Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Chapter 19

Biodiversity

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19 Biodiversity

This chapter provides an assessment of the potential impacts of the project on terrestrial, aquatic and marine biodiversity and identifies measures to address these impacts.

A detailed assessment of terrestrial and aquatic biodiversity has been carried out for the project and is included in Appendix S (Technical working paper: Biodiversity development assessment report). A detailed assessment of marine biodiversity has been carried out for the project and is included in Appendix T (Technical working paper: Marine ecology).

The Secretary's environmental assessment requirements as they relate to biodiversity, and where in the environmental impact statement these have been addressed, are detailed in Table 19-1.

Avoiding or minimising impacts has been a key consideration throughout the design and development process for the Beaches Link and Gore Hill Freeway Connection project. A conservative approach has generally been used in the assessments, with potential impacts presented before implementation of environmental management measures. The environmental management measures proposed to minimise the potential impacts in relation to biodiversity are included in Section 19.6.

Table 19-1 Secretary's environmental assessment requirements – biodiversity

Secretary's requirement	Where addressed in EIS
Biodiversity	
1. Biodiversity impacts related to the proposal are to be assessed in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR).	Biodiversity impacts related to the project are provided in **Section 19.5** and documented in **Appendix S** (Technical working paper: Biodiversity development assessment report).
2. The BDAR must include information in the form detailed in the *Biodiversity Conservation Act 2016* (s. 6.12), Biodiversity Conservation Regulation 2017 (s. 6.8) and Biodiversity Assessment Method (BAM) including details of the measures proposed to address the offset obligation as follows: a. the total number and classes of biodiversity credits required to be retired for the developments/project; b. the number of classes of like-for-like biodiversity credits proposed to be retired; c. the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; d. any proposal to fund a biodiversity conservation action; and	The biodiversity development assessment report is provided in **Appendix S** (Technical working paper: Biodiversity development assessment report).

Secretary's requirement	Where addressed in EIS
e. any proposal to make a payment to the Biodiversity Conservation Fund.	
3. The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the BAM.	**Section 19.4** describes how the development of the project has avoided and minimised direct and indirect biodiversity impacts with further discussion provided in **Appendix S** (Technical working paper: Biodiversity development assessment report). Further details about route option development are provided in **Chapter 4** (Project development and alternatives). **Section 19.5** provides an assessment of all direct, indirect and prescribed impacts in accordance with the *Biodiversity Assessment Method*. **Section 19.6** provides environmental management measures to further avoid and/or minimise biodiversity impacts and **Section 19.6.1** details the proposed offsets for the project. Further detail is included in **Appendix S** (Technical working paper: Biodiversity development assessment report).
4. If requesting the application of the variation rules, the BDAR must contain details of what reasonable steps have been taken to attempt to obtain the required like-for-like biodiversity credits.	Not applicable.
5. The BDAR must include all spatial data associated with the survey and assessment as per Appendix 11 of the BAM.	Spatial data is provided as part of the **Appendix S** (Technical working paper: Biodiversity development assessment report) submission and *Biodiversity Assessment Method* credit calculator finalisation.
6. The BDAR must be prepared by a person accredited in accordance with the Accreditation scheme for the Application of the Biodiversity Assessment Method Order 2017 under s. 6.10 of the *Biodiversity Conservation Act 2016*.	Details on accreditation in accordance with the Accreditation scheme for the Application of the Biodiversity Assessment Method Order 2017 is provided in **Appendix S** (Technical working paper: Biodiversity development assessment report).
7. In accordance with section 9.1 and 9.2 of the BAM the BDAR must assess all direct and indirect impacts of the proposal on native vegetation, threatened ecological communities and threatened species habitat.	**Section 19.5** provides an assessment of biodiversity impacts related to the project with further details provided in **Appendix S** (Technical working paper: Biodiversity development assessment report).

