightly to moderately disturbed' condition (ANZECC, 2000). If the ANZECC (2000) guidelines are followed, the discharge water quality is expected to be typically better than the current water quality of the receiving watercourses.

There would be no net loss of aquatic habitat in the medium to long term. Accordingly, the project could meet the aquatic ecology conservation requirements of the *Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005* under the EP&A Act.

9.4.2 Groundwater dependent ecosystems

There are no priority GDEs identified within the Greater Metropolitan Water Sharing Plan within five kilometres of the project footprint. Consequently, no GDEs are likely to be impacted by groundwater level decline associated with the long term impacts of the project. Long term dewatering caused by tunnel drainage could lower the water table and potentiometric heads within the Hawkesbury Sandstone, reducing the amount of groundwater available for non-GDE shallow rooted plants. The minimum depth of the water table underlying the majority of the alignment is on average two metres below ground surface and consequently flora is unlikely to be completely dependent on groundwater. This would not change following the construction of the tunnels.

In low lying areas, the low permeability of the clayey soils in combination with frequent rainfall events and higher recharge due to surface water concentration is not expected to change availability of water for plants.

9.4.3 Changes to hydrology

Appendix Q (Technical working paper: Surface water and flooding) of the EIS has concluded that no adverse cumulative surface water quality impacts are anticipated with implementation of appropriate management measures as part of the project and the residual risk to the environment would be low.

Therefore, the project is unlikely to impact on present surface or groundwater hydrology, given the lack of major rivers or streams within the site. Whites Creek is a minor tributary within the southern extent of the Rozelle Rail Yards site, and is a highly modified, consisting of a concrete channel with vertical walls. There is a low potential for impacts to occur on Whites Creek from the project.

9.4.4 Arboriculture impacts

An Arboricultural Impact Assessment report was completed for the project and is included in Annexure G. Around 1,675 trees would potentially require removal to facilitate the project. Based on the current concept design for the project, it is unlikely these trees could be retained.

The majority of trees to be removed are located at Rozelle around the Rozelle Rail Yards and associated surface road upgrades and active transport connections. This includes trees within the Rozelle Rail Yards and Ports Authority land (those remaining following site management works), along City West Link and Lilyfield Road, and areas adjacent to Whites Creek at The Crescent and Brenan Street.

A total of about 162 have been identified has having a high retention value in accordance with the Institute of Australian Consulting Arboriculturists Significance of a Tree, Assessment

Rating System (refer to Annexure G), and these trees have been recommended for further investigation during detailed design to determine their suitability to be retained.

Around a further 355 trees of low to moderate value were identified to be investigated further during detailed design to determine their suitability for retention. These trees include groups of trees along Lilyfield Road that may offer visual screening and on the approaches to Anzac Bridge.

Trees to be retained would be protected in accordance with *Australian Standard (AS) 4970-2009 Protection of trees on development site*s and suitable ground protection measures to protect the tree protection zone.

Trees 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 project footprint and concept design for the project. Management measures have been recommended as per the hierarchy to avoid (retain), minimise (investigate to retain) and mitigate (compensatory planting). 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 retention of trees is not possible, compensatory planting is recommended. Replacement trees should be planted within, or close to, the project footprint where feasible.

Compensatory planting should seek to use opportunities presented by the new open space at the Rozelle Rail Yards, including along Lilyfield Road and City West Link and in landscaping at Iron Cove Link in accordance with the Urban Design and Landscaping Plan.

9.4.5 Edge effects on adjacent native vegetation and habitat

No remnant native vegetation occurs within or adjacent to the site. Therefore, edge effects on native vegetation are not considered likely to occur as a result of the project. 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 likely to occur, but will be limited through the implementation of mitigation measures.

9.4.6 Injury and mortality of fauna

Fauna injury or mortality could occur as a result of the construction and operation of the project.

During the construction of the project, injury or mortality may occur as a result of direct collision with vehicles and equipment within construction compounds. Some mobile species may be able to move away quickly and easily such as some birds. However, other less mobile species, or those which have high fidelity with their home range, may be slower to move away or may not relocate at all, potentially resulting in injury or mortality of the individual.

During construction works at the Rozelle Rail Yards, there is a possibility that the Eastern Bentwing-bat may be injured or stressed due to disturbances associated with noise, dust or light. Direct mortality is also possible during the removal of the Victoria Road bridge, if individuals are roosting in the cavities of the bridge at the time of the construction works. Direct mortality or injury is unlikely to occur to the Grey-headed Flying-fox as result from the works. Individuals are likely to actively avoid the area during works.

Although the project may potentially result in some injury or mortality of fauna species, the project is unlikely to cause a substantial increase in fauna injury or mortality incidents as the majority of the route alignment occurs underground. Where ancillary infrastructure or construction compounds occur, the surrounding land is highly urbanised. Implementation of mitigation measures will reduce the chances or injury or mortality of fauna.

9.4.7 Invasion and spread of weeds

Weeds were common within the study area with some areas supporting weed infestations, particularly the Rozelle Rail Yards. Noxious and environmental weeds recorded within the study area during the survey period are identified in Table 9.2.

Table 9.2: Noxious and environmental weed species recorded in the study area

Scientific Name	Common Name	Class of declared weeds for Inner West LGA	WoNS*
Anredera cordifolia	Madeira Vine	-	Yes
Asparagus asparagoides	Bridal Creeper	5	Yes
Cenchrus echinatus	Spiny Burr Grass	5	-
Cestrum parqui	Green Cestrum	3	-
Cortaderia selloana	Pampas Grass	4	-
Lantana camara	Lantana	4	Yes
Ligustrum lucidum	Broad-leaved Privet	4	-
Ligustrum sinense	Small-leaved Privet	4	-
Oxalis sp.	Oxalis	5	-
Parietaria judaica	Pellitory	4	-
Ricinus communis	Castor Oil Plant	4	-
Rubus fruticosus	Blackberry	4	Yes

* WoNS – Weeds of National Significance
Class 3 – Regionally Controlled Weed; the plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed.
Class 4 – Locally Controlled Weeds; that pose a threat to primary production, the environment or human health, are widely distributed in an area to which The Noxious Weeds (Weed Control) Order 2014 order applies and are likely to spread in the area or to another area.
Class 5 – The requirements in the *Noxious Weeds Act 1993* (NSW) for a notifiable weed must be complied with.

9.4.8 Invasion and spread of 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*)
- Feral Cat (*Felis catus*)
- Common Myna (*Acridotheres tristis*).

The European Red Fox can be found in a range of habitats. They prey on medium-sized ground-dwelling and semi-arboreal mammals and ground-nesting birds. 'Predation by the European Red Fox *Vulpes vulpes*' is a KTP listed under both the EPBC Act and the TSC Act. The European Red Fox was recorded within the study area. However, the project is not likely to exacerbate the impacts of the European Red Fox on native fauna, due to its existence within the study area, highly urban context and lack of native fauna present.

The European Rabbit causes a number of environmental problems in the Australian landscape. The rabbit can increase the likelihood of soil erosion by creating numerous burrows, threaten the survival of a number of native animal species by altering habitat, reducing native food sources, displacing small animals from burrows and attracting introduced predators such as foxes. 'Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*)' is a listed KTP under both the EPBC Act and the TSC Act. The project is unlikely to exacerbate the impacts of the European Rabbit given the existing presence of the species

within the study area and the highly degraded condition of the habitats within and adjoining the study area.

Cats can be found in almost all terrestrial environments in Australia. Predation by feral cats is a particular problem affecting small mammals (such as rodents, dasyurids, and burramyids) and ground-nesting birds. 'Predation by the feral cat (*Felis catus*)' is a listed KTP under both the EPBC Act and the TSC Act. Feral cats were recorded during the field survey in the Rozelle Rail Yards, however they are also likely to forage throughout other parts of the study area given the surrounding urban development. Given the likely abundance of cats in the locality and study area, the project is unlikely to increase the abundance of cats, introduce them into new areas, or increase predation pressure on native fauna.

9.4.9 Invasion and spread of pathogens and disease

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 literature search 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*).

Myrtle Rust is an air-borne plant fungus that attacks the young leaves, shoot tips and stems of Myrtaceous plants eventually causing plant death. It is spread by movement of contaminated material such as clothing, infected plants, vehicles and equipment etc. The 'introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae' is a listed KTP under the TSC Act (OEH 2016f).

Chytrid fungus is a water-borne fungus that affects amphibians. It is spread by cross contamination of water bodies and improper handling of frogs. Chytridiomycosis is the infection that causes lethargy, emaciation, skin sloughing and a range of other symptoms that eventually result in death. The infection of frogs by amphibian chytrid fungus causing the disease Chytridiomycosis' is a listed KTP under both the EPBC Act and the TSC Act (OEH 2016e).

Phytophthora is a soil-borne fungus capable of causing tree death (dieback) by attacking the roots of native plants. Spores can be spread over large areas by water, vehicle and machinery movement as well as human and animal movement. 'Dieback caused by Phytophthora' is a listed KTP under both the EPBC Act and the TSC Act (OEH 2016d).

It is unknown if any of these three pathogens are present within the study area. However, considering the highly urban context of the site, it is unlikely that Phytophthora is present and Mrytle rust would be limited to any landscaped or planted Eucalypts. It is possible that the Chytrid fungus could be present at the Rozelle Rail Yards, where non-threatened frogs were recorded.

9.4.10 Noise, light and vibration

The project has the potential to result in indirect impacts on biodiversity caused by noise, vibration, light and dust during construction. This is particularly the case given that construction activities would occur during the day and night and would not be restricted to just daylight hours. Indirect impacts on biodiversity may also result from changes in noise levels or lighting during operation.

The threatened species most at risk from indirect noise, light, dust and vibration is the Eastern Bentwing-bat. The works for the Rozelle interchange would be occurring 24 hours per day during construction and the impacts of noise, dust and vibration are expected to continuously operate during this time. However, it is noted that there would be separation distances from these activities to the Victoria Road bridge where potential roost sites exist, prior to its demolition. Possible impacts may also occur for this species at the new Victoria Road bridge during the operation of the project. These would only occur following construction of the new bridge and any potential new roost sites that may be present.

With the exclusion of the Eastern Bentwing-bat, vibration and light are unlikely to have substantial adverse effects on the diurnal and nocturnal threatened birds and mammals that may occur within the study area from time to time, such as the Grey-headed Flying-fox. These types of indirect impacts are already widespread within the highly urbanised study area, and any exacerbation of these impacts would be limited by the proposed mitigation measures. Furthermore, night construction works would likely deter Grey-headed Flying-fox individuals from foraging within or immediately adjacent to the project footprint. In addition, construction noise and vibration impacts would be temporary. Works are expected to be conducted between 2018 and completed by 2023.

9.4.11 Impact on Key Threatening Processes

A number of KTPs have been identified as being relevant to the project. The activities associated with the project would either contribute to the KTP (known) or may potentially contribute to the KTP (potential). These are listed in Table 9.3.

Table 9.3: Known and potential KTPs and impacts on biodiversity

KTP	Relevance to the project	Potential or known
Infection of native plants by *Phytophthora cinnamomi* (TSC Act) Dieback caused by the root-rot fungus[1] *Phytophthora cinnamomi* (EPBC Act)	Movement of vehicles, equipment and people during the construction phase carries a risk of introduction and spread of the plant pathogen *Phytophthora cinnamomi.* Presence of the plant pathogen within the study area is unknown. With the implementation of appropriate mitigation measures listed in Section 10 the risk of exacerbating this KTP is considered to be low.	Potential
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae (TSC Act)	Movement of vehicles, equipment and people during the construction phase carries a risk of introduction and spread of Myrtle Rust. Presence of Myrtle Rust within the study area is unknown. With the implementation of appropriate mitigation measures listed in Section 10 the risk of exacerbating this KTP is considered to be low.	Potential
Invasion and establishment of exotic vines and scramblers (TSC Act)	Exotic vines and scramblers are present within the study area including areas along road and track edges. Movement of vehicles, equipment and people during the construction phase carries a risk of introduction and spread of these exotic vines and scramblers. Appropriate mitigation measures would be implemented to limit the spread of weeds and reduce the risk of exacerbating weed infestations to areas adjoining the study area. With the implementation of appropriate mitigation measures listed in Section 10, the risk of exacerbating this KTP is considered to be low.	Potential
Invasion, establishment and spread of *Lantana camara* (TSC Act)	*L. camara* is present within the Rozelle Rail Yards. Movement of vehicles, equipment and people carries a risk of introduction and spread of *L. camara* into unaffected areas. Appropriate mitigation measures will be implemented to limit the spread of weeds and reduce the risk of exacerbating weed infestations within and adjoining the study area as a result of the project. With the implementation of appropriate mitigation measures listed in Section 10 the risk of exacerbating this KTP is considered to be low.	Known
Human-caused climate change (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. However, 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 can be found in Chapter 22 (Greenhouse gas) of the EIS for the project. The risk of the proposal exacerbating this KTP are considered to be low.	Known

[1] It is now understood that *P. cinnamomi* is not a fungus. This was the name of the KTP when it was registered under the EPBC Act.

9.5 Impact summary

The potential direct and indirect impacts of the proposal on biodiversity are summarised below in accordance with Section 8 of the FBA. Consideration of biodiversity constraints during the design process has enabled the potential impacts of the proposal to be substantially reduced. Notwithstanding the level to which biodiversity impacts have been avoided or minimised, the project would have both direct and indirect impacts on a limited number of biodiversity values during both the construction and operational phases. Impacts are primarily associated with the construction compound infrastructure.

The potential indirect impacts on biodiversity values are considered to be minimal given the highly modified and urbanised condition of the habitats to be affected and the proposed mitigation measures (Chapter 10).

This biodiversity assessment considered both construction and operational impacts to biodiversity and includes:

- Grey-headed Flying-fox foraging habitat
- Eastern Bentwing-bat (foraging and potential roosting habitat)
- Yellow-bellied Sheathtail-bat (foraging habitat).

Impacts of the project on MNES are summarised in Table 9.1 and in sections 9.3 to 9.4. The aim of Table 9.1 is to provide an overview of the impacts and requirements for assessment under the EPBC Act.

A summary of impacts to biodiversity values are provided section 9.5, including impacts required and not required to be assessed under the FBA.

Table 9.4: Summary of impacts

Impact	Biodiversity values	Nature of impact Direct, indirect, consequential, cumulative	Extent of impact Site based, Local, Regional, State, National	Duration Short term/ Long term, pre, during or post construction	Does the project constitute or exacerbate a KTP?
Removal of native vegetation	None	N/A	N/A	N/A	N/A
Removal of threatened ecological communities	None	N/A	N/A	N/A	N/A
Removal of threatened fauna species habitat and habitat features	Grey-headed Flying-fox	Direct	Site based. Removal of up to 4.49 hectares potential foraging habitat	Long term	No
	Eastern Bentwing-bat	Direct and indirect	Site based. Direct impact on potential roost sites and removal of up to 3.78 hectares non-native vegetation (foraging habitat)	Long term	No
	Yellow-bellied Sheathtail-bat	Direct	Site based. Removal of up to 3.78 ha non-native vegetation (foraging habitat)	Long-term	No
Removal of threatened plants	None	N/A	N/A	N/A	N/A
Aquatic impacts	Potential for non-threatened values	Indirect	Local	Long-term	No
Groundwater dependent ecosystems	None	N/A	N/A	N/A	N/A
Changes to hydrology	Potential for non-threatened values	Indirect	Local	Long-term	No
Fragmentation of identified biodiversity links and habitat corridors	None	N/A	N/A	N/A	N/A
Edge effects on adjacent native vegetation and habitat	None – no adjacent native vegetation	N/A	N/A	N/A	N/A
Injury and mortality of fauna	Potential for non-threatened, native	Direct	Site based	Short-term	No

Impact	Biodiversity values	Nature of impact Direct, indirect, consequential, cumulative	Extent of impact Site based, Local, Regional, State, National	Duration Short term/ Long term, pre, during or post construction	Does the project constitute or exacerbate a KTP?
	species to be present				
Invasion and spread of weeds	None	Indirect	Site based	Short-term	· Invasion, establishment and spread of *Lantana camara* · Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Invasion and spread of pests	None	Indirect	Site based	Short-term	· Competition and grazing by the feral European rabbit (Oryctolagus cuniculus) · Predation and hybridisation of feral dogs (*Canis lupus familiaris*) · Predation by the European red fox (*Vulpes vulpes*) · Predation by the feral cat (*Felis catus*) · Predation by Plague Minnow or Mosquito Fish *(Gambusia holbrooki*)
Invasion and spread of pathogens and disease	None	Indirect	Site based	Short-term	· Infection of native plants by *Phytophthora cinnamomi* · Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae
Noise, light and vibration	Grey-headed Flying-fox and Eastern Bentwing-bat	Indirect	Site based	During construction	No

9.6 Cumulative impacts

Cumulative impacts have been summarised below for the WestConnex projects and other known or potential projects in the area.

Mitigation measures for biodiversity values impacted by the M4-M5 Link project (Grey-headed Flying-fox, Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat) are also part of other projects mitigation measures. Where possible, these mitigation measures are consistent across the WestConnex projects.

These measures are detailed in the project reports and form a condition of approval, including but not limited to:

- Unexpected finds procedure
- Bat management procedures (when required)
- Replacement tree planting
- Tree removal procedure

9.6.1 Other WestConnex projects

M4 East

The M4 East project involves upgrade and extension of the M4 Motorway from Homebush Bay Drive at Homebush to Parramatta Road and City West Link (Wattle Street) at Haberfield. This includes twin tunnels about 5.5 kilometres long and associated surface works to connect to the existing road network.

The biodiversity assessment undertaken for M4 East involved a desktop assessment and detailed field investigations. No remnant native or threatened ecological communities were recorded. The assessment determined that a formal biodiversity offset was not necessary to compensate for the minor and localised residual impacts from the project. Furthermore, significant impacts to threatened ecological communities, or threatened flora or fauna would not result from the project.

However, approximately 15.7 hectares of exotic and planted vegetation equivalent to the mapped 'urban exotic and native cover' would be impacted, and represents a minor impact to potential foraging habitat for the Grey-headed Flying-fox, Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat. The assessment is summarised at Section 4.4.1 of this BAR.

The M4-M5 Link project overlaps with the M4 East project at Haberfield, with the M4-M5 Link project utilising existing civil and tunnel sites. The M4-M5 Link would therefore not impact any of the previously identified biodiversity values assessed and managed as part of the M4 East project under Option A. However, under Option B, a few additional Grey-headed Flying-fox trees will be impacted.

Management measures proposed by M4-M5 Link for Biodiversity values are consistent with those adopted for the M4 East project.

The M4-M5 Link would remove up to 4.49 hectares of foraging habitat for the Grey-headed Flying-fox and up to 3.78 hectares of foraging habitat for the Eastern Bentwing-bat in the form of planted native or exotic vegetation, contributing to a minor cumulative impact to these species.

M4 Widening

The project involved widening the existing M4 Motorway from three to four lanes in each direction for approximately 7.5 kilometres between Pitt Street, Parramatta and Homebush Bay Drive, Homebush. The biodiversity assessment for the project formed part of an EIS and included desktop and detailed field investigations.

The assessment for the M4 Widening concluded up to 0.54 hectares of remnant native vegetation, representing threatened ecological communities listed under the TSC Act may be impacted as a result of the works. These vegetation communities occur as highly disturbed remnants in an urban landscape and included:

- Up to 0.08 hectares of Swamp Oak Floodplain Forest
- Up to 0.38 hectares of Freshwater Wetland
- Up to 0.08 hectares of Shale-Gravel Transition Forest

No cumulative impacts to these vegetation communities will occur as a result of the M4-M5 Link project.

Impacts from the M4 Widening may also occur to the following native biodiversity values:

- Four different threatened flora; *Hypsela sessiflora, Marsdenia viridiflora* subsp. *viridiflora* (endangered population), *Wahlenbergia multicaulis* and *Wilsonia backhousei*.
- Up to 8.84 hectares of potential non-native foraging habitat (mapped equivalent as urban exotic and native cover) for the long-nosed bandicoot (endangered population) woodland birds and microbats, including but not limited to the Swift Parrot, Little Lorikeet, Grey-headed Flying-fox, Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat

No cumulative impacts to the threatened flora or woodland birds will occur as a result of the M4-M5 Link project. However, the M4-M5 Link would remove up to 4.49 hectares of foraging habitat (suitable feed trees) for the Grey-headed Flying-fox and up to 3.78 hectares of foraging habitat for the Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat in the form of planted native or exotic vegetation, contributing to a minor cumulative impact to these species.

New M5

The New M5 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. The project also includes an interchange at St Peters and connections to the existing road network. Part of the New M5 overlaps with the construction area at the St Peters site for the project.

The New M5 project was assessed as a Major Project using the FBA methodology, which differed from the assessment methodology for the M4 East. The assessment is summarised at Section 4.4.1 of this BAR.

The New M5 would result in 3.31 hectares of direct impacts on native vegetation. Accordingly, the project BAR assessed the type and number of credits using the FBA methodology. 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 habitat.

No cumulative impacts to these biodiversity values will occur as a result of the M4-M5 Link project. In addition to the above impacts, 10.80 hectares of planted exotic and native vegetation would be impacted, which may represent potential foraging habitat for the Grey-headed Flying-fox.

The M4-M5 Link project overlaps with the New M5 project at St Peters only (St Peters Interchange), with the M4-M5 Link project utilising existing civil and tunnel sites, and building a new ventilation outlet within the existing footprint. None of the areas identified in the New M5 Project as having potential biodiversity values are within the M4-M5 Link project footprint and would therefore not be impacted by this project.

Management measures proposed by M4-M5 Link for biodiversity values are consistent with those adopted for the New M5 project. The M4-M5 Link would remove a small amount of foraging habitat (suitable feed trees; up to 4.49 hectares) for the Grey-headed Flying-fox in the form of planted

native or exotic vegetation, contributing to a minor cumulative impact to this species. The Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat were not identified as being impacted by the New M5 project.

King Georges Road Interchange Upgrade

The King Georges Road Interchange Upgrade involves construction works to increase capacity on the King Georges Road on and off ramps to the M5 Motorway. The biodiversity assessment for the project formed part of an EIS and included desktop and detailed field investigations.

The assessment concluded that impacts to native biodiversity values may occur and include:

- Up to 0.01 hectares of remnant Cooks River/Castlereagh Ironbark Forest, an ECC under the TSC Act and CEEC under the EPBC Act.
- Up to nine *Acacia pubescens* (Downy Wattle), listed as Vulnerable under the TSC and EPBC Acts.
- Up to 3.23 hectares of potential non-native foraging habitat (mapped equivalent as urban exotic and native cover) for woodland birds and microbats, including but not limited to the Swift Parrot, Little Lorikeet, Grey-headed Flying-fox, Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat.

No cumulative impacts to Cooks River/Castlereagh Ironbark Forest, Acacia pubescens or woodland birds will occur as a result of the M4-M5 Link project. However, the M4-M5 Link would remove up to 4.49 hectares of foraging habitat (suitable feed trees) for the Grey-headed Flying-fox and up to 3.78 hectares of foraging habitat for the Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat in the form of planted native or exotic vegetation, contributing to a minor cumulative impact to these species.

9.6.2 Other projects

Rozelle Rail Yards site management works

The Rozelle Rail Yards site management works involves the remove rail and rail related infrastructure within the Rozelle Rail Yards site, as well as vegetation, buildings and stockpiles. The biodiversity assessment for the Rozelle Rail Yards site management works involved a desktop assessment and detailed field investigations. The assessment is summarised at Section 4.1.1 of this BAR.

No threatened flora species or listed ecological communities were identified, or are considered as having potential to occur within the site. However, the Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat were recorded within the site and several Grey-headed Flying-fox were observed feeding immediately adjacent to the site. Assessments of Significance under the TSC and EPBC Act were completed as part of the biodiversity assessment and concluded that a significant impact to values under the TSC and EPBC Acts is not likely to occur.

Subject to planning approval, the M4-M5 Link project would be constructed after the site management works are completed within the Rozelle Rail Yards. This area would serve as a construction site for the Rozelle civil and tunnel site and as an operational ventilation facility. The M4-M5 Link would therefore not impact any of the previously identified biodiversity values assessed and managed as part of the Rozelle Rail Yards site management works.

The M4-M5 Link would remove up to 4.49 hectares of foraging habitat (suitable feed trees) for the Grey-headed Flying-fox and up to 3.78 hectares of foraging habitat for the Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat in the form of planted native or exotic vegetation, contributing to a minor cumulative impact to these species.

CBD and South East Light Rail Project – Rozelle maintenance depot

The CBD and South East Light Rail EIS (Transport for NSW 2013) indicated that the project is likely to have significant benefits for transport and access within and from/to the inner west of Sydney, as well as wider social, economic and environmental benefits. The Rozelle maintenance

depot occurs along Lilyfield Road, and is approximately 370 metres long and 120 metres wide. It is a former goods yard with some residential and commercial premises nearby. The key environmental impacts from the Rozelle maintenance depot include, construction impacts, land use and transport integration, operational noise and vibration, historic heritage, ecology and design, sustainability and amenity.

Whites Creek naturalisation

Sydney Water are currently investigating options to rehabilitate an approximately 420 metre section of concrete channel in Whites Creek. This project is currently at a concept design phase, with limited information available. An environmental assessment for the naturalisation works are yet to be completed. The relevant section occurs approximately 200 metres from the outlet at Rozelle Bay in Annandale, to the west of Brenan Street. The project is looking at sections that need to be repaired, and whether this can be achieved through naturalisation, by replacing the concrete banks with ones made of native plants and rocks.