Secretary's requirement	Where addressed in EIS
8. Impacts on biodiversity values that cannot be assessed using the BAM must also be otherwise assessed. The values include: a. marine mammals; b. wandering seabirds; and c. matters of national significance listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.	**Section 19.5** includes an assessment of impacts on biodiversity values that cannot be assessed using the *Biodiversity Assessment Method*. Further details are provided in **Appendix S** (Technical working paper: Biodiversity development assessment report) and **Appendix T** (Technical working paper: Marine ecology).
9. Species declared as threatened under the *Biodiversity Conservation Act 2016* and recorded recently (since 1990) within approximately 1.5 kilometres of the project's development corridor should be considered as likely to be affected by the proposal.	**Section 19.5** provides an assessment of the impacts to threatened species. Consideration of species recently recorded within 1.5 kilometres of the construction footprint are documented in **Appendix S** (Technical working paper: Biodiversity development assessment report).
10. Identify and assess the impacts of tidal flushing on the crossing of Middle Harbour. This assessment should also include details of any potential sediment accumulation and the impacts this may have on marine populations that dwell on the harbour floor.	**Section 19.5.5** provides an assessment of the impacts of tidal flushing, including low dissolved oxygen and sedimentation on marine populations. This is further discussed in **Appendix T** (Technical working paper: Marine ecology).

19.1 Legislative and policy framework

Chapter 2 (Assessment process) describes the environmental impact assessment and approval process for the project, including relevant NSW and Commonwealth legislation applicable to the project. The key legislative requirements and assessment guidelines specific to biodiversity are outlined below.

19.1.1 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* replaced the *Threatened Species Conservation Act 1995* on 25 August 2017. The *Biodiversity Conservation Act 2016* aims to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development. It establishes a framework for assessment and offsetting of biodiversity impacts as well as investment in biodiversity conservation.

The *Biodiversity Assessment Method* (Office of Environment and Heritage (OEH), 2017) is established under section 6.7 of the *Biodiversity Conservation Act 2016*. The purpose of the *Biodiversity Assessment Method* is to assess impacts on threatened species and threatened ecological communities, and their habitats, and the impact on biodiversity values, where required under the *Biodiversity Conservation Act 2016*. The Biodiversity development assessment report provided in Appendix S (Technical working paper: Biodiversity development assessment report) was prepared on the basis of the *Biodiversity Assessment Method* in force before 22 October 2020.

19.1.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) includes provisions to protect and manage matters of national environmental significance, including nationally and internationally important flora, fauna, ecological communities and migratory species, defined in the *Environment Protection and Biodiversity Conservation Act 1999* as matters of national environmental significance.

In accordance with sections 67 and 67A of the *Environment Protection and Biodiversity Conservation Act 1999*, any action that has potential to result in an impact on any matters of national environmental significance or on Commonwealth land are considered 'controlled actions' and require a referral to the Australian Government Minister for the Environment for approval. The significance of impacts on matters of national environmental significance is determined in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (Department of the Environment, 2013).

19.1.3 Fisheries Management Act 1994

The *Fisheries Management Act 1994* contains provisions for the conservation of fish stocks, key fish habitat, biodiversity, threatened species, populations and ecological communities. The *Fisheries Management Act 1994* regulates the conservation of fish, marine vegetation and some aquatic macroinvertebrates and the development and sharing of fishery resources of NSW for present and future generations. Part 7 of the *Fisheries Management Act 1994* identifies requirements for the protection of aquatic habitats, while Part 7A of the *Fisheries Management Act 1994* lists threatened species, populations and ecological communities and key threatening processes for species, populations and ecological communities in NSW waters. Section 220ZZ of the *Fisheries Management Act 1994* outlines significant impact considerations to threatened species, populations and ecological communities listed under the *Fisheries Management Act 1994*.

19.1.4 Assessment policy and guidelines

A number of assessment guidelines were used to inform the biodiversity assessment, the most relevant of which were:

- *Biodiversity Assessment Method* (OEH, 2017) – for the assessment of impacts on threatened species, threatened ecological communities, and their habitats, and the impact on biodiversity values, where required under the *Biodiversity Conservation Act 2016*
- *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (Department of the Environment, 2013) – for the assessment of significance of impacts on matters of national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999*
- *Policy and guidelines for fish habitat conservation and management* (NSW Department of Primary Industries (NSW DPI), 2013) – for the assessment of freshwater and marine biodiversity matters.

Lists of all of the assessment guidelines that were used to inform the biodiversity assessment are provided in Appendix S (Technical working paper: Biodiversity development assessment report) and Appendix T (Technical working paper: Marine ecology).