The Whites Creek naturalisation may require some tree removal for the works, which will occur in close proximity to the M4-M5 Link project footprint. However, in the long-term, the naturalisation is likely to provide a riparian corridor consisting of planted native species.

The M4-M5 Link project will extend the Whites Creek naturalisation in consultation with Sydney Water through a complementary planting regime along a section of the riparian corridor between Rozelle Bay and the light rail. The landscape plantings will occur following the widening and improvement works to the channel and bank of Whites Creek at Annandale, to manage flooding and drainage for the surface road network.

Other metropolitan roads projects

Roads and Maritime is currently investigating a number of motorway options in the Sydney metropolitan area, including the Western Harbour Tunnel crossing Sydney Harbour, a connection to the Northern Beaches and the F6 Extension to the Illawarra. These potential projects are in the very early phases of planning. If they were to progress beyond the scoping or business case, they would be subject to environmental impact assessments. These projects would be likely to have some biodiversity impact. However, the nature, extent and intensity of these impacts cannot be predicted at this early stage. There is insufficient information currently available to make any informed assessment about the potential impacts of any of these potential projects.

9.6.3 Summary of Cumulative impacts

The impacts of the WestConnex program of works have been assessed and consistent management measures have been identified. A summary of the cumulative impacts are provided in Table 9.5. In total, approximately 3.86 hectares of native vegetation would be impacted by WestConnex, which is not significant in the context of existing native vegetation across the Sydney Basin. A further 50.18 hectares of exotic and planted vegetation (mapped as ‘urban exotic and native cover’) would be removed and represents potential foraging habitat for the Grey-headed Flying-fox (total 53.49 hectares). Of this, up to 38.67 hectares has been identified as potential foraging habitat for the Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat. Offset for individual trees would be integrated into landscape plans for the individual projects, and would provide foraging habitat for species such as the Grey-headed Flying-fox and microbats.

The cumulative impacts to Grey-headed Flying-fox and the threatened microbats will not result in a significant impact. No camps or breeding sites will be impacted and the removal of potential feed trees and foraging habitat is negligible in the context of existing available foraging habitat for these species.

Table 9.5: Summary of cumulative impacts

Project	Area (hectares)			
	Native vegetation	Non-native vegetation (urban exotic and native cover)	Grey-headed Flying-fox	Microbats (Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat)
M4 East	-	15.70	15.70	15.70
M4 Widening	0.54	8.84	8.84	8.84
New M5	3.31	10.80	14.11	-
King Georges Road Interchange Upgrade	0.01	3.23	3.23	3.23
M4-M5 Link	-	4.49	4.49	3.78*
WestConnex Subtotal	***3.86***	***43.06***	***Up to 46.37***	***Up to 31.55***
Rozelle Rail Yards site management works	-	7.12^	7.12^	7.12^
Total	**3.86**	**50.18**	***Up to* 53.49**	**Up to 38.67**

* Habitat for the microbats was only considered to be present within the vicinity of the Rozelle Rail Yards and not across the whole project.
^ This area was not present in the Rozelle Rail Yards site management works REF.

10 Mitigation

Mitigation measures aim to avoid and minimise direct and indirect impacts of the project. The relevant ecological impacts and associated mitigation measures and protocols (standard and project specific) are identified in Table 10.1. It is anticipated that the standard control measures (ie inductions etc.) would be incorporated in a Construction Flora and Fauna Management Plan, which would be prepared as part of the Construction Environmental Management Plan.

Environmental management measures relating to biodiversity during construction and operation are provided in Table 10.1. All measures would be consistent with the Roads and Maritime *Biodiversity Guidelines – Protecting and Managing Biodiversity on Roads and Maritime Projects* (the Biodiversity Guidelines) (Roads and Traffic Authority 2011) Additional mitigation and management measures relevant to biodiversity are also described in the following sections of the EIS:

- Noise and vibration management measures in Chapter 10 of the EIS (Noise and vibration) to minimise fauna impacts including microbats
- Lighting management measures in Chapter 13 of the EIS (Urban design and visual amenity) to minimise fauna impacts including microbats
- Erosion and sediment control management measures in Chapter 15 of the EIS (Soil and water quality) to minimise the spread of weeds and to minimise impacts to aquatic habitat in particular at Whites Creek and Rozelle Bay
- Flooding and drainage management measures in Chapter 17 of the EIS (Flooding and drainage) to minimise impacts to aquatic habitat in particular at Whites Creek.

Table 10.1 Impacts and mitigation measures

Impact	No.	Environmental Management Measure	Timing
Impact to biodiversity values	B1	A Construction Flora and Fauna Management Plan (CFFMP) will be developed and implemented during construction. The CFFMP will include the following: · Identification of guidelines relevant to construction, the matters they apply to and what is required to ensure compliance · Pre-disturbance inspection requirements to identify features of biodiversity conservation significance and select appropriate management measures and environmental controls · Management measures and environmental controls to be implemented before and during construction including: - An unexpected threatened species finds procedure - Section 3.3.2 Standard precautions and mitigation measures of the *Policy and guidelines for fish habitat conservation and management Update 2013*(DPI (Fisheries NSW) 2013) - Tree assessment and management protocols consistent with *AS 4970-2009 Protection of trees on development sites* - Weed management protocols.	Construction
Disturbance of threatened microbats	B2	Prior to the commencement of any works associated with the modification of the Victoria Road bridge, an inspection will be carried out by a suitably qualified and experienced ecologist to confirm the presence of roosting microbats. If roosting microbats are identified, measures to manage potential impacts will be developed in consultation with an appropriate microbat expert and included in the CFFMP prior to the commencement of any work with the potential to disturb the roosting locations (as confirmed by the microbat expert). The CFFMP will include management measures outlined in the Biodiversity Assessment Report (BAR) and from any additional assessments carried out during detailed design and project delivery as relevant.	Construction
Aquatic impacts	B3	The proposed road bridge at Whites Creek will be designed with consideration of *Policy and Guidelines for Fish Habitat Conservation Update 2013* (DPI, 2013) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries, 2003).	Construction
	B4	Site-specific Erosion and Sediment Control Plans (ESCPs) will be prepared for each work location associated with or in the vicinity of waterways and culverts that will be modified as part of the project. The ESCPs will contain measures to stabilise all surfaces disturbed as a result of the CSSI as soon as possible following the disturbance to prevent erosion and to minimise sedimentation in adjacent aquatic environments.	Construction

Impact	No.	Environmental Management Measure	Timing
Loss of trees	B5	The CFFMP will include measures to manage potential impacts to trees. Measures will include: · The establishment of tree protection zones · Ground protection measures for trees to be retained.	Construction
	B6	As many trees as possible will be retained during construction. In the event that tree removal cannot be avoided, a tree replacement strategy will be prepared. Replacement trees will be included in the Urban Design and Landscape Plan to be developed and implemented for the project.	Construction
	B7	The CFFMP will include tree management protocols and provision for the development of tree management plans (in accordance with the requirements of AS 4970-2009) where required for specific trees. Protection of trees on development sites will be carried out in consultation with an arborist with a minimum Australian Qualifications Framework (AQF) Level 5 qualification in arboriculture for each tree proposed for retention where works associated with the project have the potential to impact on the tree root zone.	Construction
	B8	Tree removal, pruning and maintenance work will be carried out by an arborist with a minimum AQF Level 3 qualification in accordance with *AS 4373-2007 Pruning of Amenity Trees* and the NSW WorkCover Code of Practice for the Amenity Tree Industry (1998) and advice provided by an arborist with a minimum AQF Level 5 qualification in Arboriculture (or equivalent).	Construction
Loss of trees	B9	An Urban Design and Landscape Plan will be prepared and implemented to guide the compensatory planting for trees removed by the project. The plan will include: · A tree replacement strategy · Species recommendations for the landscape design to consider, including foraging trees for the Grey-headed Flying-fox · Relevant project specific rehabilitation and revegetation measures associated with the M4 East and New M5 projects, where there is an overlap in use of construction footprint.	Operation
Loss of aquatic habitat	B10	Consultation will be undertaken with Sydney Water regarding integration of naturalisation works at Whites Creek, including re-establishment of vegetation where possible following construction activities. Vegetation re-establishment will be undertaken in accordance with Guide 3: *Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and management biodiversity on RTA project* (RTA 2011).	Operation

11 Offsetting required

Although avoidance and mitigation measures have been considered and will be implemented during the design of the project, impacts on biodiversity, may occur in association with the project. In accordance with the FBA and the Guideline for Biodiversity Offsets (Roads and Maritime 2011), these impacts must be offset.

In accordance with the FBA, this chapter identifies areas not requiring assessment, areas not requiring offset, identification of any ecosystem or species credits requiring offset and identification of matters requiring further consideration, such as potential aquatic or landscape offsets.

11.1 Areas not requiring assessment offsets

Areas not requiring assessment or offset were:

- Cleared areas – associated with tracks, roads, buildings, and other infrastructure
- Areas dominated by exotics - classified in this assessment as urban native and exotic vegetation.

11.2 Ecosystems requiring offsets

No ecosystem offsets are required.

11.3 Species requiring offsets

No species offsets are required.

11.4 Aquatic biodiversity offsets

This section refers to aquatic habitats that are not considered under the FBA. No saline wetland vegetation or protected marine vegetation would be impacted by the project.

All other non-saline wetlands and riparian vegetation are assessed under the FBA. Loss of riparian vegetation applies to any associated PCT. Loss of freshwater aquatic habitat is not calculated in the FBA or the Fisheries Policy and Guidelines, but is assessed on a case-by-case basis for major projects when impacting KFH. As there were no aquatic biodiversity values impacted by the project, and ‘no net loss’ of KFH, there is no requirement to provide compensatory habitat.

11.5 Compensatory planting recommendations

Opportunities to retain high retention value trees should be explored where practical during detailed design and tree sensitive construction techniques should be considered. Compensatory planting is recommended for trees that cannot be retained as a result of the works. Replacement trees should be planted within, or in close proximity to the project footprint.

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Annexure A – Habitat assessment table

An assessment of likelihood of occurrence was made for threatened ecological communities and species identified from the desktop review. This was based on database records, habitat features of the site, results of the field surveys and professional judgement. Some Migratory or Marine species from the Commonwealth database search have been excluded from the assessment, due to lack of habitat. The terms for likelihood of occurrence are defined in Table A.1.

Table A.1: Likelihood of occurrence criteria

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

Note; assessments of occurrence were made both prior to field survey and following field survey. The pre-survey assessments were performed to determine which species were “affected species”, and hence determine which sorts of habitat to look for during field survey. The post-survey assessments to determine “final affected species” were made after observing the available habitat in the study area and are depicted in the table below.

It is noted that some threatened fauna that are highly mobile, wide ranging and vagrant may use portions of the study area intermittently for foraging. For these species, potential habitat impacted is not considered important for the long-term survival of a local occurrence of the species, particularly in relation to similar habitat remaining in the locality.

The records column refers to the number of records occurring within 5 km of the site (locality), as provided by the NSW Wildlife Atlas (BioNet) database search (OEH 2016a). Information provided for the habitat associations has primarily been extracted (and modified) from the Commonwealth Species Profile and Threats Database (DotEE 2016a), the NSW Threatened Species Profiles (OEH. 2016b) and NSW Department of Primary Industries (DPI 2016).

Key to the tables below:
- CE = Critically Endangered
- E = Endangered (EPBC Act, TSC Act and FM Act)
- EP = Endangered Population (TSC Act and FM Act)
- V = Vulnerable
- Mi = Migratory (EPBC Act)
- P = Protected (FM Act)

Table A.2: Threatened ecological communities – habitat assessment table

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat Associations	Likelihood of occurrence
Blue Gum High Forest	CE	Ce	A moist, tall open forest community, with dominant canopy trees of *Eucalyptus saligna* (Sydney Blue Gum) and *Eucalyptus pilularis* (Blackbutt). *Allocasuarina torulosa* (Forest Oak) and *Angophora costata* (Sydney Red Gum) also occur. Species adapted to moist habitat such as *Acmena smithii* (Lilly Pilly), *Ficus coronata* (Sandpaper Fig), *Calochlaena dubia* (Soft Bracken) and *Adiantum aethiopicum* (Maiden Hair) may also occur. Originally restricted to the ridgelines in Sydney's north from Crow's Nest to Hornsby, and extending west along the ridges between Castle Hill and Eastwood. Occurs only in areas where rainfall is high (above 1100 millimetres per year) and the soils are relatively fertile and derived from Wianamatta shale. In lower rainfall areas, it grades into Sydney Turpentine-Ironbark Forest.	None
Castlereagh Scribbly Gum and Agnes Banks Woodlands	V	E	Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion mainly occurs within the local government areas of Bankstown, Blacktown, Campbelltown, Hawkesbury, Liverpool and Penrith. It is almost exclusively found on soils derived from Tertiary alluvium, or on sites located on adjoining shale or Holocene alluvium. It is dominated by *Eucalyptus parramattensis*, *Angophora bakeri* and *Eucalyptus sclerophylla*. A small tree stratum of *Melaleuca decora* is sometimes present, generally in areas with poorer drainage. It has a well-developed shrub stratum consisting of sclerophyllous and the ground stratum consists of a diverse range of forbs.	None
Castlereagh Swamp Woodland	E	-	Occurs in western Sydney in the Castlereagh and Holsworthy areas, on deposits from ancient river systems along todays intermittent creek lines, often in poorly drained depressions. A low woodland, often having dense stands of *Melaleuca decora* along with other canopy trees, such as *Eucalyptus parramattensis*. The shrub layer is not well developed and is mostly made up of young paperbark trees. The ground layer has a diversity of plants that tolerate waterlogged conditions, such as *Centella asiatica, Juncus usitatus* and *Goodenia paniculata*.	None
Coastal Upland Swamps	E	E	Coastal Upland Swamps includes open heath, sedge land and tall scrub associated with periodically waterlogged soils on the Hawkesbury sandstone plateau. The Coastal Upland Swamp is endemic to NSW and confined to the Sydney Basin Bioregion. It occurs in the eastern Sydney Basin from the Somersby district in the north to the Robertson district in the south. In the north it occurs on the Somersby-Hornsby plateau, in the south it occurs on the Worora plateau. It occurs in elevations from 20 m to over 600 m above sea level, with the majority of swamps occurring within 200 m and 450 m elevation. Coastal Upland Swamps occur primarily on impermeable sandstone plateau with shallow groundwater aquifers in the headwaters and impeded drainage lines of streams, and on sandstone benches with abundant seepage moisture.	None
Cooks River/Castlereagh Ironbark Forest	E	CE	Occurs in western Sydney, with the most extensive stands occurring in the Castlereagh and Holsworthy areas. Ranges from open forest to low woodland, with a canopy dominated by *Eucalyptus fibrosa* and *Melaleuca decora*. The canopy may also include other eucalypts such as *Eucalyptus longifolia*. The dense shrubby understorey consists of *Melaleuca nodosa* and *Lissanthe strigosa*, with a range of 'pea' flower shrubs, such as *Dillwynia tenuifolia*, *Pultenaea villosa* and *Daviesia ulicifolia* can be locally abundant. The sparse ground layer contains a range of grasses and herbs.	None

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat Associations	Likelihood of occurrence
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	CE	CE	Occurs on soils derived from Wianamatta Shale, and throughout the driest part of the Sydney Basin. Good examples can be seen at Scheyville National Park and Mulgoa Nature Reserve. The dominant canopy trees of Cumberland Plain Woodland are *Eucalyptus moluccana* (Grey Box) and *Eucalyptus tereticornis* (Forest Red Gum), with *Eucalyptus crebra* (Narrow-leaved Ironbark), *Corymbia maculata* (Spotted Gum) and *Eucalyptus eugenioides* (Thin-leaved Stringybark) occurring less frequently. The shrub layer is dominated by *Bursaria spinosa* (Blackthorn), and it is common to find abundant grasses such as *Themeda australis* (Kangaroo Grass) and *Microlaena stipoides* var*. stipoides* (Weeping Meadow Grass).	None
Eastern Suburbs Banksia Scrub	E	E	Once occupied around 5,300 hectares of land between North Head and Botany Bay in Sydney's eastern suburbs. Surviving stands total approximately 146 hectares have been recorded from the LGAs of Botany, Randwick, Waverley, and Manly. Predominantly a sclerophyllous heath or scrub community although, depending on site topography and hydrology, some remnants contain small patches of woodland, low forest or limited wetter areas. Common species include *Banksia aemula*, *Banksia ericifolia*, *Banksia serrata*, *Eriostemon australasius*, *Lepidosperma laterale*, *Leptospermum laevigatum*, *Monotoca elliptica* and *Xanthorrhoea resinifera*.	None
Freshwater Wetlands on Coastal Floodplains	E	-	Known from along the majority of the NSW coast. It is associated with coastal areas subject to periodic flooding and where standing freshwater persists for at least part of the year in most years. Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, back swamps, lagoons and lakes, but may also occur in back barrier landforms where floodplains adjoin coastal sandplains. They are dominated by herbaceous plants with very few woody species. The structure and composition varies both spatially and temporally depending on the water regime. Those that lack standing water most of the time are usually dominated by dense grassland or sedge land vegetation, such as *Paspalum distichum, Leersia hexandra, Pseudoraphis spinescens* and *Carex appressa*.	None
Freshwater Wetlands of the Sydney Basin Bioregion	E	-	Occurs on sand dunes and low-nutrient sandplains along coastal areas in the Sydney Basin bioregion. It is known from the Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Woollahra, Waverley, Botany, Rockdale, Randwick, Sutherland and Wollongong local government areas, but is likely to occur elsewhere within the bioregion. Characteristic species include sedges and aquatic plants such as *Baumea* species, *Eleocharis sphacelata, Gahnia species, Ludwigia peploides* subsp*. montevidensis* and *Persicaria* species.	None
River-Flat Eucalypt Forests (previously known as Alluvial Woodland)	E	-	Occurs on the river flats of the coastal floodplains. It has a tall open tree layer of eucalypts, but can be considerably shorter in regrowth stands or lower site quality. The typical dominant trees include *Eucalyptus tereticornis* (Forest red gum), *Eucalyptus amplifolia* (Cabbage gum), *Angophora floribunda* (Rough-barked Apple) and *Angophora subvelutina* (Broad-leaved Apple). A layer of small trees may be present, including *Melaleuca decora, Melaleuca styphelioides* (Prickly-leaved Teatree), *Backhousia myrtifolia* (Grey Myrtle), *Melia azedarach* (White Cedar), *Casuarina cunninghamiana* (River Oak) and *Casuarina glauca* (Swamp Oak). Scattered shrubs include *Bursaria spinosa, Solanum prinophyllum, Rubus parvifolius, Breynia oblongifolia, Ozothamnus diosmifolius, Hymenanthera dentata, Acacia floribunda* and *Phyllanthus gunnii*. The groundcover is composed of abundant forbs, scramblers and grasses including *Microlaena stipoides, Dichondra repens, Glycine clandestina, Oplismenus aemulus, Desmodium gunnii, Pratia purpurascens, Entolasia marginata, Oxalis perennans* and *Veronica plebeia*. The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbances, and may be dominated by exotic shrubs, grasses, vines and forbs.	None

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat Associations	Likelihood of occurrence
Shale Sandstone Transition Forest	CE	CE	Occurs at the edges of the Cumberland Plain, where clay soils from the shale rock intergrade with soils from sandstone, or where shale caps overlay sandstone. The main tree species include *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus punctata* (Grey Gum), *Eucalyptus globoidea, Eucalyptus eugenioides* (Thin-leaved Stringybark) and *Eucalyptus fibrosa* (Broad-leaved Ironbark) and *Eucalyptus crebra* (Narrow-leaved Ironbark). Areas of low sandstone influence have an understorey that is closer to Cumberland Plain Woodland. High sandstone influence have poor rocky soils.	None
Subtropical and Temperate Coastal Saltmarsh	E	V	Found on the river flats of the coastal floodplains. Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The structure of the community may vary from tall open forests (>40 m) to woodlands. The most widespread and abundant dominant trees include *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus amplifolia* (Cabbage Gum), *Angophora floribunda* (Rough-barked Apple) and *Angophora subvelutina* (Broad-leaved Apple).	None
Swamp Oak Floodplain Forest	E	-	It is known from a number of LGA's in Sydney and along the coast of NSW occurring on coastal floodplains. It has a dense to sparse tree layer in which *Casuarina glauca* (Swamp Oak) is the dominant species. Other trees including *Acmena smithii* (Lilly Pilly), *Glochidion* spp. (Cheese Tree) and *Melaleuca* spp. (Paperbarks) may be present as subordinate species. The understorey is characterised by frequent occurrences of vines, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.	None
Swamp Sclerophyll Forest	E	-	It is known from a number of LGAs in Sydney and along the coast of NSW. It has an open to dense tree layer of eucalypts and paperbarks although some remnants now only have scattered trees as a result of partial clearing. The most widespread and abundant dominant trees include *Eucalyptus robusta* (Swamp Mahogany), *Melaleuca quinquenervia* (Paperbark) and, south from Sydney, *Eucalyptus botryoides* (Bangalay) and *Eucalyptus longifolia* (Woollybutt). A layer of small trees may also be present. Shrubs include *Acacia longifolia, Dodonaea triquetra, Ficus coronata, Leptospermum polygalifolium* subsp. *polygalifolium* and *Melaleuca* spp. The groundcover is composed of abundant sedges, ferns, forbs, and grasses.	None
Turpentine-Ironbark Forest	E	CE	Open forest, with dominant canopy trees including *Syncarpia glomulifera* (Turpentine), *Eucalyptus punctata* (Grey Gum), *Eucalyptus paniculata* (Grey Ironbark) and *Eucalyptus eugenioides* (Thin-leaved Stringybark). In areas of high rainfall *Eucalyptus saligna* (Sydney Blue Gum) is more dominant. The shrub stratum is usually sparse and may contain mesic species such as *Pittosporum undulatum* (Sweet Pittosporum) and *Polyscias sambucifolia* (Elderberry). Occurs close to the Shale/Sandstone boundary on the more fertile shale influenced soils, in higher rainfall areas on the higher altitude margins of the Cumberland Plain, and on the shale ridge caps of sandstone plateaux.	None
Upland Basalt Eucalypt Forests	-	E	The Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion is typically tall open eucalypt forests found on basalt and basalt-like substrates in, or adjacent to, the Sydney Basin Bioregion. The ecological community usually occurs at elevations between 650 m and 1050 m above sea level although outliers may occur at elevations as low as 350 m (eg closer to the coast) or as high as 1200 m (eg on higher plateau). The ecological community occurs in areas of high rainfall, generally ranging from 1000 to 1800 mm/year.	None
Western Sydney Dry Rainforest and Moist Woodland on Shale	E	CE	This community represents certain occurrences of dry rainforest and moist woodland generally found on shale soil in the Cumberland Plain Sub-region of the Sydney Basin Bioregion. It occurs generally in gullies, sheltered slopes and rugged terrain in isolated patches, largely on the edges of the Cumberland Plain in NSW, with some patches on undulating terrain in the central parts of the Cumberland Plain.	None

Table A.3: Threatened flora – habitat assessment table

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
FLORA						
Bynoe's Wattle *(Acacia bynoeana)*	E	V	*Acacia bynoeana* is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains, and has recently been found in the Colymea and Parma Creek areas west of Nowra. It is found in heath and dry sclerophyll forest, typically on a sand or sandy clay substrate, often with ironstone gravels.	2	None – suitable habitat not present	Species
(Acacia gordonii)	E	E	*Acacia gordonii* is restricted to the north-west of Sydney, occurring in the lower Blue Mountains in the west, and in the Maroota/Glenorie area in the east, within the Hawkesbury, Blue Mountains and Baulkham Hills LGAs. Grows in dry sclerophyll forest and heathlands amongst or within rock platforms on sandstone outcrops.	1	None – suitable habitat not present	Species
Downy Wattle *(Acacia pubescens)*	V	V	It occurs mainly around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravely soils, often with ironstone. Grows in open woodland and forest, in a variety of plant communities, including Cooks River-Castlereagh Ironbark forest, Shale-Gravel Transition Forest and Cumberland Plain woodland.	-	None – suitable habitat not present. No records in locality	Species
Sunshine Wattle *(Acacia terminalis* subsp. *terminalis)*	E	E	This species has a very limited distribution, mainly in near-coastal areas from the northern shores of Sydney Harbour south to Botany Bay, with most records from the Port Jackson area and the eastern suburbs of Sydney. It occurs in coastal scrub and dry sclerophyll woodland on sandy soils.	11	None – suitable habitat not present	Species
(Allocasuarina glareicola)	E	E	*Allocasuarina glareicola* is primarily restricted to the Richmond district on the north-west Cumberland Plain, with an outlier population found at Voyager Point. It grows in Castlereagh woodland on lateritic soil.	-	None – suitable habitat not present. No records in locality	Species
Nielsen Park She-oak *(Allocasuarina portuensis)*	E	E	*Allocasuarina portuensis* was originally recorded at Nielson Park in the Woollahra LGA. None of the original individuals are left within the area it was discovered and the species presently only persists from propagation material. This species once grew in tall closed woodlands on shallow sandy siliceous, coarsely textured soils.	-	None – suitable habitat not present. No records in locality	Species
(Asterolasia elegans)	E	E	It is restricted to a few localities on the NSW Central Coast north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs. It is found in sheltered forests on mid- to lower slopes and valleys, in or adjacent to gullies.	-	None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Thick Lip Spider Orchid *(Caladenia tessellata)*	E	V	*Caladenia tessellata* occurs in grassy sclerophyll woodland, often growing in well-structured clay loams or sandy soils south from Swansea, usually in sheltered moist places and in areas of increased sunlight. It flowers from September to November.	2	None – suitable habitat not present	Species
(Callistemon linearifolius)	V	-	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. Grows in dry sclerophyll forest on the coast and adjacent ranges.	-	None – suitable habitat not present. No records in locality	Species
Leafless Tongue-orchid *(Cryptostylis hunteriana)*	V	V	Known from a range of vegetation communities including swamp-heath and woodland. The larger populations typically occur in woodland dominated by *Eucalyptus sclerophylla* (Scribbly Gum)*, E. sieberi* (Silvertop Ash), *Corymbia gummifera* (Red Bloodwood) and *Allocasuarina littoralis* (Black Sheoak); where it appears to prefer open areas in the understorey and is often found in association with *Cryptostylis subulata) Cryptostylis erecta.*	-	None – suitable habitat not present. No records in locality	Species
(Darwinia biflora)	V	V	*Darwinia biflora* is an erect or spreading shrub to 80 cm high associated with habitats where weathered shale capped ridges intergrade with Hawkesbury Sandstone, where soils have a high clay content.	1	None – suitable habitat not present	Species
(Deyeuxia appressa)	E	E	Little is known of the habitat and ecology of this highly restricted NSW endemic known only from two records in the Sydney area; first collected in 1930 at Herne Bay, Saltpan Creek, off the Georges River, south of Bankstown; then collected in 1941 from Killara, near Hornsby. Grows in moist conditions.	-	None – suitable habitat not present. No records in locality	Species
(Dillwynia tenuifolia)	V	-	The core distribution is the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee. In western Sydney, may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone.	-	None – suitable habitat not present. No records in locality	Species
(Epacris purpurascens var. *purpurascens)*	V	-	*Epacris purpurascens* var. *purpurascens* has been recorded between Gosford in the north to Avon Dam in the south, in a range of habitats, but most have a strong shale soil influence.	1	None – suitable habitat not present	Species
Camfield's Stringybark *(Eucalyptus camfieldii)*	V	V	*Eucalyptus camfieldii i*s associated with shallow sandy soils bordering coastal heath with other stunted or mallee eucalypts, often in areas with restricted drainage and in areas with laterite influenced soils, thought to be associated with proximity to shale.	-	None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Narrow-leaved Black Peppermint *(Eucalyptus nicholii)*	V	V	*Eucalyptus nicholii* naturally occurs in the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield. Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite. This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. Plantings undertaken for horticultural and aesthetic purposes are not considered threatened species under the TSC Act.	6	None – suitable habitat not present. Records are landscaped plantings	Species
Bauer's Midge Orchid *(Genoplesium baueri)*	E	E	Known from coastal areas from northern Sydney south to the Nowra district. Previous records from the Hunter Valley and Nelson Bay are now thought to be erroneous. Grows in shrubby woodland in open forest on shallow sandy soils.	6	None – suitable habitat not present	Species
(Grammitis stenophylla	E	-	Occurs in moist places usually near streams, on rocks or in trees, within rainforest and moist eucalypt forest.	-	None – suitable habitat not present. No records in locality	Species
Caley's Grevillea *(Grevillea caleyi)*	E	E	Restricted to an 8 km square area around Terrey Hills, approximately 20 km north of Sydney. Occurs in three major areas of suitable habitat, namely Belrose, Ingleside and Terrey Hills/Duffys Forest within the Ku-ring-gai, Pittwater and Warringah LGAs. Sites occur on the ridgetops in association with laterite soils and a vegetation community of open forest, generally dominated by *Eucalyptus sieberi* and *E. gummifera*. Commonly found in the endangered Duffys Forest ecological community.	-	None – suitable habitat not present. No records in locality	Species
(Hibbertia puberula)	CE	CE	*Hibbertia puberula* is currently only known from near Warrimoo in Blue Mountains National Park on the Central Coast. There also several old records from a number of localities in the Sydney basin. It grows in heathy open forest in thin rocky/sandy light brown soil over sandstone.	1	None – suitable habitat not present	Species
(Lasiopetalum joyceae)	V	V	Has a restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the Hawkesbury River. It is currently known from 34 sites between Berrilee and Duffys Forest. Seventeen of these are on reserved lands. Grows in heath on sandstone.	-	None – suitable habitat not present. No records in locality	Species
(Leptospermum deanei)	V	V	Limited distribution in the north-west suburbs of Sydney with records between Port Jackson and Broken Bay. Found in riparian shrubland, woodland and open forest on sandy alluvial soil or sand on lower hillsides and along permanent freshwater creeks in Hawkesbury Sandstone areas below 100 m above sea level.	-	None – suitable habitat not present. No records in locality	Species
Deane's Paperbark *(Melaleuca deanei)*	V	V	Found in heath on sandstone, and also associated with woodland on broad ridge tops and slopes on sandy loam and lateritic soils.	10	None – suitable habitat not present	Species

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Hairy Geebung *(Persoonia hirsuta)*	E	E	*Persoonia hirsuta* occurs from Singleton in the north, south to Bargo and the Blue Mountains to the west. It grows in dry sclerophyll eucalypt woodland and forest on sandstone.	4	None – suitable habitat not present	Species
Nodding Geebung *(Persoonia nutans)*	E	E	Nodding Geebung is restricted to the Cumberland Plain region of western Sydney, NSW. The species is confined to Aeolian and alluvial sediments, below 60 m above sea level. Vegetation communities in which the species has been found include Agnes Banks Woodland, Castlereagh Scribbly Gum Woodland, Cooks River/Castlereagh Ironbark Forest and Shale Sandstone Transition Forest.		None – suitable habitat not present. No records in locality	Species
Omeo Stork's-bill *(Pelargonium* sp. *Striatellum)*	E	E	It is known to occur in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes. During dry periods, the species is known to colonise exposed lake beds. It is not known if the species' rhizomes and/or soil seedbank persist through prolonged inundation or drought.	-	None – suitable habitat not present. No records in locality	Species
(Pimelea curviflora var. *curviflora)*	V	V	*Pimelea curviflora* var. *curviflora* is confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. It grows on shale/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. Associated with the Duffys Forest Community, shale lenses on ridges in Hawkesbury sandstone geology.	1	None – suitable habitat not present	Species
Spiked Rice-flower *(Pimelea spicata)*	E	E	In western Sydney, *Pimelea spicata* occurs on an undulating topography of well-structured clay soils, derived from Wianamatta shale. It is associated with Cumberland Plains Woodland, in open woodland and grassland often in moist depressions or near creek lines. Has been located in disturbed areas that would have previously supported.	-	None – suitable habitat not present. No records in locality	Species
Seaforth Mintbush *(Prostanthera marifolia)*	E	CE	*Prostanthera marifolia* is currently only known from the northern Sydney suburb of Seaforth and has a very highly restricted distribution. It occurs in localised patches in or in close proximity to the Duffys Forest ecological community. It grows on deeply weathered clay-loam soils associated with ironstone and scattered shale lenses.	4	None – suitable habitat not present	Species
Sydney Plains Greenhood *(Pterostylis saxicola)*	E	E	Terrestrial orchid predominantly found in Hawkesbury Sandstone Gully Forest growing in small pockets of soil that have formed in depressions in sandstone rock shelves. Known from Georges River National Park, Ingleburn, Holsworthy, Peter Meadows Creek and St. Marys Tower.	-	None – suitable habitat not present. No records in locality	Species
(Pultenaea parviflora)	E	V	Endemic to the Cumberland Plain. Core distribution is from Windsor to Penrith and east to Dean Park. May be locally abundant, particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland.	-	None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Magenta Lilly Pilly *(Syzygium paniculatum)*	E	V	This species occupies a narrow coastal area between Bulahdelah and Conjola State Forests in NSW. On the Central Coast, it occurs on Quaternary gravels, sands, silts and clays, in riparian gallery rainforests and remnant littoral rainforest communities. Plantings undertaken for horticultural and aesthetic purposes are not considered threatened species under the TSC Act.	16	None – suitable habitat not present	Species
(Tetratheca glandulosa)	V	-	Associated with ridgetop woodland habits on yellow earths also in sandy or rocky heath and scrub. Often associated with sandstone / shale interface where soils have a stronger clay influence. Flowers July to November.	1	None – suitable habitat not present	Species
Black-eyed Susan *(Tetratheca juncea)*	V	V	Occurs on predominantly low nutrient soils with a dense grassy understorey of grasses although it has been recorded in heathland and moist forest. It is associated with dry open forest or woodland habitats dominated by *Corymbia gummifera, Eucalyptus capitellata, E. haemastoma* and *Angophora costata*. *Themeda australis* is generally the dominant ground cover. *Tetratheca juncea* also displays a preference for southern aspect slopes, although is slopes with different aspects. Flowers July to December.	13	None – suitable habitat not present	Species
Austral Toadflax *(Thesium australe)*	V	V	Widespread throughout the eastern third of NSW but most common on the North Western Slopes, Northern Tablelands and North Coast. Occurs in grassland or grassy woodland. Often found in damp sites in association with *Themeda australis*. The preferred soil type is a fertile loam derived from basalt although it occasionally occurs on metasediments and granite.	-	None – suitable habitat not present. No records in locality	Species
(*Zannichellia palustris)*	E	-	In NSW, known from the lower Hunter and in Sydney Olympic Park. Grows in fresh or slightly saline stationary or slowly flowing water. Flowers during warmer months. NSW populations behave as annuals, dying back completely every summer.	-	None – suitable habitat not present. No records in locality	Species
FUNGI						
An agaric fungus *(Hygrocybe collucera)*	E	-	Occurs in warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	1	None – suitable habitat not present	Species
An agaric fungus *(Hygrocybe grieoramosa)*	E	-	Occurs in warm temperate forests dominated by Lilly Pilly (Acmena smithii), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	1	None – suitable habitat not present	Species

Table A.4: Threatened fauna likelihood of occurrence

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
AMPHIBIA						
Giant Burrowing Frog *(Heleioporus australiacus)*	V	V	Forages in woodlands, wet heath, dry and wet sclerophyll forest. Associated with semi-permanent to ephemeral sand or rock based streams, where the soil is soft and sandy so that burrows can be constructed.	-	None – suitable habitat not present. No records in locality	Species (land within 40 m of heath, woodland or forest)
Green and Golden Bell Frog *(Litoria aurea)*	E	V	Utilises natural and man-made waterbodies such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands, stormwater basins, farm dams, bunded areas, drains, ditches and other structures capable of storing water. Preferable habitat includes shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading. Large permanent swamps and ponds exhibiting well-established fringing vegetation, adjacent to open grassland areas for foraging are preferable.	213	None – suitable habitat not present. Not recorded during targeted surveys as part of the Rozelle Rail Yards REF Biodiversity Assessment	Species (land within 100 m of emergent aquatic or riparian vegetation)
Growling Grass Frog, *(Litoria raniformis)*	E	V	Relatively still or slow-flowing sites such as billabongs, ponds, lakes or farm dams, especially where *Typha* sp., *Eleocharis* sp. and *Phragmites* sp. (Bulrushes) are present. This species is common in lignum shrub lands, black box and River Red Gum woodlands, irrigation channels and at the periphery of rivers in the southern parts of NSW. This species occurs in vegetation types such as open grassland, open forest and ephemeral and permanent non-saline marshes and swamps. Open grassland and ephemeral permanent non-saline marshes and swamps have also been associated with this species.	-	None – suitable habitat not present. No records in locality	Species (land within 100 m of emergent aquatic or riparian vegetation)
Stuttering Frog *(Mixophyes balbus)*	E	V	Occurs in a variety of forest habitats from rainforest through wet and moist sclerophyll forest to riparian habitat in dry sclerophyll forest that are generally characterised by deep leaf litter or thick cover from understorey vegetation. Breeding habitats are streams and occasionally springs. Not known from streams disturbed by humans or still water environments.	-	None – suitable habitat not present. No records in locality	Species (rainforest or tall open wet forest with understorey and/or leaf litter and within 100 m of streams)
Wallum Froglet *(Crinia tinnula)*	V	-	The Wallum Frog is restricted to the Wallum swamps and associated low land meandering watercourses on coastal plains. Occurs in elevations up to around 50 m and is closely related to freshwater habitats in the coastal zone. Found most commonly in Wallum wetlands characterised by low nutrients, highly acidic, tannin-stained waters that are typically dominated by paperbarks and tea-trees. Also found in sedge land and wet heathland habitats.	1	None – suitable habitat not present	Species (land within 40m of coastal swamps and wet heaths)

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
FISH						
Sydney Hawk Dragonfly *(Austrocordulia leonardi)*	E (FM Act)	-	The known distribution of the species includes three locations in a small area south of Sydney, from Audley to Picton. The species is also known from the Hawkesbury-Nepean, Georges River and Port Hacking drainages. The Sydney Hawk Dragonfly has specific habitat requirements, and has only ever been collected from deep and shady riverine pools with cooler water. Larvae are found under rocks where they co-exist with *Austrocordulia refracta*.	-	None – suitable habitat not present. No records in locality	Not Applicable – FM Act species only
Adam's Emerald Dragonfly (*Archaeophya adamsi)*	E (FM Act)	-	Adam's Emerald Dragonflies are one of Australia's rarest dragonflies. The species is only known from a few sites in the greater Sydney region. Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian.	-	None – suitable habitat not present. No records in locality	Not Applicable – FM Act species only
Black Rockcod *(Epinephelus daemelii)*	V (FM Act)	V	They are found in warm temperate and subtropical parts of the south-western Pacific, and naturally occurred along the entire NSW coast including Lord Howe Island. Adult black cod are usually found in caves, gutters and beneath bomboras on rocky reefs. They are territorial and often occupy a particular cave for life. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries.	-	None – suitable habitat not present. No records in locality	Not Applicable – FM Act species only
Australian Grayling *(Prototroctes maraena)*	P (FM Act)	V	Australian grayling occurs in freshwater streams and rivers, especially clear gravelly streams with a moderate flow, as well as estuarine areas. Australian grayling need to migrate to and from the sea to complete their life cycle (catadromous), and the construction of barriers such as dams and weirs has had a major impact on populations in some river systems.	-	None – suitable habitat not present. No records in locality	Not Applicable – FM Act species only
REPTILIA						
Broad-headed Snake *(Hoplocephalus bungaroides)*	E	V	Typical sites consist of exposed sandstone outcrops and benching where the vegetation is predominantly woodland, open woodland and/or heath on Triassic sandstone of the Sydney Basin. They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer.	-	None – suitable habitat not present. No records in locality	Species (land within 500 m of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges and sandstone outcropping)

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
DIURNAL BIRDS						
Magpie Goose *(Anseranas semipalmata)*	V	-	Mainly found in shallow wetlands less than 1 m deep, with a dense growth of rushes or sedges.	9	None – suitable habitat not present	Ecosystem
Dusky Woodswallow *(Artamus cyanopterus cyanopterus)*	V	-	The Dusky Woodswallow is often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests.	6	None – suitable habitat not present	Not provided in Bionet (recently listed threatened species)
Regent Honeyeater *(Anthochaera phrygia)*	E	CE	Mostly occur in dry box-ironbark eucalypt woodland and dry sclerophyll forest associations, wherein they prefer the most fertile sites available, eg along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing *Casuarina cunninghamiana* (River Oak), and with *Amyema cambagei* (Needle-leaf Mistletoe) are also important for feeding and breeding. At times of food shortage (eg when flowering fails in preferred habitats), they also use other woodland types and wet lowland coastal forest dominated by *Eucalyptus robusta* (Swamp Mahogany) or *Eucalyptus maculata* (Spotted Gum).	1	None – suitable habitat not present	Species
Australasian Bittern *(Botaurus poiciloptilus)*	E	E	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats. Found along the east coast and in the Murray-Darling Basin, notably in floodplain wetlands of the Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers. Favours permanent shallow waters, edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate. Also occurs in *Muehlenbeckia florulenta* (Lignum) and *Eragrostis australasica* (Canegrass) on inland wetlands.	2	None – suitable habitat not present	Species (land containing brackish or freshwater wetlands)
Bush Stone-curlew *(Burhinus grallarius)*	E	-	Associated with dry open woodland with grassy areas, dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland. Forages in areas with fallen timber, leaf litter, little undergrowth and where grass is short and patchy. Is thought to require large tracts of habitat to support breeding, in which there is a preference for a sparely vegetated understorey.	5	None – suitable habitat not present. No records in locality	Ecosystem
Curlew Sandpiper *(Calidris ferruginea)*	E	CE	Occurs in intertidal mudflats of estuaries, lagoons, mangrove channels; around lakes, dams, floodwaters, flooded saltbush surrounds of inland lakes.	168	None – suitable habitat not present. No records in locality	Ecosystem

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Great Knot *(Calidris tenuirostris)*		CE; Mi	Sheltered coastal habitats containing large intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and inlets, or exposed reefs or rock platforms.	5	None – suitable habitat not present. No records in locality	Ecosystem
Glossy Black-Cockatoo *(Calyptorhynchus lathami)*	V	-	Associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils. Intact drier forest types with less rugged landscapes are preferred. Nests in large trees with large hollows.	1	Low – suitable habitat not present	Ecosystem
Eastern Bristlebird *(Dasyornis brachypterus)*	E	E	Habitat is characterised by dense, low vegetation and includes sedgeland, heathland, swampland, shrubland, sclerophyll forest and woodland, and rainforest, as well as open woodland with a heathy understorey. In northern NSW, it occurs in open forest with tussocky grass understorey. All of these vegetation types are fire prone, aside from the rainforest habitats utilised by the northern population as fire refuge.	-	None – suitable habitat not present. No records in locality	Species Dense (>80% projected cover) heath/sedgeland or woodland with dense heath understorey
White-fronted Chat *(Epthianura albifrons)*	V	-	Endemic to Australia, in particular southern regions of Australia. In NSW it occupies temperate to arid habitats from foothills to 1000 m altitude In NSW the White-fronted Chat occurs in open habitats near the coast in close proximity to waterways including estuaries, saltmarsh or marshy wetlands.	4	None – suitable habitat not present. No records in locality	Ecosystem
Red Goshawk *(Erythrotriorchis radiatus)*	E	V	Associated with forests and woodlands with a mosaic of vegetation types, an abundance of birds and permanent water. In NSW, this species is thought to favour mixed subtropical rainforest, Melaleuca Swamp Forest, and open eucalypt forest along rivers, often in rugged terrain. The Red Goshawk nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within 1 km of permanent water.	1	None – suitable habitat not present	Not provided for Sydney Metro CMA
Black Falcon *(Falco subniger)*	V	-	Has broad range across inland regions New South Wales, where it has a sparse distributed. However, there are reports of 'Black Falcons' occurring on the tablelands and along the NSW coast. These reports are likely to represent Brown Falcons. In New South Wales there is assumed to be a single population that is continuous with a broader continental population, given that falcons are highly mobile, commonly travelling over hundreds of kilometres.	1	None – suitable habitat not present	Not provided in BioNet

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Little Lorikeet *(Glossopsitta pusilla)*	V	-	In New South Wales they are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to Albury, Parkes, Dubbo and Narrabri. Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands *Eucalyptus albens* (White Box) and *Eucalyptus melliodora* (Yellow Box) are particularly important food sources for pollen and nectar respectively.	1	None – suitable habitat not present. No records in locality	Ecosystem
Painted Honeyeater *(Grantiella picta)*	V	V	A nomadic species that typically inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests with abundant mistletoe. It is a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias, preferring *Amyema* sp. (Mistletoe).	-	None – suitable habitat not present. No records in locality	Ecosystem
Little Eagle *(Hieraaetus morphnoides)*	V	-	The Little Eagle is widespread in mainland Australia, central and eastern New Guinea. The Little Eagle is seen over woodland and forested The population of Little Eagle in NSW is considered to be a single population. This species was recently listed as vulnerable due to a moderate reduction in population size based on geographic distribution and habitat quality lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest.	1	Low – suitable habitat not present	Ecosystem
Black Bittern *(Ixobrychus flavicollis)*	V	-	Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation. In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves.	1	None – suitable habitat not present	Species (land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation)

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Swift Parrot *(Lathamus discolor)*	E	CE	Breeds in Tasmania between September and January. Feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts. Favoured feed trees include winter flowering species such as *Eucalyptus robusta*, *Corymbia maculata, Corymbia gummifera, Eucalyptus sideroxylon, Eucalyptus albens* and *Eucalyptus tereticornis.* Box-ironbark habitat in drainage lines, and coastal forest in NSW is thought to provide food resources during periods of drought or low food abundance elsewhere.	1	None – suitable habitat not present	Ecosystem
Turquoise Parrot *(Neophema pulchella)*	V	-	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species. Spends much of the time on the ground foraging on seed and grasses. It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs.	1	None – suitable habitat not present	Ecosystem
Scarlet Robin *(Petroica boodang)*	V	-	Found in south-eastern and south-western Australia, as well as on Norfolk Island, from south of latitude 25°S from south-eastern Queensland along the coast of New South Wales (and inland to western slopes of Great Dividing Range) to Victoria and Tasmania, and west to Eyre Peninsula, South Australia. It lives in open forests and woodlands, but prefers rainforest habitats on Norfolk Island. During winter, it will visit more open habitats such as grasslands and will be seen in farmland and urban parks and gardens at this time.	1	None – suitable habitat not present	Ecosystem
Flame Robin *(Petroica phoenicea)*	V	-	Flame Robins are found in a broad coastal band around the south-east corner of the Australian mainland, from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. Flame Robins prefer forests and woodlands up to about 1800 m above sea level.	1	None – suitable habitat not present	Ecosystem
Superb Fruit-Dove *(Ptilinopus superbus)*	V	-	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees. Part of the population is migratory or nomadic. At least some of the population, particularly young birds, moves south through Sydney, especially in autumn. Breeding takes place from September to January.	7	Low – suitable habitat not present	Ecosystem
Diamond Firetail *(Stagonopleura guttata)*	V	-	Typically found in grassy eucalypt woodlands, but also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. It is often found in riparian areas and sometimes in lightly wooded farmland. Appears to be sedentary, though some populations move locally, especially those in the south.	1	None – suitable habitat not present. No records in locality	Ecosystem
Freckled Duck *(Stictonetta naevosa)*	V	-	Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters.	1	None – suitable habitat not present	Ecosystem

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
AVES (NOCTURNAL)						
Powerful Owl *(Ninox strenua)*	V	-	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes. Large trees with hollows at least 0.5 m deep are required for shelter and breeding.	102	Low – suitable roosting habitat not present. Marginal foraging habitat may be present within site	Ecosystem
Masked Owl *(Tyto novaehollandiae)*	V	-	Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland and especially the ecotone between wet and dry forest, and non-forest habitat. Known to utilise forest margins and isolated stands of trees within agricultural land and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained.	1	None – suitable roosting habitat not present	Ecosystem
Sooty Owl *(Tyto tenebricosa)*	V	-	Associated with tall wet old growth forest on fertile soil with a dense under-storey and emergent tall Eucalyptus. Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes caves. Typically associated with an abundant and diverse supply of prey and a selection of large tree hollows.	1	None – suitable roosting habitat not present	Ecosystem
MAMMALS (BATS)						
Large-eared Pied Bat *(Chalinolobus dwyeri)*	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces.	-	None – suitable habitat not present. No records in locality	Ecosystem and Species (land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels)
Little Bentwing-bat *(Miniopterus australis)*	V	-	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. It known to roost in caves, hollows and structures.	1	None – targeted surveys did not record this species. Suitable habitat not present	Ecosystem and Species
Eastern Bentwing-bat *(Miniopterus schreibersii oceanensis)*	V	-	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland. It forages above and below the tree canopy on small insects. Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter. Returns to known limestone cave maternal breeding sites in winter.	53	Recorded – targeted surveys	Ecosystem and Species (land containing caves or similar structures)

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Eastern Freetail-bat *(Mormopterus norfolkensis)*	V	-	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range. Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges. Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut.	10	None – targeted surveys did not record this species. Suitable breeding habitat not present	Ecosystem
Southern Myotis *(Myotis macropus)*	V	-	Occupies moist habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, as long as they are close to water. While roosting it is most commonly associated with caves, but has been observed to roost in tree hollows, amongst vegetation, in clumps of Pandanus, under bridges, in mines, tunnels and stormwater drains. Species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used.	9	None – targeted surveys did not record this species. Suitable breeding habitat not present	Ecosystem and Species (hollow-bearing trees, bridges, caves or artificial structures within 200 m of riparian zone)
Yellow-bellied Sheathtail-bat *(Saccolaimus flaviventris)*	V	-	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland, open country, mallee, rainforests, heathland and waterbodies. Roosts in tree hollows, but may also use caves; and has also been recorded in abandoned sugar glider nests. Dependent on hollows to provide roosts, which may be a limiting factor on populations in cleared or fragmented habitats.	-	Recorded Possible call from targeted surveys - foraging activity.	Ecosystem
Grey-headed Flying-fox *(Pteropus poliocephalus)*	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. Camps are often located in gullies, typically close to water, in vegetation with a dense canopy.	275	High – suitable foraging habitat only. No camps or roost sites within the site	Ecosystem and Species (Species credit species only if impacts occur to known camps or roost sites)
MAMMALS						
Long-nosed Bandicoot population in inner western Sydney *(Perameles nasuta)*	EP	-	The Long-nosed Bandicoot is a medium sized marsupial with an extensive distribution throughout eastern Australia. The inner western Sydney population is restricted to the inner city suburbs within the Marrickville and Canada Bay LGAs where it shelters beneath older houses and buildings and forages in parks and back yards. The full distribution of this species is unknown and may occur over a broader region.	25	Low – potential habitat limited. Not recorded during targeted surveys as part of the Rozelle Rail Yards REF Biodiversity Assessment.	Species
Eastern Quoll *(Dasyurus viverrinus)*	E	CE	Associated with a variety of habitats, including dry sclerophyll forest, shrub, heath land, riparian forests and agricultural areas. Requires features such as hollow logs and rock piles for shelter.	1	None – suitable habitat not present	Not provided in BioNet