19.2 Assessment methodology

The biodiversity assessment includes consideration of potential impacts on:

- Terrestrial biodiversity, consistent with the *Biodiversity Assessment Method* (Section 19.2.1)
- Aquatic (freshwater) biodiversity (Section 19.2.2)
- Marine biodiversity (Section 19.2.3).

The key terminology used for the terrestrial, aquatic and marine biodiversity assessments with regard to extent of assessments and identification of impacts is summarised in Table 19-2.

Table 19-2 Biodiversity assessment extent terminology

Term	Definition
Terrestrial biodiversity	
Assessment area	An area within 500 metres of the construction footprint
Construction footprint	The aboveground area to be directly impacted by the project
Terrestrial biodiversity locality	An area within 10 kilometres of the construction footprint
Aquatic biodiversity	
Assessment area	An area within 500 metres of the construction footprint
Construction footprint	The aboveground area to be directly impacted by the project
Aquatic biodiversity study area	An area encompassing the construction footprint and areas immediately adjacent (about 500 metres around the construction footprint)
Marine biodiversity	
Project area	The marine area to be directly impacted by the project
Marine biodiversity study area	Estuarine areas from the highest astronomical tide encompassing the project area and areas nearby from Yeoland Point to Grotto Point
Marine biodiversity study locality	An area within 10 kilometres of the project area (for the purpose of the desktop review)

19.2.1 Terrestrial biodiversity

The assessment of potential impacts on terrestrial biodiversity has been carried out in accordance with the *Biodiversity Assessment Method* (OEH, 2017). The assessment methodology is summarised below, with further detail provided in Appendix S (Technical working paper: Biodiversity development assessment report).

Desktop assessment

A desktop assessment was carried out for the project, including review of information from relevant databases, vegetation maps, topographic maps, aerial photography, reports and published literature.

The following databases were searched on several occasions between June 2016 and April 2020:

- BioNet Atlas of NSW Wildlife
- Environment Protection and Biodiversity Conservation Act 1999 Protected Matters Search Tool
- Threatened species profile search.

The database searches were carried out for the terrestrial biodiversity locality.

The desktop assessment was used to identify threatened species, populations, communities and their habitats with a likelihood of occurrence in areas that may be impacted by the project.

Field surveys

Multiple field surveys were carried out between May 2016 and April 2020, and included:

- Random meander surveys to verify vegetation communities and the condition of vegetation across accessible land within the construction footprint
- Targeted flora and fauna surveys for species identified as having a high or moderate likelihood of occurrence in areas that may be impacted by the project, as identified through the desktop assessment
- Vegetation integrity plots involving quantitative (quadrat/transect) site surveys in accordance with the *Biodiversity Assessment Method*
- Floristic analysis of vegetation plot data to determine vegetation community and plant community types. Native vegetation was classified according to the plant community types in the Vegetation Information System Classification (DPIE (EES), 2020b). Areas of non-PCT vegetation were also identified and mapped.

Further detail on the field surveys between May 2016 and April 2020 is provided in Appendix S (Technical working paper: Biodiversity development assessment report).

Assessment of potential impacts

The potential impacts of the project were assessed against the relevant matters in the *Biodiversity Assessment Method* (OEH, 2017), including:

- Removal of native vegetation and habitat, including direct and indirect impacts on native vegetation and threated flora
- The potential for serious and irreversible impacts on identified threatened species and ecological communities
- The prescribed biodiversity impacts under the *Biodiversity Assessment Method* (OEH, 2017)
- The potential for impacts on relevant matters of national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999*.

For the purposes of the assessment, it is assumed that all vegetation within the construction footprint would be removed, except for the Burnt Bridge Creek riparian corridor exclusion zone shown in Figure 19-3.

19.2.2 Aquatic biodiversity

The freshwater aquatic habitat assessment was informed by the results of inspections carried out across five waterways, and associated tributaries, and two waterbodies within the aquatic biodiversity study area:

- Willoughby Creek
- Flat Rock Creek
- Burnt Bridge Creek
- Manly Creek
- Manly Dam
- Trefoil Creek
- Wakehurst Golf Course dam – a dam downstream of the Wakehurst Parkway east construction support site (BL13).

The extent and condition of freshwater habitats within the aquatic biodiversity study area was recorded during the site inspections.