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Spotted-tailed Quoll SE mainland population) *(Dasyurus maculatus maculatus)*	V	E	It inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests, more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in. Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows.	-	None – suitable habitat not present. No records in locality	Ecosystem
Greater Glider *(Petauroides volans)*	-	V	The greater glider is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and Woodlands. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	-	None – suitable habitat not present. No records in locality	Not provided in BioNet
Brush-tailed Rock-wallaby *(Petrogale penicillata)*	E	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices.	-	None – suitable habitat not present. No records in locality	Species (land within 1km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines)
Koala (Combined populations of Qld, NSW and the ACT). *(Phascolarctos cinereus)*	V	V	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70 per cent, with acceptable Eucalypt food trees. Some preferred Eucalyptus species are: *Eucalyptus tereticornis, Eucalyptus punctata, Eucalyptus cypellocarpa* and *Eucalyptus viminalis.*	-	None – suitable habitat not present. No records in locality	Species
Southern Brown Bandicoot (Eastern) *(Isoodon obesulus obesulus)*	E	E	Associated with heath, coastal scrub, sedgeland, heathy forests, shrubland and woodland on well drained, infertile soils, within which they are typically found in areas of dense ground cover. Suitable habitat includes patches of native or exotic vegetation which contain understorey vegetation structure with 50–80 per cent average foliage density in the 0.2–1 m height range. Is thought to display a preference for newly regenerating heathland and other areas prone to fire, but requires a mosaic of burnt and unburnt areas for survival.	-	None – suitable habitat not present. No records in locality	Species
New Holland Mouse *(Pseudomys novaehollandiae)*	-	V	A small burrowing native rodent with a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Inhabits open heathlands, open woodlands with a heathland understorey and vegetated sand dunes. A social animal, living predominantly in burrows shared with other individuals. The home range of the New Holland Mouse ranges from 0.44 ha to 1.4 ha and the species peaks in abundance during early to mid-stages of vegetation succession typically induced by fire.	-	None – suitable habitat not present. No records in locality	Ecosystem

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
MIGRATORY SPECIES						
Common Sandpipe *(Actitis hypoleucos)*		Mi	In Australia, it is found in coastal or inland wetlands, both saline and fresh. It is found mainly on muddy edges or rocky shores. During the breeding season in the northern hemisphere, it prefers freshwater lakes and shallow rivers.	5	None – suitable habitat not present	Not applicable
Fork-tailed Swift *(Apus pacificus)*	-	Mi	Sometimes travels with Needletails. Varied habitat with a possible tendency to more arid areas but also over coasts and urban areas.	6	None – suitable habitat not present	Not applicable
Wedge-tailed Shearwater *(Ardenna pacificus)*	-	Mi	The Wedge-tailed Shearwater is a pelagic, marine bird known from tropical and subtropical waters. The species tolerates a range of surface-temperatures and salinities, but is most abundant where temperatures are greater than 21 °C and salinity is greater than 34.6 %.	4	None – suitable habitat not present	Not applicable
Ruddy Turnstone *(Arenaria interpres)*	-	Mi	Frequents beaches along the coast of NSW. Flies from Siberia or Alaska to Australia in August - September each year (ibid).	5	None – suitable habitat not present	Not applicable
Sharp-tailed Sandpiper *(Calidris acuminata)*	-	Mi	It prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewerage treatment ponds, flooded grasslands, mudflats, mangroves, rocky shores and beaches.	69	None – suitable habitat not present	Not applicable
Sanderling *(Calidris alba)*	-	Mi	Occurs in coastal areas on low beaches, near reefs and inlets along tidal mudflats and bare open coastal lagoons. Rarely seen in near-coastal wetlands such as lagoons, hypersaline lakes, salt ponds and samphire flats.	2	None – suitable habitat not present	Not applicable
Red Knot *(Calidris canutus)*	-	Mi	Red Knots are widespread around the Australian coast, less in the south and with few inland records. Small numbers visit Tasmania and off-shore islands. It is widespread but scattered in New Zealand. They breed in North America, Russia, Greenland and Spitsbergen. Red Knots are a non-breeding visitor to most continents.	8	None – suitable habitat not present.	Not applicable
Pectoral Sandpiper *(Calidris melanotos)*	-	Mi	Prefers shallow fresh to saline wetlands, found at coastal lagoons, estuaries, bays, swamps, inundated grasslands, saltmarshes and artificial wetlands. This species breeds in the Northern Hemisphere.	9	None – suitable habitat not present	Not applicable
Red-necked Stint *(Calidris ruficollis)*	-	Mi	The Red-necked Stint breeds in north-eastern Siberia and northern and western Alaska. It follows the East Asian-Australasian Flyway to spend the southern summer months in Australia. It is found widely in Australia, except in the arid inland. In Australia, Red-necked Stints are found on the coast, in sheltered inlets, bays, lagoons, estuaries, intertidal mudflats and protected sandy or coralline shores. They may also be seen in salt works, sewage farms, saltmarsh, shallow wetlands including lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in salt flats, flooded paddocks or damp grasslands. They are often in dense flocks, feeding or roosting.	141	None – suitable habitat not present	Not applicable

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Greater Sand-plover *(Charadrius leschenaultii)*	-	Mi	Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries, roosting during high tide on sandy beaches or rocky shores.	4	None – suitable habitat not present	Not applicable
Lesser Sand-plover *(Charadrius mongolus)*	-	Mi	Favours coastal areas including beaches, mudflats and mangroves where they forage. They may be seen roosting during high tide on sandy beaches or rocky shores.	4	None – suitable habitat not present	Not applicable
Oriental Cuckoo *(Cuculus optatus)*	-	Mi	It mainly inhabits forests, occurring in coniferous, deciduous and mixed forest. It feeds mainly on insects and their larvae, foraging for them in trees and bushes as well as on the ground.	-	None – suitable habitat not present. No records in locality	Not applicable
Latham's Snipe *(Gallinago hardwickii)*	-	Mi	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover. Occupies a variety of vegetation around wetlands including wetland grasses and open wooded swamps.	9	None – suitable habitat not present	Not applicable
Sooty Oystercatcher *(Haematopus fuliginosus)*	-	Mi	A coastal species that inhabits rock coastlines, coral cays, reefs and occasionally sandy beaches.	1	None – suitable habitat not present	Not applicable
Pied Oystercatcher *(Haematopus longirostris)*	-	Mi	Roosts and forages on sandy beaches, sand banks, mudflats and estuaries.	4	None – suitable habitat not present	Not applicable
White-bellied Sea-Eagle *(Haliaeetus leucogaster)*	-	Mi	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas. Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away.	25	None – suitable habitat not present	Not applicable
White-throated Needletail *(Hirundapus caudacutus)*	-	Mi	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas. Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather.	4	None – suitable habitat not present	Not applicable
Caspian tern *(Hydrophone caspia)*	-	Mi	The Caspian Tern is mostly found in sheltered coastal embayment's (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and salt works.	3	None – suitable habitat not present	Not applicable

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Broad-billed Sandpipe *(Limicola falcinellus)*	V	Mi	It breeds in northern Siberia before migrating southwards in winter to Australia on the northern coast, particularly in the north-west, with birds located occasionally on the southern coast. In NSW, the main site for the species is the Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary. Broad-billed Sandpipers favour sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayment's, lagoons, saltmarshes and reefs as feeding and roosting habitat.	2	None – suitable habitat not present	Not applicable
Bar-tailed Godwit *(Limosa lapponica)*	-	Mi	Mainly coastal, usually sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats. Breeds in Northern Russia, Scandinavia, NW Alaska.	165	None – suitable habitat not present	Not applicable
Black-tailed Godwit *(Limosa limosa)*	-	Mi	Primarily found along the coast on sand spits, lagoons and mudflats. The species has also been found to occur inland on mudflats or shallow receding waters of portions of large muddy swamps or lakes.	6	None – suitable habitat not present	Not applicable
Rainbow Bee-eater *(Merops ornatus)*	-	Mi	Resident in coastal and subcoastal northern Australia; regular breeding migrant in southern Australia, arriving September to October, departing February to March. Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs.	-	None – suitable habitat not present. No records in locality	Not applicable
Black-faced Monarch *(Monarcha melanopsis)*	-	Mi	Occurs in rainforest and eucalypt forests, feeding in tangled understorey.	-	None – suitable habitat not present. No records in locality	Not applicable
Spectacled Monarch *(Monarcha melanopsis)*	-	Mi	Occurs in rainforest and eucalypt forests, feeding in tangled understorey.	-	None – suitable habitat not present. No records in locality	Not applicable
Yellow Wagtail *(Motacilla flava)*	-	Mi	An insectivorous bird, inhabiting open country near water, such as wet meadows. It nests in tussocks.	-	None – suitable habitat not present. No records in locality	Not applicable
Satin Flycatcher *(Myiagra cyanoleuca)*	-	Mi	Occurs in wet, dense forest, often at high elevations.	-	None – suitable habitat not present. No records in locality	Not applicable
Eastern Curlew *(Numenius madagascariensis)*	-	CE	Intertidal coastal mudflats, coastal lagoons, sandy spits. Breeds in Russia and north-east China.	3	None – suitable habitat not present	Not applicable

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Little Curlew *(Numenius minutus)*	-	Mi	The Little Curlew is known to breed in Siberia, with migrants arriving after early April. Southern migration begins in September following the Chinese coast and, after a staging in Mongolia, continues to Northern Australia and New Guinea. Outside of the breeding season, the species inhabits grasslands, open plains, parklands and mud-flats of Northern Australia.	2	None – suitable habitat not present	Not applicable
Whimbrel *(Numenius phaeopus)*	-	Mi	Known to occur in intertidal coastal mudflats, river deltas and mangrove and occasionally at sandy beaches. It breeds in Siberia and Alaska.	1	None – suitable habitat not present	Not applicable
Pacific Golden Plover *(Pluvialis fulva)*	-	Mi	The Pacific Golden Plover breeds in North Siberia and Alaska. It occurs mainly in coastal areas, at beaches, mudflats, sandflats and other open areas such as recreational playing fields in Australia.	38	None – suitable habitat not present	Not applicable
Rufous Fantail *(Rhipidura rufifrons)*	-	Mi	Summer breeding migrant to south-eastern Australia. The Rufous Fantail is found in rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation. Open country may be used by the Rufous Fantail during migration.	-	None – suitable habitat not present. No records in locality	Not applicable
Common Tern *(Sterna hirundo)*	-	Mi	Common Terns are marine, pelagic and coastal. In Australia, they are recorded in all marine zones, but are commonly observed in near-coastal waters, both on ocean beaches, platforms and headlands and in sheltered waters, such as bays, harbours and estuaries with muddy, sandy or rocky shores.	15	None – suitable habitat not present	Not applicable
Little Tern *(Sternula albifrons)*	E	Mi	The Little Tern is almost exclusively coastal, preferring sheltered areas. However, it may occur several kilometres inland in harbours, inlets and rivers. Australian birds breed on sandy beaches and sand spits.	30	None – suitable habitat not present	Species Land within 40 m of inshore coastal waters or shallow waters of estuaries, coastal lagoons and/or lakes)
Grey-tailed Tattler *(Tringa brevipes)*	-	Mi	The Grey-tailed Tattler is found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. It can also be found at intertidal rocky, coral or stony reefs as well as platforms and islets that are exposed at low tide.	3	None – suitable habitat not present	Not applicable
Wood Sandpiper *(Tringa glareola)*	-	Mi	The Wood Sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially Melaleuca and River Red Gums.	2	None – suitable habitat not present	Not applicable

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Common Greenshank *(Tringa nebularia)*	-	Mi	Found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayment's, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms.	2	None – suitable habitat not present	Not applicable
Marsh Sandpiper *(Tringa stagnatilis)*	-	Mi	The Marsh Sandpiper occurs in coastal areas, in permanent or ephemeral wetlands of varying degrees of salinity, commonly inland. It breeds in Eastern Europe to Eastern Siberia and migrates to Australia during the northern hemisphere winter months.	2	None – suitable habitat not present	Not applicable
Terek Sandpiper *Xenus cinereus*	V	Mi	In Australia, it has been recorded on coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 km inland around brackish pools.	4	None – suitable habitat not present	Ecosystem

Annexure B – Species recorded

Table B.1: Flora species recorded during the field surveys.

Species Name	Common Name	Noxious Weed Status
Native		
^*Acacia baileyana*	Cootamundra Wattle	
^*Acacia longifolia* subsp. *sophorae*	Coastal Wattle	
^*Acacia saligna*	Golden Wreath Wattle	
Alisma plantago-aquatica	Water Plantain	
Angophora costata	Smooth-bark Apple	
Banksia integrifolia	Coast Banksia	
^*Callistemon citrinus*	Crimson Bottlebrush	
Casuarina glauca	Swamp Oak	
^*Corymbia maculata*	Spotted Gum	
Cyathea cooperi	Australian Tree Fern	
^*Cynodon dactylon*	Couch	
Dianella sp.	Blue Flax Lily	
^*Eucalyptus pilularis*	Blackbutt	
Eucalyptus resinifera?	Red Mahogany	
Eucalyptus sp.	Eucalypt	
^*Eucalyptus* spp. *(planted)*	Eucalypt	
^*Ficus* sp.	Fig Tree	
^*Grevillea robusta*	Southern Silky Oak	
Juncus usitatus	Common Rush	
Lomandra longifolia	Spiny-headed Mat-rush	
^*Melaleuca quinquenervia*	Broad-leaved Paperbark	
Pittosporum undulatum	Sweet Pittosporum	
Psilotum nudum	Skeleton Fork-Fern	
Pteridium esculentum	Bracken	
^*Typha orientalis*	Cumbungi	
Exotic		
**Acetosa sagittata*	Turkey Rhubarb	
**Ageratina adenophora*	Crofton Weed	
**Andropogon virginicus*	Whiskey Grass	
**Anredera cordifolia*	Madeira Vine	WoNS
**Asparagus asparagoides*	Bridal Creeper	Class 5. WoNS

Species Name	Common Name	Noxious Weed Status
**Axonopus fissifolius*	Common Carpetgrass	
**Bidens pilosa*	Cobblers Peg	
**Briza maxima*	Quaking Grass	
**Celtis occidentalis*	Hackberry	
**Cenchrus echinatus*	Spiny Burr Grass	Class 5
**Cestrum parqui*	Green Cestrum	Class 3
**Chenopodium ambrosioides*	Wormseed	
**Chloris gayana*	Rhodes Grass	
**Cinnamomum camphora*	Camphor Laurel	
**Conyza* sp.	Fuzzweed	
**Cortaderia selloana*	Pampas Grass	Class 4
**Cotoneaster glaucophyllus*	Cotoneaster	
**Cyperus eragrostis*	Umbrella Sedge	
**Digitaria* sp.		
**Ehrharta erecta*	Panic Veldtgrass	
**Eragrostis curvula*	African Love Grass	
**Foeniculum vulgare*	Fennel	
**Fumaria* sp.	Common Fumitory	
**Gleditsia triacanthos*	Honey Locus	
**Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	
**Hypochaeris radicata*	Catsear	
**Ipomoea indica*	Morning Glory	
**Lantana camara*	Lantana	WoNS
**Ligustrum lucidum*	Large-leaved Privet	Class 4
**Ligustrum sinense*	Small-leaved Privet	Class 4
**Lolium* sp.	Rye Grass	
**Medicago* sp.	Medic	
**Melinis repens*	Red Natal Grass	
**Modiola caroliniana*	Red-flowered Mallow	
**Olea europaea*	African Olive	
**Oxalis* sp.	Oxalis	Class 5
**Panicum maximum*	Guinea Grass	
**Parietaria judaica*	Pellitory	Class 4
**Paspalum dilatatum*	Paspalum	
**Pennisetum clandestinum*	Kikuyu	

Species Name	Common Name	Noxious Weed Status
**Pennisetum alopecuroides*	Swamp Foxtail	
**Phoenix canariensis*	Canary Island Date Palm	
**Phyllostachys aurea*	Bamboo	
**Plantago lanceolata*	Ribwort	
**Ricinus communis*	Castor Oil Plant	Class 4
**Rubus fruticosus* agg.	Blackberry	Class 4. WoNS
**Sechium edule*	Choko	
**Senna pendula*	Cassia	
**Setaria* spp.	Pigeon Grass	
**Sida rhombifolia*	Paddy's Lucerne	
**Solanum nigrum*	Blackberry Nightshade	
**Solanum* sp.		
**Sonchus oleraceus*	Common Sowthistle	
**Stellaria media*	Common Chickweed	
**Triadica sebifera*	Chinese Tallow	
**Trifolium repens*	White clover	
**Trifolium* spp.	Clover	
**Ulmus parvifolia*	Chinese Elm	
**Verbascum virgatum*	Twiggy Mullein	
**Verbena bonariensis*	Purple Tops	
**Vicia sativa* subsp. *sativa*	Common Vetch	

^ denotes a non-indigenous or planted native species

Noxious weed class for the Inner West LGA:

- Class 3 – Regionally Controlled Weed; the plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed.
- Class 4 – Locally Controlled Weeds; that pose a threat to primary production, the environment or human health, are widely distributed in an area to which The Noxious Weeds (Weed Control) Order 2014 applies and are likely to spread in the area or to another area.
- Class 5 – The requirements in the *Noxious Weeds Act 1993* (NSW) for a notifiable weed must be complied with.
- WoNs – Weed of National Significance.

Annexure C – Secretary's Environmental Assessment Requirements for Biodiversity and Department of Primary Industries requirements

Table 12.1 The Secretary's Environmental Assessment Requirements (SEARs) for biodiversity. Extracted from the SEARs for the project (SSI 16_7485) and are detailed in the EIS.

Key Issue and desired performance outcome	Requirement (specific assessment requirements in addition to the general requirements)	Current guidelines
6. **Biodiversity** The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.	1. The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA) and be carried out by a person accredited in accordance with section 142B(1)(c) of the *Threatened Species Conservation Act, 1995*. 2. The Proponent must assess any impacts on biodiversity values not covered by the FBA. Impacts on species, populations and ecological communities that will require further consideration and provision of information specified in section 9.2 of the FBA include any identified through consultation with the OEH. Species specific surveys shall be undertaken for those species and in accordance with the survey requirements specified by the OEH. The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the *Threatened Species Conservation Act 1995* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environmental Protection and Biodiversity Conservation Act 2000* (EPBC Act).	NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014) Framework for Biodiversity Assessment (OEH, 2014) Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013 (DPI, 2013) Threatened Species Survey and Assessment Guidelines (DEC 2004) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003) NSW Sustainable Design Guidelines Version 3.0 (Transport for NSW, 2013) Aquatic Ecology in Environmental Impact Assessment – EIA Guideline (Marcus Lincoln Smith 2003)

Table 12.2 Department of Primary Industries (DPI) (Water and Fisheries) requirements for the SEARs in relation to biodiversity. Extracted from the DPI request for SEARs requirements.

Key Issue and desired performance outcome	Requirement (specific assessment requirements in addition to the general requirements)	Current guidelines
DPI Water (requirements relating to the BAR). NB: Other requirements from DPI Water, not outlined here are provided elsewhere in the EIS	**Groundwater Dependent Ecosystems** The EIS must consider the potential impacts on any Groundwater Dependent Ecosystems (GDEs) at the site and in the vicinity of the site and: · Identify any potential impacts on GDEs as a result of the proposal including: o the effect of the proposal on the recharge to groundwater systems; o the potential to adversely affect the water quality of the underlying groundwater system and adjoining groundwater systems in hydraulic connections; and o the effect on the function of GDEs (habitat, groundwater levels, connectivity) · Provide safeguard measures for any GDEs. **Watercourses, Wetlands and Riparian Land** The EIS should address the potential impacts of the project on all watercourses likely to be affected by the project, existing riparian vegetation and the rehabilitation of riparian land. It is recommended the EIS provides details on all watercourses potentially affected by the proposal, including: · Scaled plans showing the location of: o wetlands/swamps, watercourses and top of bank; o riparian corridor widths to be established along the creeks; o existing riparian vegetation surrounding the watercourses (identify any areas to be protected and any riparian vegetation proposed to be removed); o the site boundary, the footprint of the proposal in relation to the watercourses and riparian areas; and o proposed location of any asset protection zones. · Photographs of the watercourses / wetlands and a map showing the point from which the photos were taken. · A detailed description of all potential impacts on the watercourses/riparian land. · A detailed description of all potential impacts on the wetlands, including potential impacts to the wetlands hydrologic regime; groundwater recharge; habitat and any species that depend on the wetlands. · A description of the design features & measures to be incorporated to mitigate potential impacts. · Geomorphic and hydrological assessment of water courses including details of stream order (Strahler System), river style and energy regimes both in channel and on adjacent floodplains.	NSW Guidelines for Controlled Activities on Waterfront Land (NOW, 2012) NSW Aquifer Interference Policy (NOW, 2012) Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NOW, 2012) Australian Groundwater Modelling Guidelines (NWC, 2012) The NSW State Rivers and Estuaries Policy (1993) NSW Wetlands Policy (2010) NSW State Groundwater Policy Framework Document (1997) NSW State Groundwater Quality Protection Policy (1998) NSW State Groundwater Dependent Ecosystems Policy (2002) NSW Water Extraction Monitoring Policy (2007)

DPI Fisheries (requirements relating to the BAR). **NB: Other requirements from DPI Fisheries, not outlined here are provided elsewhere in the EIS**	**General Requirements** · Site address and contact details. · Property description (eg Lot and DP numbers). · A clear description of the proposal including details of construction methods and materials. · Map(s) of the development area and adjacent areas - this should include nearby waterways, adjacent infrastructure (such as jetties) and land use. · Clear photographs of the site (at low and high tide in estuaries), including photographs of any riparian and aquatic vegetation present (including pest species such as *Caulerpa taxifolia*). · A clear description of the physical and hydrological features of the development area (which may extend upstream and downstream of the development site in the case of flowing rivers or tidal waterways). · A clear description of aquatic environments including: o an aquatic and riparian vegetation survey map (where relevant) of the area which shows the location and/or coverage of saltmarsh, mangrove, seagrass, macroalgae, macrophytes, riparian vegetation and snags, · Details of the nature, timing, magnitude and duration of the proposed disturbance to the aquatic environment. · Assessments of predicted impacts upon any threatened species (fish and marine vegetation) (i.e. completion of a 7-part test and/or species impact statement(s)) and other aquatic flora and fauna. · Details of any mitigation measures to limit environmental impacts. · Details of the general regional context, any protected areas, other developments in the area, and/or cumulative impacts. · A copy of the land owner's consent where relevant. · Notification of any other matters relevant to the particular proposal and of interest to NSW DPI.	

Annexure D – Anabat survey results

METHODS

Two anabats ultrasonic call recorders (anabat) were set over two consecutive nights between the 21 and 22 September 2016. Each anabat was programed to record microbat calls across the entire night beginning at 5.30 pm and ceasing at 6.00 am the next morning. The overall survey effort was four anabat-survey nights. Each anabat was set to survey a particular habitat type as described below:

- B32RRG – Vegetated rock wall and vegetated drainage line.
- SN81147 –Victoria Road bridge.
- SN81997 – Mostly un-vegetated rock wall, well-lit area near large shed and crib rooms.
- SN81781 – Underground cement culvert that water flowing in the vegetation drainage line flows into.

Additional early evening surveys were undertaken to confirm that the high levels of activity among *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) obtained during the initial anabat survey, was not a random event. This involved anabat units being set to record beneath the Victoria Road bridge between 6.30pm and 7.45am on 27 September 2016. A visual assessment of the structures below the bridge was undertaken during the day and at night to determine the likelihood of microbats (in particular the cave and culvert dwelling Eastern Bentwing-bat) roosting there and to watch for bats as they enter or leave these potential roosts.

Data analysis

Bat calls were analysed by Dr Rodney Armistead using the program AnalookW (Version 3.8 25 October 2012, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW. Available at http://www.forest.nsw.gov.au/research/bats/default.asp.

Bat calls are analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Rinehold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et. al. 2006) were followed:

- Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al. 2002).
- Recordings containing less than three pulses were not analysed and these sequences were labelled as short (Law et al. 1999).
- Four categories of confidence in species identification were used (Mills et al. 1996):
  - definite – identity not in doubt
  - probable – low probability of confusion with species of similar calls
  - possible – medium to high probability of confusion with species with similar calls
  - unidentifiable – calls made by bats which cannot be identified to even a species group.
- *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004).
- Sequences not attributed to microbat echolocation calls were labelled as junk or non-bat calls and don't represent microbat activity at the site.
- Sequences labelled as low were of poor quality and therefore not able to be identified to any microbat species, they can however be used as an indicator of microbat activity at the site.

RESULTS

There were 210 sequences recorded on the four anabat detectors. Of these, 160 (76.19%) were of sufficient quality or length to enable positive identified to genus or species. The remaining sequence were either to short or of low quality, thus preventing positive identification.

There were at least five microbat species identified in this survey, including two species listed as vulnerable under the *Threatened Species Conservation Act 1995* (TSC Act) (Table D.1 – Table D.7). The two threatened species that were recorded during this survey:

- Miniopterus schreibersii oceanensis (Eastern Bentwing-bat)
- Saccolaimus flaviventris (Yellow-bellied Sheathtail Bat)

The species diversity was similar across all survey sites, with at least two species being recorded at each site (Table D.1). The most commonly recorded species was the threatened Eastern Bentwing-bat (Table D.2 – Table D.7). This species was recorded at three of the four survey sites. Very high levels of activity among Eastern Bentwing-bats was recorded at the Victoria Road bridge (Table D.3, Table D.6 and Table D.7).

The high levels of activity among Eastern Bentwing-bats witnessed during the initial surveys were supported during the early evening surveys conducted on the 27 September 2016. The high level of activity will be confirmed over subsequent surveys. Roosting among Eastern Bentwing-bats primarily occurs in caves, mines, culverts, stormwater channels, buildings, and occasionally tree-hollows (Hall et al. 2008). According to the anabat data recorded over the three survey periods undertaken at the bridge, activity among this species begun at dusk, continued throughout the evening and into the early morning. This does not provide conclusive evidence that this species is roosting in the bridge, but strongly suggest that it is likely. Indeed, the visual assessment of the bridge identified several small openings of suitable diameter (approximately 200 mm across) to allow Eastern Bentwing-bats to enter, roost and leave. The depth of these structures could not be determined. Further surveys involving an internal investigation (eg burrow-scope) of these structures will be required to provide conclusive evidence that bats are roosting beneath the bridge.

Further, whilst conducting this visual assessment, several Eastern Bentwing-bats were observed flying rapidly beneath the bridge and among the nearby vegetation. Identification of the flying microbats was made after analysing calls recorded on a hand held anabat. It is possible that, in addition to these microbats roosting below the bridge, they are using it as a fly-way to avoid the well-lit road and pedestrian footpath above the bridge. Previous research has shown that microbat could avoid areas lit by artificial street lights because of the following reasons:

- Artificial light could reduce a microbats ability to capture prey because it interferes with their ultrasonic-navigation systems.
- Artificial light increases the ambient temperatures surrounding the light source, that could enhance insect activity (movement and manoeuvrability, rather than densities), making them more difficult for the microbats to capture them.
- Artificial light could affect a microbats perception of being predated upon.

These reasons, in isolation and collectively, could encourage microbats to forage elsewhere in the landscape, away from the artificial lighting, such as the area below the Victoria Road bridge (Linley 2015).

Activity

Activity levels were spread across the night with the majority of the bat activity occurring in the evening and early mornings. Generally, single bat calls were recorded every five minutes across the three sites. The greatest level of activity was recorded at Victoria Road bridge with the numerous Eastern Bentwing-bat calls previously discussed (Table D.3).

Most of the bat calls that were recorded during this survey were clear, often long and easily interpreted. A few feeding buzzes were observed in the data set, indicating that bats were also likely to be actively foraging at the site.

Survey Limitations

Calls were only positively identified when defining characteristics were present such as call shape and when the characteristic frequency allowed discrimination of a species. In this survey, there

were only a small number of species with similar call profile that could not be positively identify to species level. Where this was apparent, species with similar call profiles were lumped together into groups of two or three potential species depending on the recorded, and defining all call characteristics. When this occurred these calls were assigned to the lowest certainty level of 'possible' (Table D.1 – Table D.3).

The calls of and Eastern Bentwing-bat and *Vespadelus regulus* (Southern Forest Bat) can be difficult to separate in the range 43.5 – 46 kHz. Alternatively, calls with curved, often down sweeping tails were generally identified as Eastern Bentwing-bat. Alternatively, those calls with even consecutive pulses were identified as being from Southern Forest Bat (Penny et al. 2004). When no distinguishing characteristics were present within the calls, they were assigned as Southern Forest Bat / Eastern Bentwing-bat.

No Southern Forest Bat were recorded, all of these calls were identified as Eastern Bentwing-bat
The call profiles that were difficult to separate are not shown in this document as all of the species discussed were positively identified.

Table D.1: Microbat species diversity recorded during the Rozelle survey between 30 March and 10 April 2016

Species Name	Common Name	B3266RG		SN81147		SN81997		SN81781	
		Rock wall		Victoria Road bridge		Rock wall		Culvert	
		Positive	Possibly	Positive	Possibly	Positive	Possibly	Positive	Possibly
Austronomus australis	White-striped Freetail Bat	X		X					
Chalinolobus gouldii	Gould's Wattled Bat						X		X
Miniopterus schreibersii (*orianae*) *oceanensis**	Eastern Bentwing-bat			X		X			X
Rhinolophus megaphyllus	Eastern Horseshoe Bat				X				
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat		X		X				X
Species Diversity (Positive identification)		**1**		**2**		**1**		**1**	
Species Diversity (Possible)			**1**		**2**		**1**		**2**
Total (at least) number of species		**2**		**4**		**2**		**3**	

* Threatened species listed under TSC Act

[1] Threatened species listed under the EPBC Act

Table D.2: Anabat results for B3266RG located near rock wall across the 21 and 22 September 2016 (two survey nights)

Species Name	Common name	Positive	Potential	Possible	Total
Austronomus australis	White-striped Free-tailed Bat	2	2	0	4
Saccolaimus flaviventris	Yellow-bellied Sheathtailbat	0	4	0	4
Low					**2**
Short					**0**
Useable calls					**8**
Total Calls					**9**
Percentage usable calls					**88.89**

* Threatened species

Table D.3: Anabat results for SN81147 located near Victoria Road bridge between 21 and 22 September 2016 (two survey nights)

Species Name	Common name	Positive	Potential	Possible	Total
Austronomus australis	White-striped Free-tailed Bat	1	6	3	10
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	102	2	0	104
Rhinolophus megaphyllus	Eastern Horseshoe Bat	0	1	0	1
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	0	4	0	4
Low					**23**
Short					**13**
Useable calls					**119**
Total Calls					**155**
Percentage usable calls					**76.77**

* Threatened species

Table D.4: Anabat results for SN81781 near a cement underground culvert across 21 and 22 September 2016 (two survey nights)

Species Name	Common name	Positive	Potential	Possible	Total
Chalinolobus gouldii	Goulds Wattled Bat	0	0	1	1
*Miniopterus schreibersii (orianae) oceanensis****	Eastern Bentwing-bat	16	5	0	21
Low					2
Short					1
Useable calls					**22**
Total Calls					**25**
Percentage usable calls					**88**

* Threatened species

Table D.5: Anabat results for SN81997 near rock wall near site office between 21 and 22 September 2016 (two survey nights)

Species Name	Common name	Positive	Potential	Possible	Total
Chalinolobus gouldii	Gould's Wattled Bat	1	2	0	3
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	0	1	1	2
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	0	0	7	7
Low					**9**
Short					**0**
Useable calls					**12**
Total Calls					**21**
Percentage usable calls					**57.14**

* Threatened species

Table D.6: Results of short term assessment undertaken at the bridge between 1830 and 1945 on 27 September using SN81081

Species Name	Common name	Positive	Potential	Possible	Total
Austronomus australis	White-striped Free-tailed Bat	0	1	0	1
Miniopterus orianae oceanensis	Eastern Bentwing-bat	40	0	0	40
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail-bat	1	0	1	2
Low					**3**
Short					**0**
Useable calls					**43**
Total Calls					**46**
Percentage usable calls					**93.47**

* Threatened species

Table D.7: Results of short term assessment undertaken at the bridge between 1830 and 1945 on 27 September using SN81147

Species Name	Common name	Positive	Potential	Possible	Total
Miniopterus orianae oceanensis	Eastern Bentwing-bat	12	0	1	13
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail-bat	0	0	2	2
Low					**0**
Short					**0**
Useable calls					**15**
Total Calls					**15**
Percentage usable calls					**100**

* Threatened species

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Annexure E – EPBC Act Significant Impact Criteria

The EPBC Act establishes a process for assessing the environmental impact of activities and developments where "Matters of national environmental significance" (MNES) may be affected. Under the Act, any action which "has, will have, or is likely to have a significant impact on a MNES" is defined as a "controlled action", and requires approval from the Commonwealth Department of the Environment and Energy (DotEE), which is responsible for administering the EPBC Act (DotEE 2013).

The process includes conducting an Assessment of Significance for listed threatened species and ecological communities that represent a matter of NES that will be impacted as a result of the proposed action. Significant impact guidelines (DotEE 2013) that outline a number of criteria have been developed by the Commonwealth, to provide assistance in conducting the Assessment of Significance and help decide whether or not a referral to the Commonwealth is required.

The threatened ecological values that are the subject this assessment include:

- Pteropus poliocephalus (Grey-headed Flying-fox)

Pteropus poliocephalus (Grey-headed Flying-fox)

The Grey-headed Flying-fox is listed as a vulnerable threatened species under the EPBC Act.
This species utilises a wide variety of habitats (including disturbed areas) for foraging, and have been recorded travelling long distances on feeding forays. Fruits and flowering plants of a wide variety of species are the main food source. The species roosts in large 'camps' of up to 200 000 individuals. Camps are usually formed close to water and along gullies, however, the species has been known to form camps in urban areas (DotEE 2016a).

Grey-headed Flying Fox has not been recorded on site but is known from within close proximity to the study area. The vegetation within the study area provides marginal potential foraging habitat in the form of individual Fig Trees (*Ficus* sp.) and limited flowering eucalyptus (planted street scapes). It is considered likely that this species would use the site and adjacent areas on occasion for foraging purposes. No roosting camps are located within the site.

Criterion a: lead to a long-term decrease in the size of an important population of a species

The population of Grey-headed Flying-fox within Australia is considered to be a single important population. However, the site does not support key resources for the important population for breeding or dispersal, or support resources necessary to maintain genetic diversity. Furthermore, the site is not at the limit of the species range or distribution.

Criterion b: reduce the area of occupancy of an important population

The population of Grey-headed Flying-fox within Australia is considered to be a single important population. However, the works are not considered to reduce the area of occupancy, as there will not be any impacts to a roosting camp, nor any impacts to important habitat for the species.

Criterion c: fragment an existing important population into two or more populations

The vegetation (foraging habitat) to be impacted by the works occurs within and on the edge of the subject site. Potential foraging habitat for this species is abundant throughout the locality, and the species is known to travel large distances for food sources. Whilst the habitat may contribute as a 'stepping stone' for this highly mobile species to other more substantial foraging habitat sites, this function is unlikely to be significantly inhibited by the works. Furthermore, this species has been recorded in urban environments and is likely to continue to forage adjacent to the site and across the broader locality. Therefore, the works will not fragment an existing important population into two or more populations.

Criterion d: adversely affect habitat critical to the survival of a species

No breeding habitat (camps) would be impacted by the project. However, approximately 4.49 ha of potential foraging habitat consisting of individual trees will be removed.

Under the DECC (2009b) Draft National Recovery Plan for the Grey-headed Flying-fox, foraging habitat within a 50 kilometre radius of a roost site with greater than 30,000 individuals is considered foraging habitat critical to survival. The closest roosting camps to the project footprint are at Centennial Park and Turrella can vary in number of individuals present, from zero up to 50,000 individuals at the Centennial Park camp (National Flying-fox monitoring viewer; DotEE 2015). In addition, the camp at Gordon can also range between zero to 80,000 (Ku-ring-gai Council 2013). Therefore, there is foraging habitat present which meets the definition of habitat critical to the survival of the species. However, the amount of loss of habitat is not considered to be significant in terms of the regional context. From analysis of the Native Vegetation mapping GIS dataset for the Sydney Metropolitan Area (OEH 2013), more than 75,000 (and up to 93,000) hectares of native vegetation occurs within 50km of each of these camps. Noting that the dataset is limited to the Sydney Metropolitan Catchment Management Authority area, and thus does not include all of the native vegetation within 50km of these camps.

Criterion e: disrupt the breeding cycle of an important population

Whilst the Grey-headed flying-fox population within Australia is considered to be a single important population, the study area does not support ‘camps’ of flying foxes, and therefore the works which may remove up to 4.49 ha of potential foraging habitat, is not considered to disrupt the breeding cycle of an important population.

Criterion f: modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The habitat to be removed consists of individual trees representing a negligible amount of potential foraging resources within the species foraging range. A number of areas providing potential habitat for this species are present in close proximity to the site, at nearby local parks and across the broader landscape. In consideration of the species foraging activity, widely across the landscape on a variety of vegetation, the loss of 4.49 hectares of potential foraging habitat within the project footprint is unlikely to cause a decline in the species.

Criterion g: Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species’ habitat

The proposed works will not result in the establishment of an invasive species that is harmful to the Grey-headed Flying-fox.

Criterion h: Introduce disease that may cause the species to decline

The proposed works will not result in the introduction of a disease that is harmful to the Grey-headed Flying-fox.

Criterion i: Interfere substantially with the recovery of the species

Considering the above factors, the proposed works will not interfere substantially with the recovery of the species.

Conclusion

In consideration of the above, the proposed works are not considered likely to have a significant impact on the Grey-headed Flying-fox, and therefore, an EPBC Act referral is not required.

Annexure F – FBA Methodology and where addressed in document

Table F-1: Location of FBA methodology requirements for a 'Biodiversity Assessment Report' for stages 1 and 2 and where these are addressed in this report.

Report section	Information	Maps & data	FBA reference	Section in this report
Introduction	Introduction to the biodiversity assessment including: • identification of development site footprint, including: ○ operational footprint ○ construction footprint indicating clearing associated with temporary construction facilities and infrastructure • general description of development site • sources of information used in the assessment, including reports and spatial data.	• Site Map (as described in Section 3.2) • Location Map (as described in Section 3.2) • Digital shape files for all maps and spatial data	Chapter 3 and Section 3.2	Chapter 1 – Introduction and Chapter 2 – The project
Landscape features	Identification of landscape features at the development site, including: • IBRA bioregions and subregions, NSW landscape region and area (ha) • native vegetation extent in the outer assessment circle or buffer area • cleared areas • evidence to support differences between mapped vegetation extent and aerial imagery • rivers and streams classified according to stream order • wetlands within, adjacent to and downstream of development site • landscape value score components, including: ○ identification of method applied (ie linear or site-based) ○ per cent native vegetation cover in the landscape ○ connectivity value ○ patch size ○ area to perimeter ration • landscape value score.	• IBRA bioregions and subregions (as described in Paragraphs 4.1.1.3–4) • NSW landscape regions (as described in Paragraphs 4.1.1.5– 6) • Rivers and streams (as described in Paragraphs 4.1.1.8–10 • Wetlands (as described in Paragraphs 4.1.1.11–13) • Other landscape features (as required by SEARs) • Native vegetation extent (as described in Paragraphs 4.1.1.12–15) • State, regional and local biodiversity links (as described in Paragraphs 4.1.1.16–17) • Regional vegetation used to calculate patch size	Section 4.1, Appendix 4 and Appendix 5	Chapter 3 – Landscape features

Report section	Information	Maps & data	FBA reference	Section in this report
Native vegetation	Identify native vegetation extent within the development site, including cleared areas and evidence to support differences between mapped vegetation extent and aerial imagery. Describe PCTs within the development site, including: • vegetation class • vegetation type • area (ha) for each vegetation type • species relied upon for identification of vegetation type and relative abundance • justification of evidence used to identify a PCT (as outlined in Paragraph 5.2.1.8) • EEC status (as outlined in Subsection 5.2.1) • estimate of per cent cleared value of PCT. Describe vegetation zones within the development site, including: • condition class and subcategory (where relevant) • area (ha) for each vegetation zone • survey effort as described in Paragraphs 5.2.1.5–7 (number of plots/transects). Where use of local data is proposed: • identify relevant vegetation type • identify source of information for local benchmark data • justify use of local data in preference to database values.	• Map of native vegetation extent within the development site (as described in Section 5.1) • Map of PCTs within the development site • Map of condition class and subcategory (where relevant) • Map of plot and transect locations relative to PCTs and condition class • Map of EECs • Plot and transect field data (MS Excel format) • Plot and transect field data sheets • Table of current site value scores for each vegetation zone within the development site • Map of vegetation zones with a current site value score of <17.	Chapter 5	Chapter 4 – Native vegetation and Annexure B for flora species list

Report section	Information	Maps & data	FBA reference	Section in this report
Threatened species	Identify ecosystem credit species associated with PCTs on the development site as outlined in Section 6.3, including: • list of species derived • justification for exclusion of any ecosystem credit species predicted above. Identify species credit species on the development site as outlined in Sections 6.5 and 6.6, including: • list of candidate species • justification for inclusions and exclusions based on habitat features • indication of presence based on targeted survey or expert report • details of targeted survey technique, effort, timing and weather • species polygons • species that cannot withstand a further loss. Where use of local data is proposed: • identify relevant species or population • identify aspect of species/population data • identify source of information for local data • justify use of local data in preference to database values. Where expert reports are used in place of targeted survey: • identify the relevant species or population • justify the use of an expert report • indicate and justify the likelihood of presence of the species or population and information considered in making this assessment • estimate the number of individuals or area of habitat (whichever unit of measurement applies to the species/individual) for the development site, including a description of how the estimate was made • identify the expert and provide evidence of their expert credentials.	• Table of vegetation zones and landscape Tg values, particularly indicating where these have changed due to species exclusion • Targeted survey locations • Table detailing the list of species credit species and presence status on site as determined by targeted survey, indicating also where presence was assumed and/or where presence was determined by expert report • Species credit species polygons (as described in Paragraph 6.5.1.19) • Table detailing species and habitat feature/component associated with species and its abundance on site (as described in Paragraph 6.5.1.19) • Species polygons for species that cannot withstand a loss	Chapter 6	Chapter 5 – Threatened Species Annexure A – Habitat assessment table and likelihood of occurrence for threatened species. Annexure B – Fauna species list

Report section	Information	Maps & data	FBA reference	Section in this report
Avoid and minimise impacts	Demonstration of efforts to avoid and minimise impact on biodiversity values in accordance with Section 8.3. Identification of final project footprint during construction and operation in accordance with Subsection 8.3.3. Assessment of direct and indirect impacts unable to be avoided at the development site in accordance with Sections 8.3 and 8.4. The assessment would include but not be limited to: type, frequency, intensity, duration and consequence of impact. Statement of onsite measures proposed to avoid and minimise direct and indirect impacts of the Major Project.	• Table of measures to be implemented before, during and after construction to avoid and minimise the impacts of the project, including action, outcome, timing and responsibility • Map of final project footprint, including construction and operation • Maps demonstrating indirect impact zones where applicable	Chapter 8	Chapter 8 – Avoidance, mitigation, and impacts
Impact summary	Identification of areas not requiring assessment in accordance with Section 9.5. Identification of areas not requiring offset in accordance with Section 9.4. Identification of PCTs and species polygons requiring offset in accordance with Section 9.3. Identification of impacts that require further consideration in accordance with Section 9.2, including: • the entity and/or impact for which further consideration is necessary • supporting information relevant to the impact, as outlined in Subsection 9.2.2. Ecosystem credits and species credits that measure the impact of the Major Project on biodiversity values at the development site, including: • future site value score for each vegetation zone at the development site • change in landscape value score • number of required ecosystem credits for the impact of development on each vegetation zone at the development site • number of required species credits for the impact of development on each threatened species that occurs on the development site.	• Map of areas not requiring assessment • Map of PCTs and species polygons not requiring offset • Map of PCTs and species polygons requiring offset • Map of the occurrence of the entity or impact that requires further consideration • Table of PCTs requiring offset and the number of ecosystem credits required • Table of species and populations requiring offset and the number of species credits required • Full biodiversity Credit Calculator output • Submitted proposal in the Credit Calculator	Chapter 9 Subsections 10.4.3 and 10.4.4	Chapter 9 – Impact summary
Biodiversity credit report	Credit profiles for ecosystem credits and species credits at the development site.	• Table of credit type and matching credit profile • Biodiversity credit report from the Credit Calculator	Subsection 10.4.5	Not provided. No offsets required under FBA.

Annexure G – Arboricultural Impact Assessment

Roads and Maritime Services

WestConnex – M4-M5 Link

Technical working paper: Biodiversity impact assessment

Annexure G – Arboricultural impact assessment

August 2017

Prepared for

Roads and Maritime Services

Prepared by

Eco Logical Pty Ltd

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Glossary of terms and abbreviations

Term	Definition
Alignment	The geometric layout (eg of a road) in plan (horizontal) and elevation (vertical).
AQF	Australian Qualifications Framework
AS	Australian Standards
At-grade	A road at ground level, not on an embankment or in a cutting.
Campbell Road civil and tunnel site	A construction ancillary facility for the M4-M5 Link project at St Peters
CFFMP	Construction Flora and Fauna Management Plan
Concept design	Initial functional layout of a road/road system or other infrastructure. Used to facilitate understanding of a project, establish feasibility and provide basis for estimating and to determine further investigations needed for detailed design.
Construction	Includes all physical work required to construct the project.
Construction ancillary facilities	Temporary facilities during construction that include, but are not limited to construction sites (civil and tunnel), sediment basins, temporary water treatment plants, pre-cast yards and material stockpiles, laydown areas, parking, maintenance workshops and offices.
Darley Road civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located at Leichhardt
DBH	Diameter at Breast Height
Detailed design	The phase of the project following concept design where the design is refined, and plans, specifications and estimates are produced, suitable for construction
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
EIS	Environmental impact statement
ELA	Eco Logical Australia
Haberfield civil and tunnel site / Haberfield civil site	Construction ancillary facilities for the M4-M5 Link project located at Haberfield
HDD	Horizontal directional drilling
IACA	Institute of Australian Consulting Arboriculturalists
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Iron Cove Link	Around one kilometre of twin tunnels that would connect Victoria Road near the eastern abutment of Iron Cove Bridge and Anzac Bridge
Iron Cove Link civil site	A construction ancillary facility for the M4-M5 Link project located at Rozelle
LGA	Local Government Area
m	Metre
mm	Millimetre
NDE	Non-destructive excavation
NO	Number
Northcote Street civil site	A construction ancillary facility for the M4-M5 Link project located at Haberfield
NSW	New South Wales
Parramatta Road East civil site	A construction ancillary facility for the M4-M5 Link project at Haberfield
Parramatta Road West civil and tunnel site	A construction ancillary facility for the M4-M5 Link project at Ashfield
Pre-construction	All work prior to, and in respect of the State Significant Infrastructure, that is excluded from the definition of construction.

Term	Definition
Project	A new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange
Project footprint	The land required to construct and operate the project. This includes permanent operational infrastructure (including the tunnels), and land required temporarily for construction
Pyrmont Bridge Road tunnel site	A construction ancillary facility for the M4-M5 Link project at Annandale
Roads and Maritime	NSW Roads and Maritime Services
Rozelle civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located at Lilyfield and Rozelle
Rozelle interchange	A new interchange at Lilyfield and Rozelle that would connect the M4-M5 Link mainline tunnels with City West Link, Anzac Bridge, the Iron Cove Link and the proposed future Western Harbour Tunnel and Beaches Link
Rozelle Rail Yards	The Rozelle Rail Yards is bound by City West Link to the south, Lilyfield Road to the north, Balmain Road to the west, and White Bay to the east. Note that the project only occupies part of the Rozelle Rail Yards site
SEARs	Secretary's Environmental Assessment Requirements. Requirements and specifications for an environmental assessment prepared by the Secretary of the Department of Planning and Environment under section 115Y of the *Environmental Planning and Assessment Act 1979* (NSW).
SP	Species
SRZ	Structural root zone
St Peters interchange	A component of the New M5 project, located at the former Alexandria Landfill site at St Peters. Approved and under construction as part of the New M5 project. Additional construction works proposed as part of the M4-M5 Link project.
STARS	Significance of a Tree Assessment Rating System
Study area	A 15 metre buffer around the project footprint that is the subject of this arboricultural assessment
The Crescent civil site	A construction ancillary facility for the M4-M5 Link project located at Annandale
TPZ	Tree protection zone
Victoria Road civil site	A construction ancillary facility for the M4-M5 Link project located at Rozelle
VTA	Visual tree assessment
Wattle Street civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located at Haberfield
WestConnex program of works	A program of works that includes the M4 Widening, King Georges Road Interchange Upgrade, M4 East, New M5 and M4-M5 Link projects

1 Introduction

1.1 Project overview

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of the Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange.

Eco Logical Australia Pty Ltd (ELA) was commissioned by Roads and Maritime to prepare an arboricultural impact assessment for the project.

As identified in **Chapter 1** (Introduction) of the environmental impact statement (EIS), the detail of the design and construction approach presented in the EIS is indicative only, based on a concept design. A summary of the potential impacts on trees from the concept design is outlined in this report; however, this is subject to detailed design and construction planning to be undertaken by the design and construction contractor.

1.2 Purpose of this report

The purpose of this report is to:

- Identify the trees within and adjacent to the project footprint that are likely to be affected by the project (subject trees)
- Assess the current overall health and condition of the subject trees
- Evaluate the significance of the subject trees and assess their suitability for retention (where possible)
- Provide mitigation measures to reduce impacts on the subject trees (where possible) and to compensate for the loss of those trees requiring removal.

1.3 Assessment requirements

Table 1-1 outlines the Secretary's Environmental Assessment Requirements (SEARs) for the project as relevant to the arboricultural assessment, and notes where they have been addressed in this EIS.