No fish or macroinvertebrate sampling was carried out during the inspections. The likelihood of occurrence of aquatic species has been assessed based on the availability of suitable habitat. Further details of the inspection locations are provided in Annexure D (Freshwater ecology impact assessment) of Appendix S (Technical working paper: Biodiversity development assessment report).

In summary, the aquatic assessment involved the following:

- Identification of the location, extent and condition of waterways potentially impacted by the project
- Assessment of potential impacts to freshwater ecology, including threatened species and ecological communities, and geomorphology due to construction and operation of the project
- Identification of environmental management measures and offsets required to manage potential impacts to aquatic biodiversity.

19.2.3 Marine biodiversity

The assessment methodology for marine biodiversity is summarised below, with further details provided in Appendix T (Technical working paper: Marine ecology).

Desktop assessment

A desktop assessment was carried out for the project, including review of information from relevant databases, aerial photography, reports and published literature.

The following databases were searched:

- BioNet Atlas of NSW Wildlife
- Environment Protection and Biodiversity Conservation Act 1999 Protected Matters Search Tool
- Threatened species profile search
- NSW Department of Planning, Industry and Environment's Fish Communities and Threatened Species Distribution of NSW
- NSW Department of Planning, Industry and Environment's Listed Protected Fish Species website
- NSW Department of Planning, Industry and Environment's Listed Threatened Species, Populations and Ecological Communities website
- National System for the Prevention and Management of Marine Pest Incursions website
- Atlas of Living Australia.

The database searches were carried out for the marine biodiversity study locality.

The desktop assessment was used to identify threatened species, populations, communities and their habitats with a likelihood of occurrence in areas to be impacted by the project.

Field surveys

Preliminary sampling and predictive habitat mapping from aerial photography captured in May 2017 was used to identify areas for field surveys. Sites for field surveys also took into account the outcomes of the desktop assessment, including consideration of relevant species, communities, populations and habitats, and their likelihood of occurrence in areas that may be impacted by the project.

Field surveys were carried out within Middle Harbour in November and December 2017, between Yeoland Point at Castle Cove and Grotto Point at the entrance to Middle Harbour. The field surveys included mapping and confirmation of seagrass, subtidal rocky reef, intertidal rocky reef and deep water soft sediment habitats. Surveys of macroalgae, sessile invertebrate and epibiota coverage and fish numbers, and macroinvertebrate sampling were also carried out in relevant habitats.

Assessment of potential impacts

A risk based approach was applied to the assessment of potential direct and indirect impacts of the project on marine biodiversity, including impacts associated with:

- Removal of habitat
- Turbidity
- Sedimentation
- Mobilisation of contaminants
- Introduction/spread of marine pests
- Altered hydrodynamics
- Underwater noise
- Boat strike to marine mammals and reptiles
- Spill of contaminants.

The assessment considered the sensitivity of key fish habitat types, including Type 1 (highly sensitive), Type 2 (moderately sensitive) and Type 3 (minimally sensitive) habitats.

The likelihood and consequence of direct and indirect impacts on each key fish habitat were evaluated to determine an anticipated level of risk. The levels of risk applied to the assessment are summarised in Table 19-3.

Table 19-3 Risk levels applied to the assessment of potential marine biodiversity impacts

Level of risk	Description
Extreme	The risk is unmanageable and unjustified. Measures to reduce the risk to a lower level are required.
High	The risk is significant and requires substantial measures for risk reduction and/or management.
Medium	The risk may be acceptable and requires routine management measures.
Low	The risk is acceptable and requires either routine management measures or no further measures.

19.3 Existing environment

This section summarises the existing key biodiversity values along and around the project alignment, including:

- Terrestrial flora (Section 19.3.1)
- Terrestrial fauna (Section 19.3.2)
- Aquatic biodiversity (Section 19.3.3)
- Marine biodiversity (Section 19.3.6).

19.3.1 Terrestrial flora

Vegetation communities

Vegetation communities within the construction footprint are summarised in Table 19-4 and shown in Figure 19-1 to Figure 19-5.