Table 1-1 Relevant SEARs addressed in this report

SEARs	
6. Biodiversity	
Requirement	**Section where addressed in report**
3. The Proponent must assess any impacts to trees within the project area. Impacts should be minimised; following the hierarchy of avoid minimise and mitigate impacts to trees.	This report and **Appendix S** (Technical working paper: Biodiversity) of the EIS

1.4 Structure of this report

This report is the Arboricultural Impact Assessment for the project and is structured as follows:

- **Chapter 1** presents the background information on the project
- **Chapter 2** outlines the assessment methodology
- **Chapter 3** contains the results
- **Chapter 4** summarises the findings and recommendations.

2 Assessment methodology

2.1 Study area

Subject trees were identified based on a study area comprising a 15 metre buffer around the project footprint. This buffer is considered the maximum extent for potential impacts to occur to a tree's Tree Protection Zone (see explanation in **Attachment B**). An overview of the study area is shown on **Figure 2-1** and more detailed maps are provided at **Attachment A**. Subject trees are those that satisfy the tree assessment criteria specified in **section 2.2**.

The study area excluded the following:

- Haberfield (Option A: Wattle Street civil and tunnel site (C1a), Haberfield civil and tunnel site (C2a)/ Haberfield civil site (C2b), Northcote Street civil site (C3a) and Campbell Road civil and tunnel site (C10) – these footprints have already been assessed as part of the M4 East and New M5 projects respectively. No additional tree removal for the M4-M5 Link project is assumed to be required in these areas
- Trees assessed and approved for removal as part of the Rozelle Rail Yards Site Management Works. This footprint has already been assessed as part of the *Rozelle Rail Yards – Site Management Works Review of Environmental Factors* (Roads and Maritime 2016).

2.2 Visual tree assessment

The subject trees were assessed in accordance with a stage one visual tree assessment (VTA) as formulated by *The Body Language of Trees. A Handbook for Failure Analysis* (Mattheck & Breloer, 1994), and practices consistent with modern arboriculture. Further information and guidelines on tree assessment are provided in **Attachment B** to **E**.

Subject trees are those trees that are located within the study area, and include both street trees and trees planted within and adjacent to the project footprint, and comprise native and exotic trees. For the purposes of this report, trees must be at least three metres in height with a trunk diameter of greater than 100 millimetres.

The following limitations apply to this assessment:

- Trees were inspected from ground level, without the use of any invasive or diagnostic tools and testing
- Trees on private properties have not been mapped in this report as access was not available and a complete visual inspection and assessment was therefore not possible. Impacts on trees on private properties and their management would need to be addressed during the detailed design phase of the project as necessary
- Tree heights, canopy spread and diameter at breast height (DBH) was estimated, unless otherwise stated
- Tree identification was based on broad taxonomical features present and visible from ground level at the time of inspection
- Trees of the same species, with similar dimensions growing in close proximity to each other, have been documented as a group and presented under a single coordinate/record and identification number.

The subject trees were inspected between 10 January and 9 June 2017. All surveys and assessments were undertaken by ELA's consulting arborists. All arborists hold an Australian Qualifications Framework (AQF) Level 5 in arboriculture.

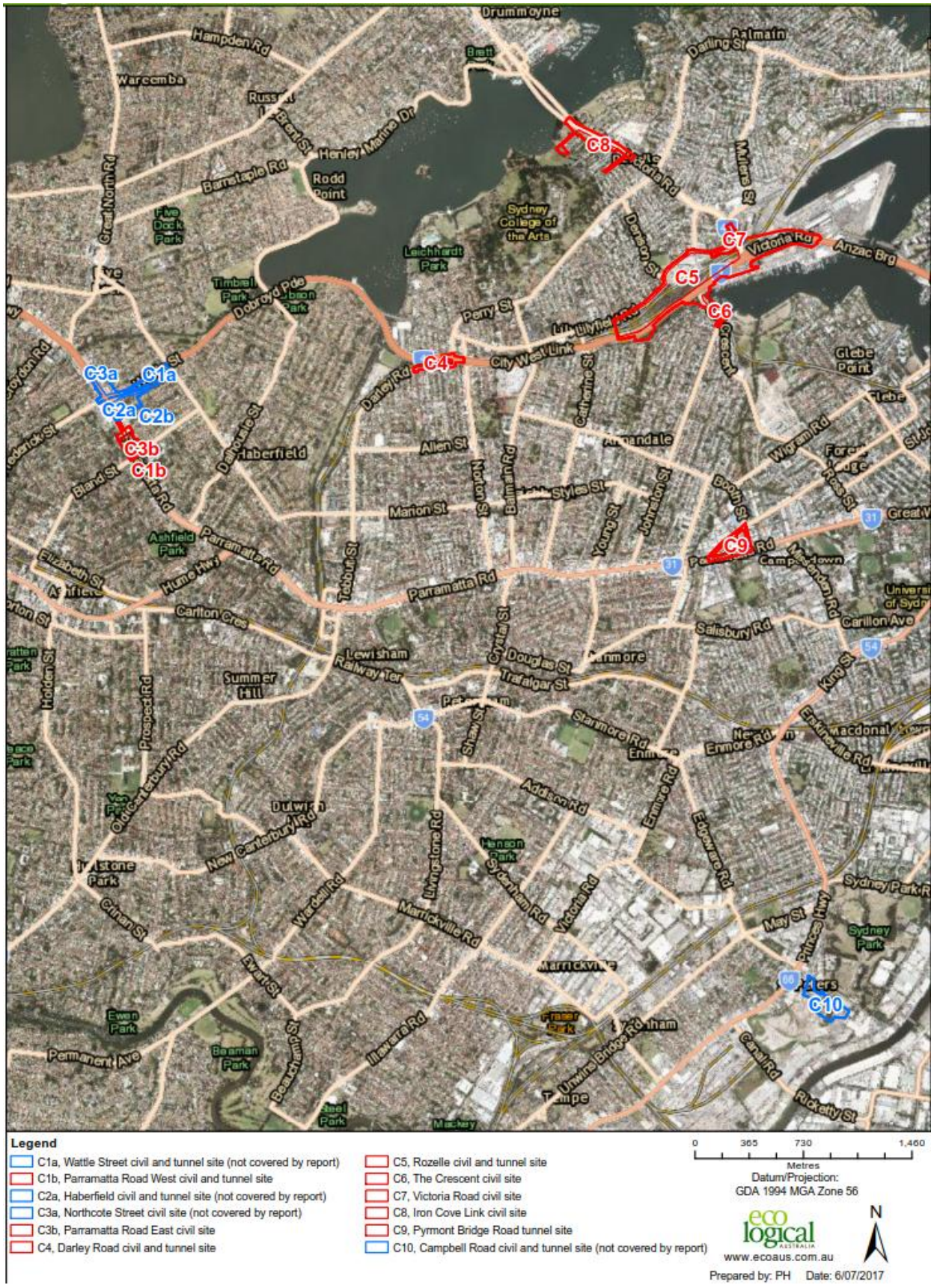

Figure 2-1 Arboricultural assessment study area

2.3 Retention value

This tree retention assessment has been undertaken in accordance with the Institute of Australian Consulting Arboriculturalists (IACA)'s Significance of a Tree Assessment Rating System (STARS). The system uses a scale of Low, Medium and High significance in the landscape. Once the landscape significance of an individual tree has been defined, the retention value can be determined. Each tree must meet a minimum of three assessment criteria to be classified. Further details and the assessment criteria are included in **Attachment F**.

The retention value of a tree or group of trees has been determined using a combination of environmental, cultural, physical and social values. It has also included consideration of a tree's health, life expectancy and suitability for retention within the project footprint.

- **Low:** These trees are not considered important for retention as they are of low significance and/or have a short useful life expectancy, nor do they require special works or design modification to be implemented for their retention
- **Medium:** These trees are moderately important for retention as they are of low significance but have a medium to long useful life expectancy. Their removal should only be considered if adversely affecting the proposed building/works and all other alternatives have been considered and exhausted
- **High:** These trees are considered important for retention as they are of medium or high significance and have a medium to long useful life expectancy. These trees should be retained and protected, if possible. Where possible, design modification should be considered to accommodate the setbacks as prescribed by AS 4970 - *Protection of trees on development sites*.

For the purposes of this assessment, only high retention value trees have been allocated a singular record and identification number. Subject trees assessed as medium or low retention value have been grouped and represented under a colour coded polygon.

2.4 Mapping of assessed trees

Subject trees have been grouped into categories based on their location within the study area and the anticipated level of impact from construction activities, and represented under colour coded polygons on maps in **Attachment A**. These categories are as follows:

- **Areas of trees to retain (N):** Subject trees within the study area that are unlikely to be impacted by the project, subject to detailed design. These trees can successfully be retained
- **Areas of trees to be removed (R):** Subject trees within the study area that would be directly impacted by the project. It is unlikely these subject trees would be retained
- **Areas of trees to investigate for retention (I):** Subject trees within the study area that are anticipated to be directly impacted by the project. Their impact should be further investigated during detailed design due to their retention value, including:
    - Groupings of trees that have the potential to provide vegetative screening of the project and/or where the individual trees are not considered high retention value, but as a group, they provide high values
    - Individual trees identified as high retention value.

Individual trees that are healthy and vigorous with good growth form, locally indigenous, visually prominent and/or culturally or spiritually significant. These are represented as **high retention value trees** and are located throughout the study area, and may be located within each of the areas of trees to retain, to be removed, or to investigate for retention. High retention trees are mapped in **Attachment A** under a single record and identification number (ie shown on maps as individual trees). These trees are considered important and should be retained and protected wherever possible. All opportunities for retaining these subject trees through the use of design modification and tree sensitive construction techniques should be explored.

3 Results

Table 3-1 provides an information summary of subject trees within the project footprint, and includes details such as map reference, number of trees, dominant species, height range and health. **Table 3-2** provides information on the high retention value trees identified in the study area, including observations and measurements specific to each tree. All trees identified during the assessment were planted trees and none were considered native remnant trees.

Key findings of the arboricultural assessment are:

- **Areas of trees to retain:** About 540 subject trees were identified within the study area that can be successfully retained by the project, subject to detailed design. Of these, 21 trees were identified as high retention value
- **Areas of trees to be removed:** About 1,675 subject trees were identified within the study area that would be directly impacted by the project. It is unlikely these subject trees would be retained. Of these, 107 trees were identified as high retention value. While these trees are identified to be removed, all opportunities for retaining these high retention value trees through the use of design modification and tree sensitive construction techniques should be explored where possible. The majority of trees to be removed are a result of the Rozelle interchange and associated surface road upgrades and active transport connections. This includes trees within the Rozelle Rail Yards and Ports Authority land (not including trees already approved to be removed under the Site Management Works), along City West Link and Lilyfield Road, and areas adjacent to Whites Creek (at The Crescent and Brenan Street)
- **Areas to be investigated:** About 355 subject trees were identified within the study area to be investigated further during detailed design to determine their suitability for retention. Of these, 34 trees were identified as high retention value. These areas identified to be further investigated include groups of trees along Lilyfield Road that may offer visual screening, and the approaches to Anzac Bridge.

In total, about 162 high retention value trees have been identified within the study area to be investigated further during detailed design to determine their suitability to be retained.

The EIS includes two options for construction ancillary facilities around Haberfield, which are denoted by the suffix *a* (for Option A) or *b* (for Option B). The above findings are based on Option A (along with the other construction ancillary facilities nominated within the EIS). In the context of this report, Option B would result in additional impacts due to the use of the Parramatta Road West civil and tunnel site (C1b) and Parramatta Road East civil site (C3b).

Should Option B be selected, the following additional findings apply to the overall assessment:

- **Areas of trees to be retained:** Three subject trees were identified within the Parramatta Road study area and could be successfully retained by the project, subject to detailed design
- **Areas of trees to be removed:** About 12 subject trees were identified within the Parramatta Road study area that would be directly impacted by the project. It is unlikely these subject trees would be retained
- **Areas to be investigated:** Up to 17 trees in the Parramatta Road study area would require further investigation during detailed design to determine their suitability for retention. This would be based on the recommended TPZ for these trees, and incorporation of these TPZs into a revised construction layout during detailed design.

Table 3-1 Tree impact area summaries

Map reference	ID	Dominant species	Health and structure range	Height Range	Estimated no. of trees	Proposed outcome
Map 1	17I	*Ficus sp., mixed sp.*	Fair – Good	2m–9m	11	Investigate for retention
Map 1	18I	*Jacaranda mimosifolia,* mixed species	Fair – Good	4m–13m	6	Investigate for retention
Map 1	24R	*Lophostemon confertus*	Fair	3m	1	Remove
Map 1	25R	*Jacaranda mimosifolia*	Fair	6m	1	Remove
Map 1	26R	*Juniperus chinensis, Musa sp.*	Fair – Good	5m–6m	4	Remove
Map 1	27R	*Lophostemon confertus, Archontophoenix alexandrae, Araucaria heterophylla*	Poor – Good	4–14m	6	Remove
Map 1	36N	*Lagerstroemia indica*	Fair	4m	3	Retain
Map 2	1I	*Corymbia maculate*	Good	12m-15m	2	Investigate for retention
Map 2	1N	*Corymbia maculata, Phoenix canariensis, Erythrina X sykesii, Celtis Australis*	Good	3m-10m	6	Retain
Map 2	1R	*Pittosporum undulatum, Lophostemon confertus, Celtis australis, Cinnamomum camphora, Ligustrum lucidum, Eucalyptus x botryoides,* mixed weed species	Fair – Good	2m-12m	30	Remove
Map 2	2I	Mixed species	N/A	1m-2m	N/A	Investigate for retention
Map 2	2N	*Corymbia maculata, Celtis australis, Glochidion ferdinandi, Callistemon viminalis, Ligustrum lucidum*	Fair – Good	3m-10m	21	Retain
Map 2	3I	*Callistemon viminalis*	Poor – Good	4m	1	Investigate for retention
Map 2	3N	*Robinia pseudoacacia, Corymbia maculata, Araucaria cunninghamii*	Poor – Good	9m-12m	3	Retain
Map 2	4I	*Acacia sp., Callistemon viminalis, Tristaniopsis laurina*	Poor – Good	2m-5m	6	Investigate for retention

Map reference	ID	Dominant species	Health and structure range	Height Range	Estimated no. of trees	Proposed outcome
Map 2	4N	*Araucaria cunninghamii, Jacaranda mimosifolia, Ficus hillii*	Fair – Good	3m-9m	8	Retain
Map 2	5I	*Callistemon viminalis, Fraxinus raywood*	Fair – Good	3m-4m	2	Investigate for retention
Map 2	6I	*Jacaranda mimosifolia, Araucaria cunninghamii,* mixed species	Fair – Good	3m-12m	5	Investigate for retention
Map 3	5R	*Casuarina glauca, Phoenix canariensis, Celtis australis, Allocasuarina littoralis, Acacia longifolia, Cupressus sp., Pittosporum undulatum, Cinnamomum camphora, Morus sp.*	Poor – Good	3m-15m	167	Remove
Map 3	6R	*Phoenix canariensis, Ficus hillii, Olea africana, Agonis flexuosa, Casuarina cunninghamiana, Eucalyptus sp., Acacia longifolia, Corymbia maculata, Lophostemon confertus, Pittosporum undulatum*	Poor – Good	1m-11m	72	Remove
Map 3	7I	*Ficus hillii*	Poor – Good	5m-16m	9	Investigate for retention
Map 3	8I	*Ficus hillii, Grevillea robusta, Phoenix canariensis, Olea africana, Ficus benjamina, Nerium oleander,* mixed weed species	Poor – Good	3m-10m	16	Investigate for retention
Map 3	31N	*Casuarina cunninghamiana, Eucalyptus sp., Casuarina glauca*	Fair	8m-12m	57	Retain
Map 3	12I	*Phoenix canariensis, Ficus hillii*	Fair – Good	6m-14m	6	Investigate for retention
Map 3	13N	*Casuarina glauca, Phoenix canariensis*	Fair – Good	4m-16m	27	Retain
Map 3	16R	Unknown species	Unknown	10m	21	Remove
Map 3	17R	*Casuarina glauca, Melaleuca armillaris, mixed natives,* mixed weed species	Fair	7m-12m	127	Remove
Map 4	10R	*Mixed native species, Celtis australis, Acacia sp., Casuarina glauca, Cinnamomum camphora*	Fair	8m-12m	145	Remove
Map 4	13R	*Casuarina cunninghamiana, Callistemon viminalis, Mixed natives*	Fair	8m	82	Remove
Map 4	15I	*Casuarina cunninghamiana, Callistemon viminalis, Phoenix canariensis, Ficus hillii, Ficus rubiginosa*	Fair – Good	3m–12m	51	Investigate for retention
Map 4	16I	*Casuarina glauca, Casuarina cunninghamiana*	Fair	5m–8m	255	Investigate for retention

Map reference	ID	Dominant species	Health and structure range	Height Range	Estimated no. of trees	Proposed outcome
Map 4	22R	*Casuarina glauca, Callistemon viminalis, Mixed native species*	Fair – Good	3m-12m	430	Remove
Map 4	24N	*Casuarina glauca, Casuarina cunninghamiana, Archontophoenix alexandrae, Phoenix canariensis, Ficus elastica*	Fair – Good	3m-8m	86	Retain
Map 4	25N	*Casuarina cunninghamiana, Callistemon viminalis, Phoenix canariensis, Ficus hillii*	Fair – Good	3m-12m	16	Retain
Map 5	7R	*Banksia integrifolia, Tristaniopsis laurina, Corymbia citriodora, Triadica sebifera, Robinia pseudoacacia, Jacaranda mimosifolia*	Good	3m-15m	10	Remove
Map 5	11R	*Casuarina cunninghamiana, Shinus areira*	Good	3m-7m	10	Remove
Map 5	12N	*Ficus hillii, Tristaniopsis laurina, Celtis australis*	Fair	3m-5m	7	Retain
Map 5	14N	*Ficus rubiginosa*	Fair – Good	8m-17m	1	Retain
Map 5	15N	*Grevillea robusta, Washingtonia robusta*	Fair – Good	6m-22m	8	Retain
Map 5	16N	*Grevillea robusta*	Fair – Good	20m-21m	5	Retain
Map 5	34N	*Eucalyptus crebra, Eucalyptus saligna*	Poor – good	20m	2	Retain
Map 5	35N	*Eucalyptus crebra, Callistemon viminalis, Celtis australis, Melaleuca sp., Melaleuca quinquenervia*	Fair – Good	2m-16m	14	Retain
Map 6	18N	Private residential trees	-	-	-	Retain
Map 6	19N	*Ficus benjamina, Melaleuca quinquenervia*	Fair – Good	21m-23m	9	Retain
Map 6	20R	*Callistemon citrinus, Casuarina glauca, melia azedarach, Corymbia maculata, Callistemon viminalis, Casuarina cunninghamiana*	Fair Good	2m-13m	268	Remove
Map 6	37N	Mixed species	Fair – Good	2m – 15m	50	Retain
Map 6	38N	*Acacia sp., Ficus benjamina, Musa sp., Cinnamomum camphora*	Fair – Good	4m – 16m	16	Retain

Map reference	ID	Dominant species	Health and structure range	Height Range	Estimated no. of trees	Proposed outcome
Map 7	8R	*Phoenix canariensis, Casuarina cunninghamiana, Eucalyptus sideroxylon, Eucalyptus grandis, Callistemon citrinus, Eucalyptus crebra, Casuarina glauca, Hakea salicifolia, Corymbia eximia, Cupressus sempervirens, Eucalyptus saligna, Grevillea robusta, Lophostemon confertus, Celtis australis, Ficus macrophylla*	Fair – Good	2m-17m	160	Remove
Map 7	9R	*Melaleuca sp., Casuarina cunninghamiana, Callistemon viminalis, Cinnamomum camphora, Celtis australis, Eucalyptus sideroxylon, Ficus sp., Eucalyptus pilularis, Eucalyptus microcorys, Eucalyptus grandis*	Fair – Good	3m-14m	40	Remove
Map 7	12R	*Lophostemon confertus*	Good	8m	1	Remove
Map 7	18R	*Casuarina cunninghamiana, Phoenix canariensis, Eucalyptus sp., Celtis australis*	Fair – Good	2m-8m	40	Remove
Map 7	20N	*Eucalyptus punctata, Eucalyptus microcorys, Casuarina glauca, Eucalyptus robusta, Eucalyptus fibrosa*	Fair – Good	5m-18m	16	Retain
Map 7	21N	*Eucalyptus sp.*	Fair – Good	6m–8m	2	Retain
Map 7	22N	*Lophostemon confertus*	Fair	9m-10m	4	Retain
Map 7	23N	*Callistemon viminalis, Eucalyptus sp.*	Fair – Good	4m–9m	11	Retain
Map 7	32N	*Lophostemon confertus, Phoenix canariensis*	Fair – Good	3m-5m	4	Retain
Map 8	19R	Mixed species	Good	5m	4	Remove
Map 8	21R	*Casuarina glauca*	Good	6m-7m	28	Remove
Map 9	2R	*Melaleuca quinquenervia*	Fair	4m	1	Remove
Map 9	5N	*Eucalyptus microcorys*	Good	15m-16m	6	Retain
Map 9	3R	*Ficus macrophylla, Acacia sp., Laurus nobilis, Casuarina glauca*	Fair – Good	2m-4m	29	Remove
Map 9	6N	*Tristaniopsis laurina, Ficus rubiginosa*	Poor – Good	5m-15m	4	Retain
Map 9	7N	*Tristaniopsis laurina, Callistemon sp., Acacia sp., Cupressus sp., Eucalyptus grandis*	Fair – Good	3m-13m	27	Retain

Map reference	ID	Dominant species	Health and structure range	Height Range	Estimated no. of trees	Proposed outcome
Map 9	8N	*Casuarina glauca, Celtis australis, Banksia integrifolia, Ficus rubiginosa, Cupaniopsis anacardioides, Cupaniopsis sp.*, fair-good health and structure	Fair – Good	3m-10m	58	Retain
Map 9	11N	*Jacaranda mimosifolia*	Fair	8m	2	Retain
Map 9	39N	*Acacia sp.*	Fair	4m-5m	22	Retain
Map 9	40N	*Casuarina glauca, Eucalyptus robusta*	Good	3m–8m	15	Retain
Map 10	41N	*Corymbia maculata*	Fair – Good	15m	1	Retain
Map 10	42N	*Ficus hillii, Jacaranda mimosifolia*	Poor – Fair	2m-14m	4	Retain
Map 10	14R	*Triadica sebifera*	Fair	10m	2	Remove
Map 10	28N	*Eucalyptus microcorys*	Good	18m	1	Retain

Table 3-2 High retention value tree table

Map reference	Tree ID	Botanical name	No. of trees	Height (m)	Spread (m)	Health	Structure	DBH (mm)	TPZ (m)	SRZ (m)
Map 2	61	*Lophostemon confertus*	1	16	8	Good	Good	600	7.2	2.7
Map 2	62	*Lophostemon confertus*	1	17	9	Good	Good	900	10.8	3.2
Map 2	63	*Lophostemon confertus*	1	12	6	Good	Good	400	4.8	2.3
Map 2	64	*Eucalyptus saligna x botryoides*	1	18	20	Good	Fair	1,200	14.4	3.6
Map 3	21	*Ficus hillii*	1	12	12	Good	Good	700	8.4	2.9
Map 3	22	*Ficus hillii*	1	14	14	Good	Good	900	10.8	3.2
Map 3	23	*Ficus hillii*	1	12	8	Good	Good	300	3.6	2
Map 3	24	*Ficus hillii*	1	8	8	Good	Good	400	4.8	2.3
Map 3	25	*Ficus hillii*	1	8	8	Good	Good	600	7.2	2.7
Map 3	33	*Ficus hillii*	1	11	10	Good	Good	1,000	13.2	3.3
Map 3	34	*Ficus hillii*	1	10	10	Good	Good	600	7.2	2.7
Map 3	35	*Ficus hillii*	1	14	14	Good	Good	1,000	13.2	3.3
Map 3	36	*Ficus hillii*	1	16	14	Good	Good	1,000	13.2	3.3
Map 3	37	*Ficus hillii*	1	12	9	Good	Good	850	10.3	3.1
Map 3	38	*Ficus hillii*	1	13	17	Good	Good	1,000	13.2	3.3
Map 3	39	*Ficus hillii*	1	12	12	Good	Good	1,200	14.4	3.6
Map 3	40	*Ficus hillii*	1	10	8	Fair	Good	800	9.6	3
Map 4	14	*Corymbia maculata*	1	12	5	Good	Good	400	4.8	2.3

Map reference	Tree ID	Botanical name	No. of trees	Height (m)	Spread (m)	Health	Structure	DBH (mm)	TPZ (m)	SRZ (m)
Map 4	15	*Group of native shrubs*	1	2	2	Fair	Fair	150	2	1.5
Map 4	16	*Callistemon viminalis*	20	3	2	Good	Good	150	2	1.5
Map 4	17	*Callistemon viminalis*	10	3	2	Good	Good	150	2	1.5
Map 4	18	*Group of mixed natives*	20	3	2	Fair	Fair	150	2	1.5
Map 4	19	*Ficus rubiginosa*	1	5	6	Good	Fair	200	2.4	1.7
Map 4	20	*Callistemon viminalis*	20	3	2	Fair	Fair	150	2	1.5
Map 5	41	*Casuarina cunninghamiana*	7	15	6	Good	Good	400	4.8	2.3
Map 5	42	*Shinus areira*	3	10	6	Good	Good	600	7.2	2.7
Map 5	84	*Ficus rubiginosa*	1	17	15	Good	Good	1,000	12	3.3
Map 5/ Map 6	43	*Banksia integrifolia*	1	7	5	Good	Good	400	4.8	2.3
Map 5/ Map 6	44	*Tristaniopsis laurina*	1	5	4	Good	Good	200	2.4	1.7
Map 5/ Map 6	45	*Tristaniopsis laurina*	1	4	4	Good	Good	200	2.4	1.7
Map 5/ Map 6	46	*Tristaniopsis laurina*	1	4	3	Good	Good	200	2.4	1.7
Map 5/ Map 6	47	*Tristaniopsis laurina*	1	4	4	Good	Good	150	2	1.5
Map 5/ Map 6	48	*Tristaniopsis laurina*	1	3	3	Good	Good	150	2	1.5
Map 5/ Map 6	49	*Corymbia citriodora*	1	15	12	Good	Good	800	9.6	3
Map 5/ Map 6	50	*Triadica sebifera*	1	8	6	Good	Good	300	3.6	2
Map 5/ Map 6	51	*Robinia pseudoacacia*	1	8	8	Good	Good	550	6.6	2.6

Map reference	Tree ID	Botanical name	No. of trees	Height (m)	Spread (m)	Health	Structure	DBH (mm)	TPZ (m)	SRZ (m)
Map 5/ Map 6	52	*Jacaranda mimosifolia*	1	6	7	Good	Good	300	3.6	2
Map 5/ Map 6	78	*Eucalyptus saligna*	1	20	6	Good	Good	600	7.2	2.7
Map 5/ Map 6	79	*Grevillea robusta*	1	21	6	Good	Fair	550	6.6	2.6
Map 5/ Map 6	80	*Grevillea robusta*	1	21	7	Good	Good	500	6	2.5
Map 5/ Map 6	81	*Grevillea robusta*	1	20	5	Good	Good	500	6	2.5
Map 5/ Map 6	82	*Grevillea robusta*	1	22	5	Fair	Good	350	4.2	2.1
Map 5/ Map 6	83	*Grevillea robusta*	1	21	7	Good	Good	450	5.4	2.4
Map 6	85	*Ficus benjamina*	1	21	14	Good	Good	800	9.6	3
Map 6	86	*Ficus benjamina*	1	22	13	Good	Good	550	6.6	2.6
Map 6	87	*Ficus benjamina*	1	22	13	Good	Good	400	4.8	2.3
Map 6	88	*Ficus benjamina*	1	23	15	Good	Good	1,300	15	3.7
Map 6	89	*Ficus benjamina*	1	23	15	Good	Good	900	10.8	3.2
Map 7	1	*Eucalyptus pilularis*	1	8	7	Good	Good	500	6	2.5
Map 7	2	*Casuarina cunninghamiana*	1	10	6	Good	Good	450	5.4	2.4
Map 7	3	*Eucalyptus microcorys*	1	12	8	Good	Good	550	6.6	2.6
Map 7	4	*Eucalyptus microcorys*	1	14	8	Good	Good	550	6.6	2.6
Map 7	5	*Melaleuca quinquenervia*	3	9	3	Good	Good	200	2.4	1.7
Map 7	6	*Eucalyptus microcorys*	1	10	6	Fair	Good	300	3.6	2

Map reference	Tree ID	Botanical name	No. of trees	Height (m)	Spread (m)	Health	Structure	DBH (mm)	TPZ (m)	SRZ (m)
Map 7	7	*Eucalyptus grandis*	1	16	9	Good	Fair	550	6.6	2.6
Map 7	8	*Casuarina glauca*	17	9	3	Good	Good	300	3.6	2
Map 7	9	*Eucalyptus grandis*	1	14	10	Good	Good	500	6	2.5
Map 7	10	*Ficus macrophylla*	1	16	18	Fair	Good	1,200	14.4	3.6
Map 7	11	*Eucalyptus grandis*	1	16	5	Good	Good	300	3.6	2
Map 7	12	*Ficus macrophylla*	1	14	14	Good	Good	800	9.6	3
Map 7	13	*Ficus macrophylla*	1	12	13	Good	Good	450	5.4	2.4
Map 9	53	*Eucalyptus robusta*	1	8	4	Good	Good	400	4.8	2.3
Map 9	54	*Ulmus parvifolia*	1	10	10	Good	Good	500	6	2.5
Map 9	55	*Eucalyptus microcorys*	1	16	14	Good	Good	800	9.6	3
Map 9	56	*Eucalyptus microcorys*	1	16	14	Good	Good	800	9.6	3
Map 9	56	*Eucalyptus microcorys*	1	16	12	Good	Good	800	9.6	3
Map 9	57	*Eucalyptus microcorys*	1	16	12	Good	Good	800	9.6	3
Map 9	58	*Eucalyptus microcorys*	1	16	14	Good	Good	800	9.6	3
Map 9	59	*Eucalyptus microcorys*	1	16	14	Good	Good	800	9.6	3
Map 9	60	*Ficus rubiginosa*	1	15	12	Good	Good	850	10.3	3.1

Notes: DBH – Diameter at Breast Height; TPZ – Tree Protection Zone; SRZ – Structural Root Zone

4 Recommendations

The recommendations for tree protection have been developed to ensure that impacts of the project on trees are minimised, following the hierarchy of avoid, minimise and mitigate as follows:

- Impacts to trees have been avoided through design and are demonstrated by the number of trees able to be retained
- Impacts to trees have been potentially minimised through the identification of high retention trees or groups of trees that may be able to be retained during detailed design, through further investigation
- Impacts to trees have been mitigated through a commitment for compensatory planting, planted within or in close proximity to the project footprint and in consultation with relevant councils.

4.1 Trees to be investigated for retention

This assessment has been based on the current project footprint and concept design for the project. Further opportunities to retain trees may emerge during detailed design. These areas have been highlighted in **Attachment A** and include groups of trees as well as all individual high retention value trees. All opportunities for retaining additional trees through tree sensitive design and construction methods will be discussed and explored during detailed design.

4.2 Protection of trees proposed for retention

The following tree protection measures would be required for any trees identified for retention in **Chapter 3** and **Attachment A** as well as trees located on private property which are likely to be impacted by construction activities.

A Construction Flora and Fauna Management Plan (CFFMP) would be developed and implemented during construction. The CFFMP would include measures to manage potential impacts to trees, including:

- The establishment of tree protection zones (TPZs)
- Ground protection measures for trees to be retained.

The CFFMP will include tree management protocols and provision for the development of tree management plans in accordance with the requirements of *AS 4970-2009 Protection of trees on development sites,* where required for specific trees. Protection of trees will be carried out in consultation with an arborist with a minimum AQF Level 5 qualification in arboriculture for each tree proposed for retention where works associated with the project have the potential to impact on the tree root zone.

Further information and guidelines on tree protection is in **Attachment F**.

4.3 Compensatory planting recommendations

Opportunities to retain high retention value trees should be explored where practical during detailed design. Compensatory planting is recommended for trees that cannot be retained as a result of the works. Replacement trees should be planted within, or close to, the project footprint or other locations in consultation with the relevant councils.

Compensatory planting should seek to use opportunities presented by the open space created within the Rozelle interchange, including along Lilyfield Road and City West Link. Opportunities should also be sought as part of landscaping associated with the Iron Cove Link.

4.4 Tree removal work

Tree removal, pruning and maintenance work will be carried out by an arborist with a minimum AQF Level 3 qualification in accordance with *AS 4373-2007 Pruning of Amenity Trees* and the *NSW WorkCover Code of Practice for the Amenity Tree Industry* (1998) and advice provided by an arborist with a minimum AQF Level 5 qualification in Arboriculture (or equivalent).

References

Australian Standards, AS 4373-2007 - *Pruning of Amenity Trees*.

Australian Standards, AS 4970-2009 - *Protection of Trees on Development Sites*.

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Mattheck, C. 2007. *Updated field guide for visual tree assessment*. Karlsruhe: Forschungszentrum Karlsruhe.

WorkCover NSW. 1998. *Code of Practice: Amenity Tree Industry*

Attachments

Attachment A - Tree location maps


Tree Locations and Impact
WestConnex - Map 1
24R
25R
C1b Parramatta Road West Civil and Tunnel Site
C3b Parramatta Road East Civil Site
C3b
27R
15m Construction Footprint Buffer (Study Area)
18I
C1b
26R
36N
17I
Legend
C1b - Parramatta Road West civil and tunnel site
C3b - Parramatta Road East civil site
15m Construction Footprint Buffer (Study Area)
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 25 50 100
Metres
Datum/Projection:
GDA 1994 MGA Zone 56
N
eco logical AUSTRALIA
www.ecoaus.com.au
Prepared by: PH Date: 9/08/2017


Tree Locations and Impact
WestConnex - Map 2
CITY-WEST LINK ROAD
DARLEY ROAD
C4
1N
1I
2N
1R
2I
3I
4I
5I
6I
3N
4N
G1
G2
G3
G4
15m Construction Footprint Buffer (Study Area)
CHARLES STREET
HUBERT STREET
FRANCIS STREET
JAMES STREET
NORTON STREET
Legend
C4 - Darley Road civil and tunnel site
15m Construction Footprint Buffer (Study Area)
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 20 40 80
Metres
Datum/Projection:
GDA 1994 MGA Zone 56
N
eco logical AUSTRALIA
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Prepared by: PH Date: 10/08/2017


Tree Locations and Impact
WestConnex - Map 3
15m Construction Footprint Buffer (Study Area)
Refer to: "Roads and Maritime, 2016, Rozelle Rail Yards – Site Management Works Review of environmental factors"
C5
JOSEPH STREET
JUSTIN STREET
LAMB STREET
RYAN STREET
LILYFIELD ROAD
CITYWEST LINK ROAD
RAILWAY PARADE
PRITCHARD STREET
BREILLAT STREET
ANNANDALE STREET
CATHERINE STREET
BRENAN STREET
12N
8I
7I
6R
17R
12I
13N
16R
5R
31N
8R
Legend
C5 - Rozelle civil and tunnel site
15m Construction Footprint Buffer (Study Area)
Rozelle Rail Yards Site Management Works
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 25 50 100
Metres
Datum/Projection:
GDA 1994 MGA Zone 56
N
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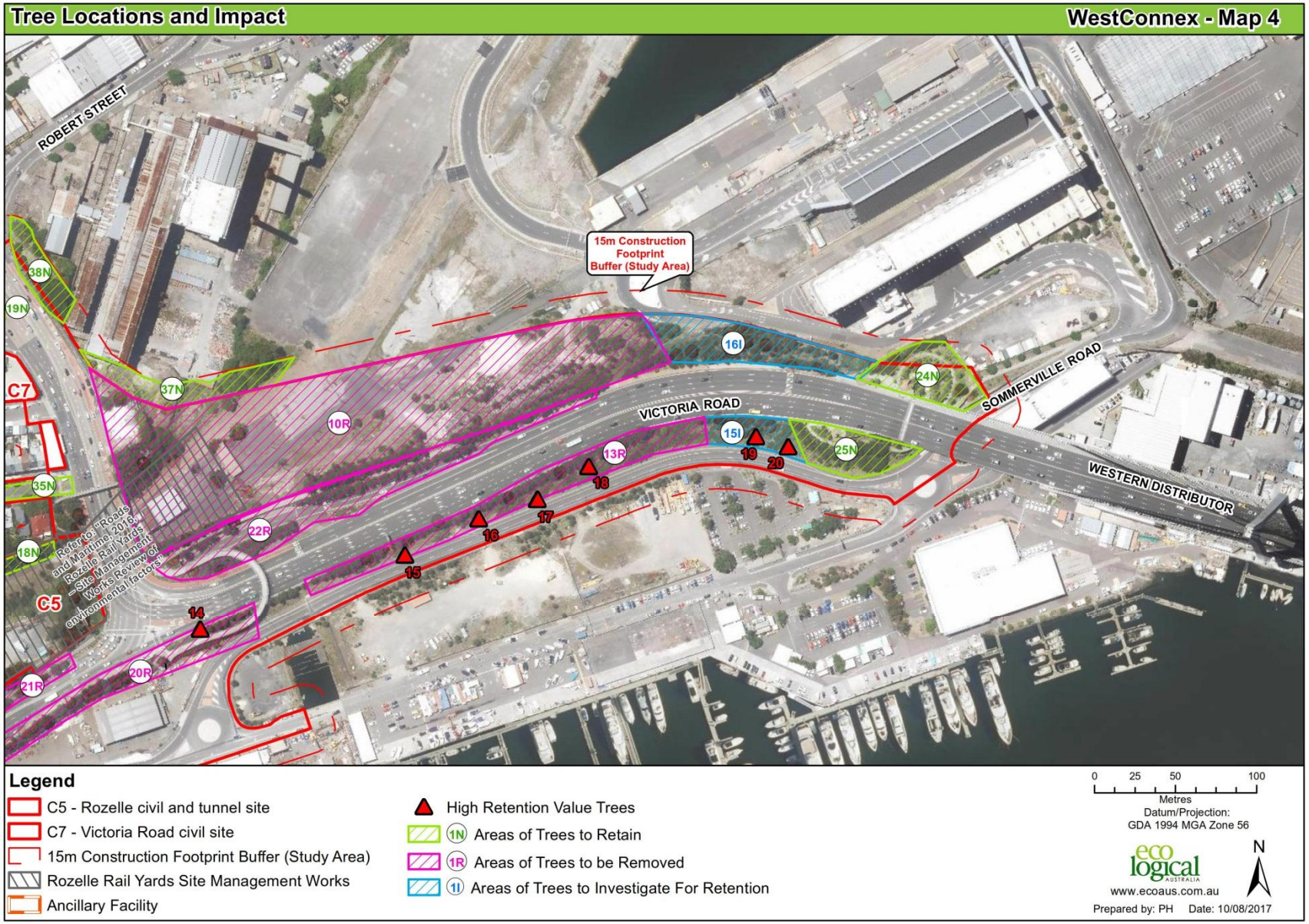
Tree Locations and Impact
WestConnex - Map 4
ROBERT STREET
15m Construction Footprint Buffer (Study Area)
VICTORIA ROAD
SOMMERVILLE ROAD
WESTERN DISTRIBUTOR
C7
C5
38N
19N
37N
10R
16I
24N
15I
25N
13R
35N
22R
18N
21R
20R
14
15
16
17
18
19
20
Refer to "Roads and Maritime, 2016, Rozelle Rail Yards – Site Management Works Review of environmental factors"
Legend
C5 - Rozelle civil and tunnel site
C7 - Victoria Road civil site
15m Construction Footprint Buffer (Study Area)
Rozelle Rail Yards Site Management Works
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 25 50 100
Metres
Datum/Projection:
GDA 1994 MGA Zone 56
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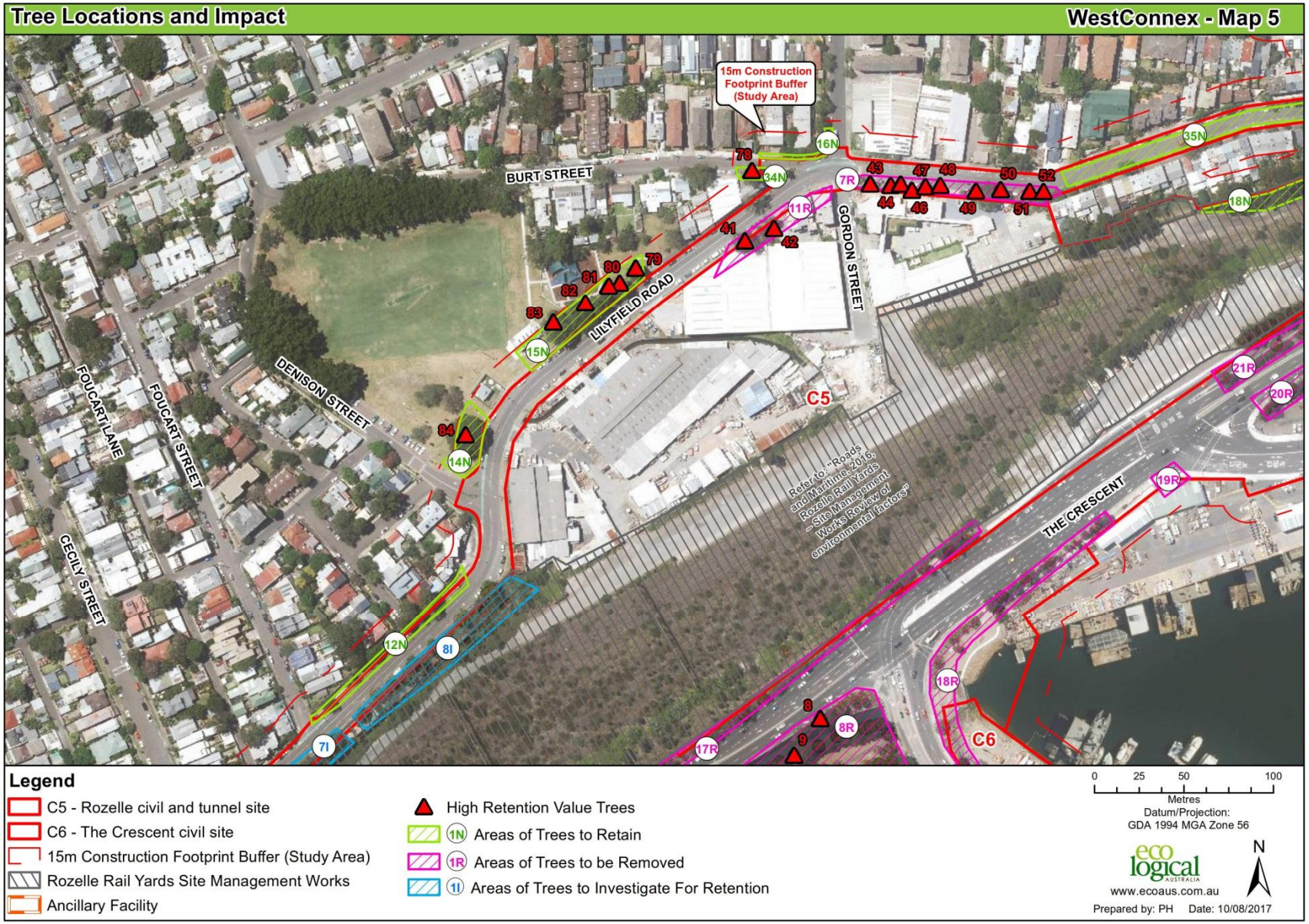
Tree Locations and Impact
WestConnex - Map 5
15m Construction Footprint Buffer (Study Area)
BURT STREET
LILYFIELD ROAD
GORDON STREET
DENISON STREET
FOUCART LANE
FOUCART STREET
CECILY STREET
THE CRESCENT
C5
C6
Refer to: "Roads and Maritime, 2016, Rozelle Rail Yards – Site Management Works Review of environmental factors"
Legend
C5 - Rozelle civil and tunnel site
C6 - The Crescent civil site
15m Construction Footprint Buffer (Study Area)
Rozelle Rail Yards Site Management Works
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 25 50 100
Metres
Datum/Projection:
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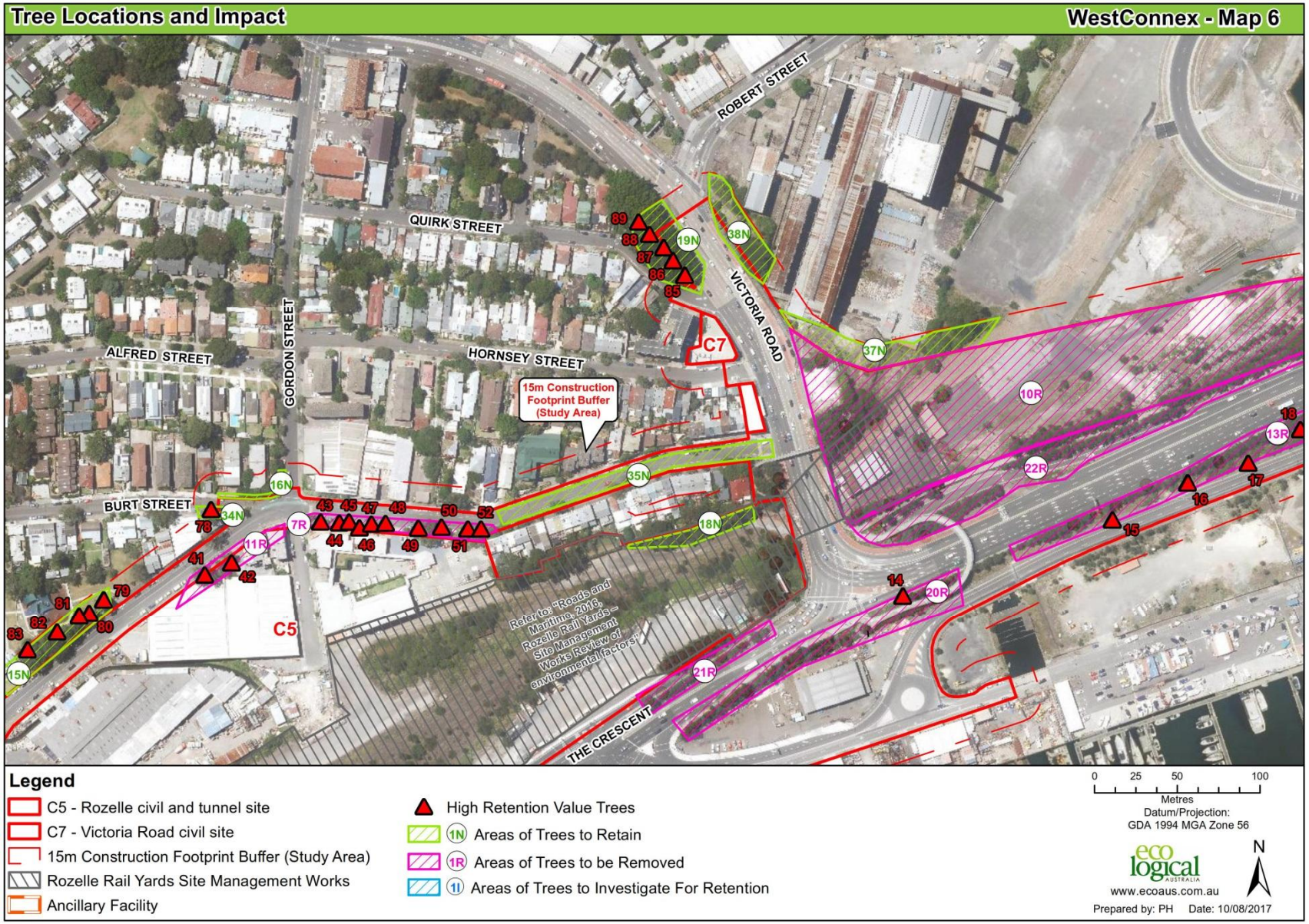
Tree Locations and Impact
WestConnex - Map 6
ROBERT STREET
QUIRK STREET
GORDON STREET
ALFRED STREET
HORNSEY STREET
VICTORIA ROAD
BURT STREET
THE CRESCENT
C7
C5
15m Construction Footprint Buffer (Study Area)
Refer to "Roads and Maritime, 2015, Rozelle Rail Yards – Rozelle Rail Yards Site Management Works Review of environmental factors"
Legend
C5 - Rozelle civil and tunnel site
C7 - Victoria Road civil site
15m Construction Footprint Buffer (Study Area)
Rozelle Rail Yards Site Management Works
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 25 50 100
Metres
Datum/Projection:
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Tree Locations and Impact
WestConnex - Map 7
C5
C6
CITY WEST LINK ROAD
RAILWAY PARADE
PRITCHARD STREET
ANNANDALE STREET
KENTVILLE AVENUE
BAYVIEW CRESCENT
JOHNSTON STREET
15m Construction Footprint Buffer (Study Area)
Refer to "Roads and Maritime, 2016, Rozelle Rail Yards – Site Management Works Review of environmental factors"
Legend
C5 - Rozelle civil and tunnel site
C6 - The Crescent civil site
15m Construction Footprint Buffer (Study Area)
Rozelle Rail Yards Site Management Works
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 25 50 100
Metres
Datum/Projection:
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Tree Locations and Impact
WestConnex - Map 8
C5
C6
JAMES CRAIG ROAD
THE CRESCENT
15m Construction Footprint Buffer (Study Area)
Refer to: "Roads and Maritime, 2018, Rozelle Rail Yards – Site Management Works Review of environmental factors"
Legend
C5 - Rozelle civil and tunnel site
C6 - The Crescent civil site
15m Construction Footprint Buffer (Study Area)
Rozelle Rail Yards Site Management Works
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 20 40 80
Metres
Datum/Projection:
GDA 1994 MGA Zone 56
N
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Tree Locations and Impact
WestConnex - Map 9
59
39N
40N
8N
54
3R
C8
7N
11N
2R
6N
60
56
55
57
53
59
5N
15m Construction Footprint Buffer (Study Area)
Legend
C8 - Iron Cove Link civil site
15m Construction Footprint Buffer (Study Area)
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 40 80 160
Metres
Datum/Projection:
GDA 1994 MGA Zone 56
N
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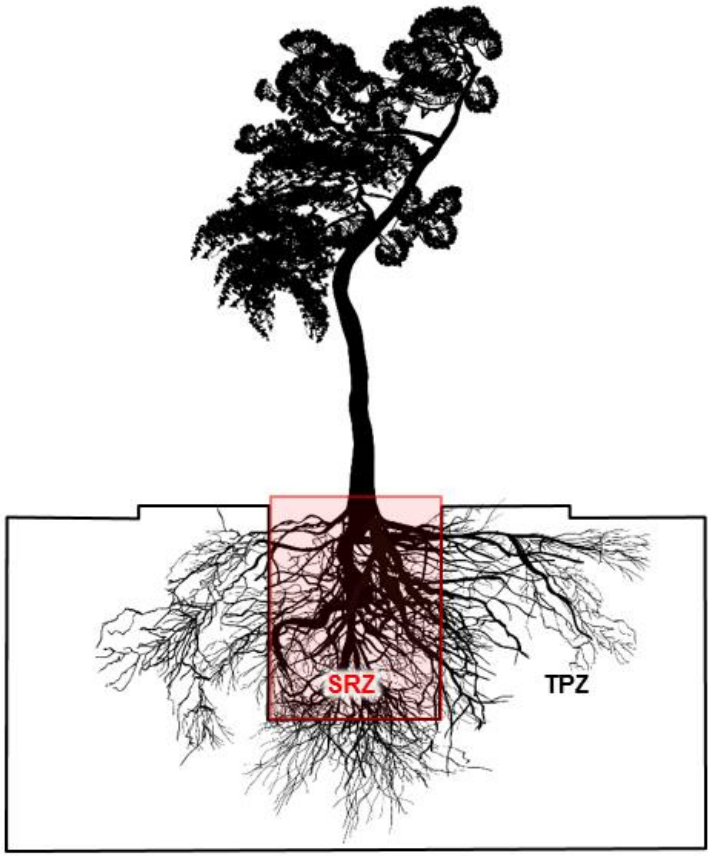
Tree Locations and Impact
WestConnex - Map 10
15m Construction Footprint Buffer (Study Area)
C9
42N
14R
28N
41N
Legend
C9 - Pyrmont Bridge Road tunnel site
15m Construction Footprint Buffer (Study Area)
Ancillary Facility
High Retention Value Trees
1N Areas of Trees to Retain
1R Areas of Trees to be Removed
1I Areas of Trees to Investigate For Retention
0 25 50 100
Metres
Datum/Projection:
GDA 1994 MGA Zone 56
eco logical AUSTRALIA
www.ecoaus.com.au
Prepared by: PH Date: 9/08/2017
N

Attachment B - Impact assessment

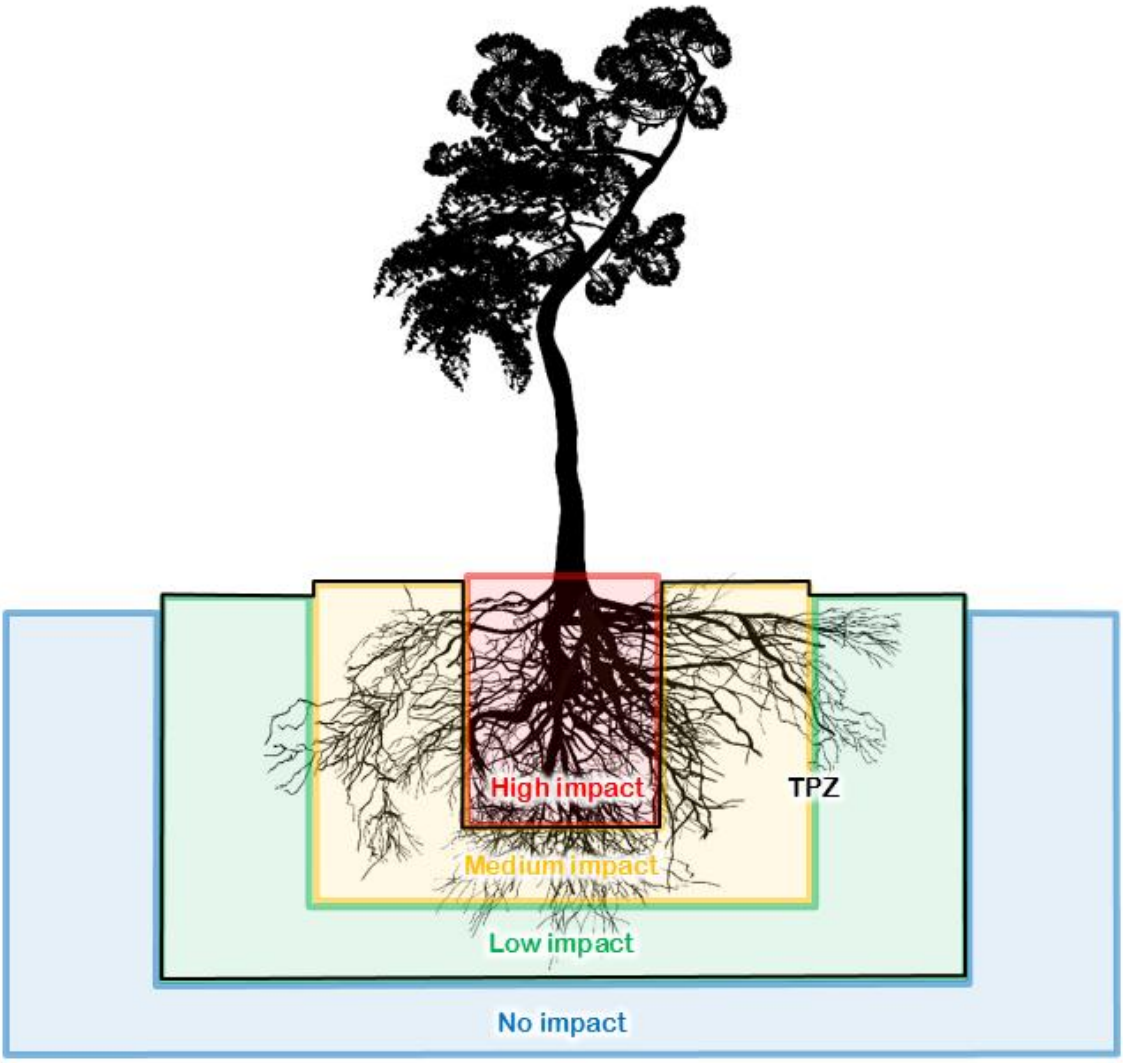
- **Tree protection zone:** The tree protection zone (TPZ) is the optimal combination of crown and root area (as defined by AS 4970-2009) that requires protection during the construction process so that the tree can remain viable. The TPZ is an area that is isolated from the work zone to insure no disturbance or encroachment occurs into this zone. Tree sensitive construction measures must be implemented if works are to proceed within the Tree Protection Zone
- **Structural root zone:** The structural root zone (SRZ) is the area of the root system (as defined by AS 4970-2009) used for stability, mechanical support and anchorage of the tree. The SRZ only considers a tree's structural stability, not the area of root zone required for long term viability. Severance of structural roots (>50 mmØ) within the SRZ is generally not recommended as it may lead to the destabilisation and/or decline of the tree
- **Root investigation:** When assessing the potential impacts of encroachment into the TPZ consideration will need to be given to the location and distribution of the roots, including above or below ground restrictions affecting root growth. Location and distribution of roots may be determined through non-destructive excavation (NDE) methods such as hydro-vacuum excavation (sucker truck), air spade and manual excavation. Root investigation is used to determine the extent and location of roots within the zone of conflict. Root investigation does not guarantee the retention of the tree.



Indicative TPZ and SRZ

Attachment C - Impacts within the TPZ

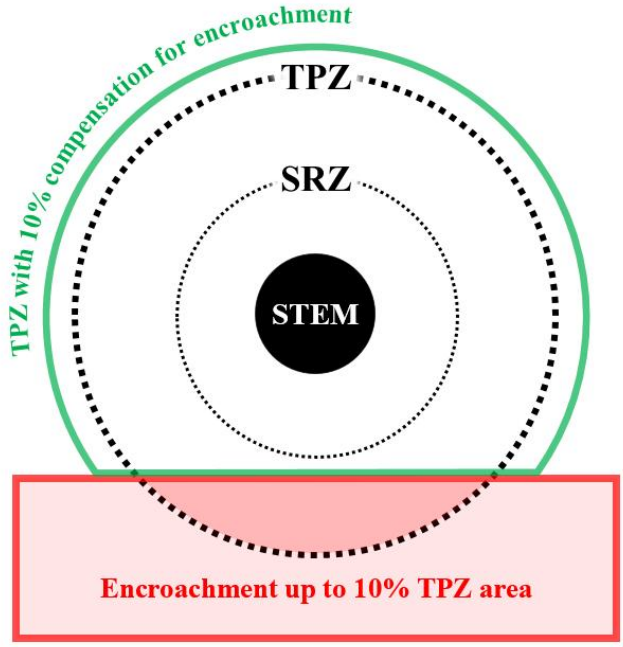
- **No impact (0%):** No likely or foreseeable encroachment within the TPZ
- **Low impact (<10%):** If the proposed encroachment is less than 10% (total area) of the TPZ, and outside of the SRZ, detailed root investigations should not be required. The area lost to this encroachment should be compensated for elsewhere, and be contiguous with the TPZ
- **Medium impact (<20%):** If the proposed encroachment is greater than 10% of the TPZ and outside of the SRZ, the project arborist must demonstrate that the tree(s) remain viable. The area lost to this encroachment should be compensated for elsewhere, and be contiguous with the TPZ. All work within the TPZ must be carried out under the supervision of the project arborist
- **High impact (>20%):** If the proposed encroachment is greater than 20% of the TPZ the SRZ may be impacted. Tree sensitive construction techniques may be used for minor works within this area providing no structural roots are likely to be impacted, and the project arborist can demonstrate that the tree(s) remain viable. Root investigation by non-destructive methods is essential for any proposed works within this area.

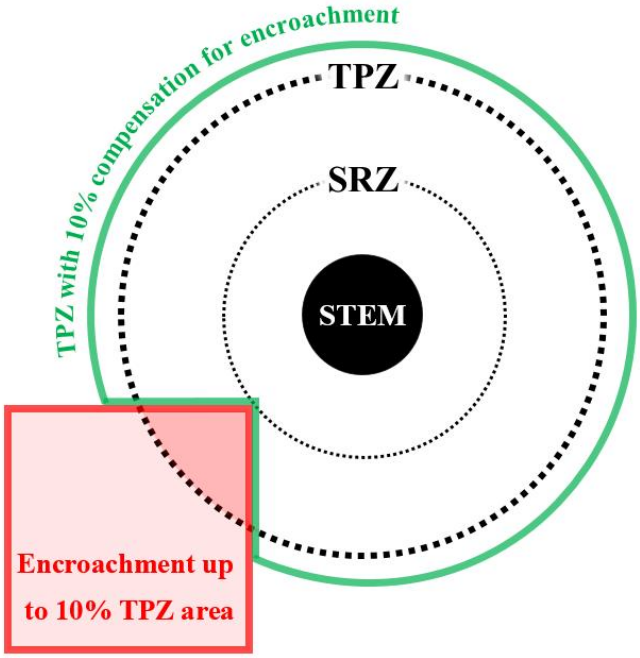


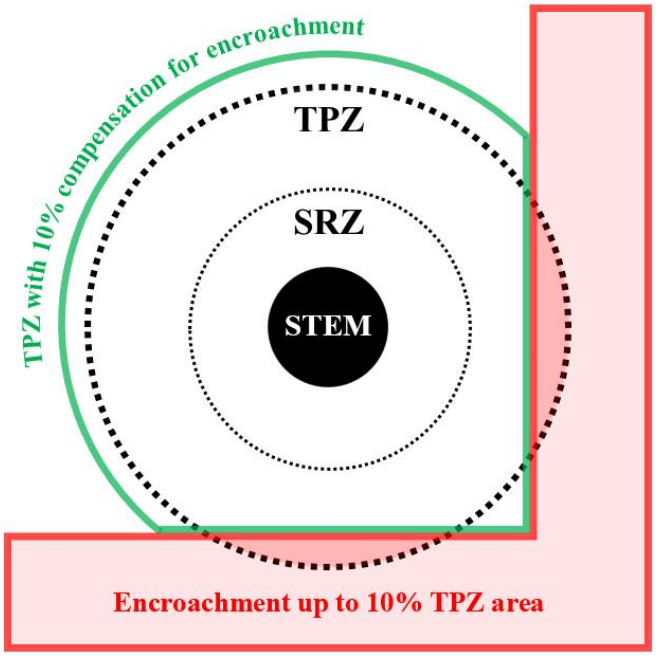
Indicative zones of impact within the TPZ

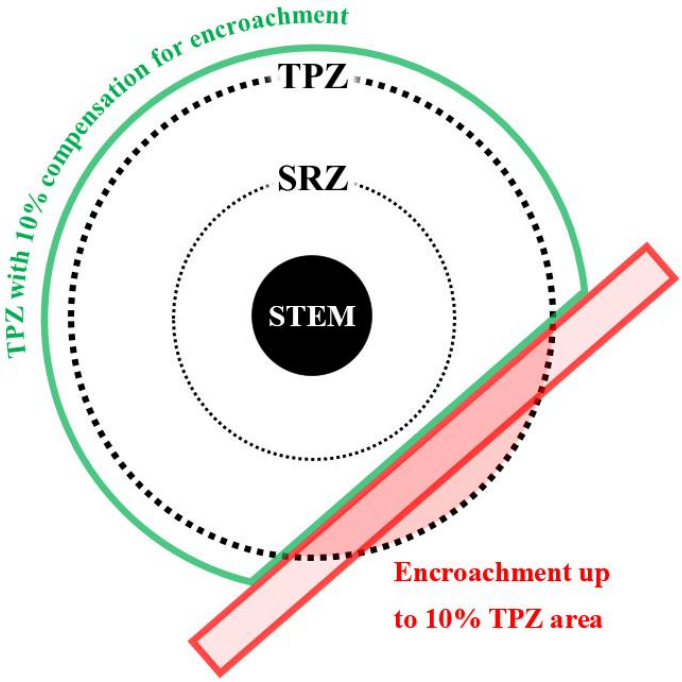
Attachment D - Encroachment within the TPZ

The following examples of minor encroachment are considered to be acceptable and will generally not require detailed root investigation.









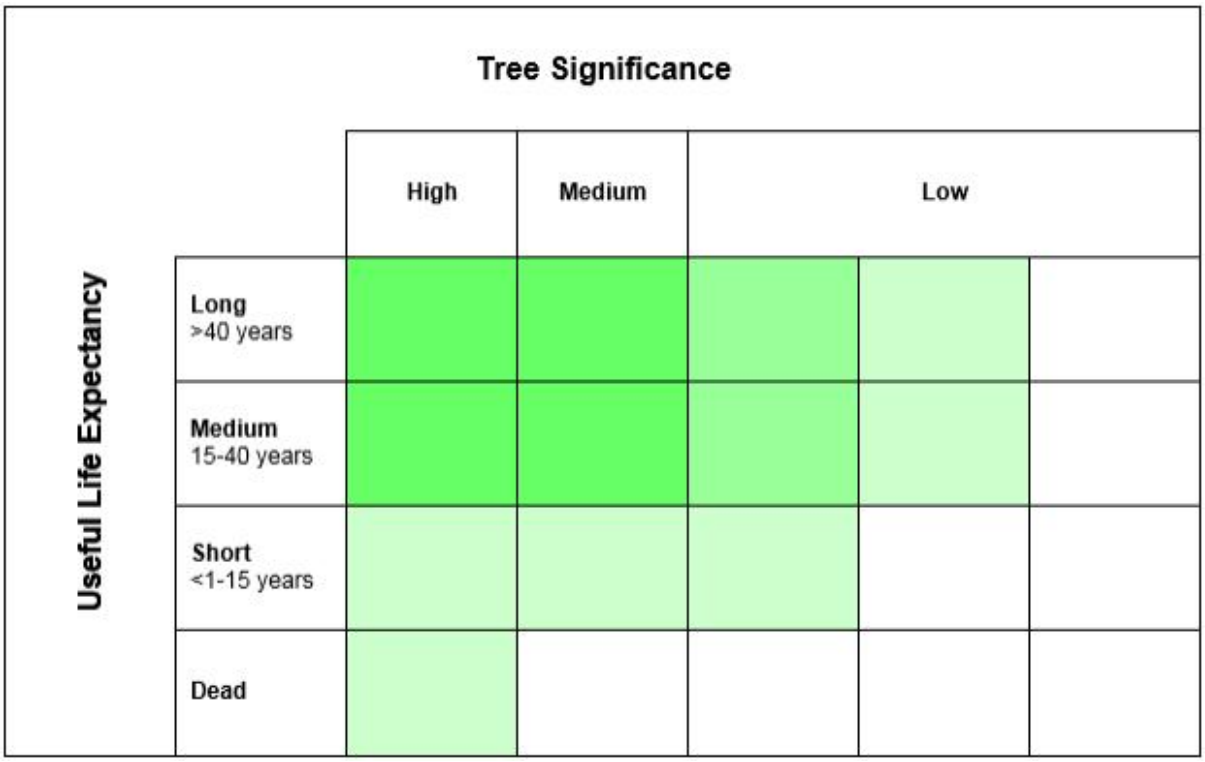
Reference

Council of Standards Australia (August 2009)
AS 4970-2009 Protection of Trees on Development Sites
Standards Australia, Sydney.

Attachment E - Tree retention assessment

Tree Significance – Assessment Criteria – STARS©		
Low	**Medium**	**High**
The tree is in fair to poor condition and good or low vigour The tree has form atypical of the species The tree is not visible or is partly visible from the surrounding properties or obstructed by other vegetation or buildings The tree provides a minor contribution or has a negative impact on the visual character and amenity of the local area The tree is a young specimen which may or may not have reached dimensions to be protected by local Tree Preservation Orders or similar protection mechanisms and can easily be replaced with a suitable specimen The tree's growth is severely restricted by above or below ground influences, unlikely to reach dimensions typical for the taxa in situ – tree is inappropriate to the site conditions The tree is listed as exempt under the provisions of the local Council Tree Preservation Order or similar protection mechanisms The tree has a wound or defect that has the potential to become structurally unsound. The tree is an environmental pest species due to its invasiveness or poisonous/allergenic properties. The tree is a declared noxious weed by legislation.	The tree is in fair to good condition The tree has form typical or atypical of the species The tree is a planted locally indigenous or a common species with its taxa commonly planted in the local area The tree is visible from surrounding properties, although not visually prominent as partially obstructed by other vegetation or buildings when viewed from the street The tree provides a fair contribution to the visual character and amenity of the local area The tree's growth is moderately restricted by above or below ground influences, reducing its ability to reach dimensions typical for the taxa in situ.	The tree is in good condition and good vigour The tree has a form typical for the species The tree is a remnant or is a planted locally indigenous specimen and/or is rare or uncommon in the local area or of botanical interest or of substantial age. The tree is listed as a heritage item, threatened species or part of an endangered ecological community or listed on councils significant tree register The tree is visually prominent and visible from a considerable distance when viewed from most directions within the landscape due to its size and scale and makes a positive contribution to the local amenity. The tree supports social and cultural sentiments or spiritual associations, reflected by the broader population or community group or has commemorative values. The tree's growth is unrestricted by above and below ground influences, supporting its ability to reach dimensions typical for the taxa in situ – tree is appropriate to the site conditions.

Useful Life Expectancy – Assessment Criteria			
Dead	**Short**	**Medium**	**Long**
Trees that should be removed within the next 5 years. Dead, dying, suppressed or declining trees because of disease or inhospitable conditions. Dangerous trees because of instability or recent loss of adjacent trees. Dangerous trees because of structural defects including cavities, decay, included bark, wounds or poor form. Damaged trees that are clearly not safe to retain. Trees that could live for more than 5 years but may be removed to prevent interference with more suitable individuals or to provide space for new planting. Trees that are damaging or may cause damage to existing structures within 5 years. Trees that will become dangerous after removal of other trees for the reasons.	Trees that appear to be retainable at the time of the assessment for 5-15 years with an acceptable level of risk. Trees that may only live between 5 and 15 more years. Trees that could live for more than 15 years but may be removed for safety or nuisance reasons. Trees that could live for more than 40 years but may be removed to prevent interference with more suitable individuals or to provide space for new planting. Trees that could be made suitable for retention in the medium term by remedial tree care.	Trees that appear to be retainable at the time of the assessment for 15-40 years with an acceptable level of risk. Trees that may only live between 15 and 40 more years. Trees that could live for more than 40 years but may be removed for safety or nuisance reasons. Trees that could live for more than 40 years but may be removed to prevent interference with more suitable individuals or to provide space for new planting. Trees that could be made suitable for retention in the medium term by remedial tree care.	Trees that appear to be retainable at the time of the assessment for more than 40 years with an acceptable level of risk. Structurally sound trees located in positions that can accommodate future growth. Trees that could be made suitable for retention in the long term by remedial tree care. Trees of special significance for historical, commemorative or rarity reasons that would warrant extraordinary efforts to secure their long term retention.



Legend for Matrix Assessment	
	Priority for retention (High): These trees are considered important for retention and should be retained and protected. Design modification or re-location of building/s should be considered to accommodate the setbacks as prescribed by AS 4970 – *Protection of trees on development sites*. Tree sensitive construction measures must be implemented if works are to proceed within the Tree Protection Zone.
	Consider for retention (Medium): These trees may be retained and protected. These are considered less critical; however their retention should remain priority with the removal considered only if adversely affecting the proposed building/works and all other alternatives have been considered and exhausted.
	Consider for removal (Low): These tree are not considered important for retention, nor require special works or design modification to be implemented for their retention.
	Consider for removal (Low): These tree are not considered important for retention, nor require special works or design modification to be implemented for their retention.

Attachment F - Tree protection guidelines

The following tree protection guidelines must be implemented during the construction period in the event that no tree-specific recommendations are detailed.

Tree protection fencing

The TPZ is a restricted area delineated by protective fencing or the use of an existing structure (such as a wall or fence).

Trees that are to be retained must have protective fencing erected around the TPZ (or as specified in the body of the report) to protect and isolate it from the construction works. Fencing must comply with AS 4687-2007 - *Temporary fencing and hoardings*.

Tree protection fencing must be installed prior to site establishment and remain intact until completion of works. Once erected, protective fencing must not be removed or altered without the approval of the project arborist.

If the protective fencing requires temporary removal, trunk, branch and ground protection must be installed and must comply with *AS 4970-2009, Protection of Trees on Development Sites*.

Tree protection fencing shall be:

- Enclosed to the full extent of the TPZ (or as specified in the Recommendations and Tree Protection Plan).
- Cyclone chain wire link fence or similar, with lockable access gates.
- Certified and Inspected by the Project Arborist.
- Installed prior to the commencement of works.
- Prominently signposted with 300mm x 450mm boards stating 'NO ACCESS – TREE PROTECTION ZONE'.

Crown protection

Tree crowns/canopy may be injured or damaged by machinery such as excavators, drilling rigs, trucks, cranes, plant and vehicles. Where crown protection is required, it will usually be located at least one metre outside the perimeter of the crown.

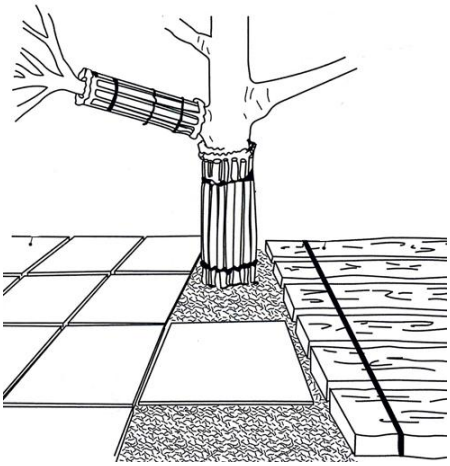
Crown protection may include the installation of a physical barrier, pruning selected branches to establish clearance, or the tying/bracing of branches.

Trunk protection

Where provision of tree protection fencing is impractical or must be temporarily removed, truck protection shall be installed for the nominated trees to avoid accidental mechanical damage.

The removal of bark or branches allows the potential ingress of micro-organisms which may cause decay. Furthermore, the removal of bark restricts the trees' ability to distribute water, mineral ions (solutes), and glucose.

Trunk protection shall consist of a layer of either carpet underfelt, geotextile fabric or similar wrapped around the trunk, followed by 1.8 m lengths of softwood timbers aligned vertically and spaced evenly around the trunk (with an approx. 50 mm gap between the timbers).



The timbers must be secured using galvanised hoop strap (aluminium strapping). The timbers shall be wrapped around the trunk but not fixed to the tree, as this will cause injury/damage to the tree.

Ground protection

Tree roots are essential for the uptake/absorption of water, oxygen and mineral ions (solutes). It is essential to prevent the disturbance of the soil beneath the dripline and within the TPZ of trees that are to be retained. Soil compaction within the TPZ will adversely affect the ability of roots to function correctly.

If temporary access for machinery is required within the TPZ ground protection measures will be required. The purpose of ground protection is to prevent root damage and soil compaction within the TPZ. Ground protection may include a permeable membrane such as geotextile fabric beneath a layer of mulch, crushed rock or rumble boards.

If the grade is to be raised within the TPZ, the material should be coarser or more porous than the underlying material.

Root protection and pruning

If incursions/excavation within the TPZ are unavoidable, exploratory excavation (under the supervision of the Project Arborist) using non-destructive methods may be considered to evaluate the extent of the root system affected, and determine whether or not the tree can remain viable.

If the project arborist identifies conflicting roots that requiring pruning, they must be pruned with a sharp implement such as; secateurs, pruners, handsaws or a chainsaw back to undamaged tissue. The final cut must be a clean cut.

Underground services

All underground services should be routed outside of the TPZ. If underground services need to be installed within the TPZ, they should be installed using horizontal directional drilling (HDD). The horizontal drilling/boring must be at minimum depth of 600 mm below grade. Trenching for services is to be regarded as ‘excavation’.

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