The construction footprint of the project overlaps with the construction footprint of the Western Harbour Tunnel and Warringah Upgrade project at Warringah Freeway/Cammeray Golf Course construction support site (BL1). This overlap area was previously assessed as part of the environmental impact statement prepared for the Western Harbour Tunnel and Warringah Upgrade project in 2020. As such, consideration of vegetation within the overlap is not included in the assessment of the Beaches Link and Gore Freeway Connection project.

In addition, the recently completed Northern Beaches Hospital road upgrade project overlaps with the northern extent of the construction footprint. The area of overlap has been heavily modified/cleared due to the construction of the Northern Beaches Hospital road upgrade project. As such, for the purposes of this assessment, all calculations of biodiversity impacts have excluded the area of overlap (see Figure 19-5).

Field surveys carried out for the project identified seven native vegetation communities within the construction footprint, consistent with the following plant community types (PCT):

- PCT 1250: Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion
- PCT 1292: Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion
- PCT 1783: Red Bloodwood - Scribbly Gum/Old-man Banksia open forest on sandstone ridges of northern Sydney and the Central Coast
- PCT 1786: Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region
- PCT 1824: Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin
- PCT 1841: Smooth-barked Apple - Turpentine - Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region
- PCT 1845: Smooth-barked Apple - Red Bloodwood - Blackbutt tall open forest on shale sandstone transition soils in eastern Sydney.

These vegetation communities cover around 15.05 hectares within the construction footprint.

Other vegetation within the construction footprint is also described in Table 19-4 and shown in Figure 19-1 to Figure 19-5 and includes:

- Native revegetation
- Native plantings
- Urban exotic/native
- Weeds and exotics.

This vegetation covers around 6.77 hectares within the construction footprint.

A vegetation exclusion zone is shown on Figure 19-3. This zone was included to reduce the direct impact on the Burnt Bridge Creek riparian corridor and is further discussed in Section 19.4.

Threatened ecological communities

Several patches of the Duffys Forest endangered ecological community (aligned with PCT 1786) have been identified within the construction footprint, as shown in Figure 19-4 and Figure 19-5. This community is listed as endangered under the *Biodiversity Conservation Act 2016*.

The Wakehurst Parkway north construction support site (BL14) would be the same site that was used as the main construction support site for the Northern Beaches Hospital road upgrade project (refer to Figure 19-5). Revegetation works were carried out at this site, including planting with species consistent with the Duffys Forest endangered ecological community within the eastern section of the decommissioned construction support site. During site establishment of the Wakehurst Parkway north construction support site (BL14), this revegetated area would remain fenced off and protected from disturbance. Due to the timing of these recent revegetation works, the current site layout of the Wakehurst Parkway north construction support site (BL14) does not show the revegetation area. During further design development and construction planning, the temporary construction support site layout would be refined to show the revegetation area, and ensure it is avoided and protected during construction.

Table 19-4 Vegetation communities within the construction footprint

Mapped vegetation[1]	Corresponding plant community type (PCT)	Location within the construction footprint	Area within the construction footprint (ha)
Native vegetation community	Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion (PCT 1250)	This community occurs on sandy soils influenced by Hawkesbury Sandstone and alluvium geologies. Within the construction footprint, the community was found adjoining the Wakehurst Parkway, within a steep gully forming the head of a tributary of Manly Creek.	0.20
Native vegetation community	Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion (PCT 1292)	This community occurs on sandy soils derived from sandstone and alluvium geologies. Within the construction footprint, this community occurs along the Burnt Bridge Creek riparian corridor within Balgowlah Golf Course, and the Kitchener Street construction support site (BL11). Within the construction footprint, this community experiences moderate to high levels of disturbance intersected by walking paths and roads as well being exposed to rubbish, stormwater debris and erosion of substrates and creek banks. It is likely that these factors have contributed to the diversity of exotic plant species recorded within the construction footprint. Weed coverage however is generally restricted to the mid-storey and groundcover with only three exotic canopy trees recorded.	0.88
Native vegetation community	Red Bloodwood - Scribbly Gum/Old-man Banksia open forest on sandstone ridges of northern Sydney and the Central Coast (PCT 1783)	This community occurs along the Wakehurst Parkway on dry sandy soils derived from Hawkesbury sandstone. Along the Wakehurst Parkway the community is subjected to disturbance such as walking paths, edge effects associated with the road and minor weed incursions. This community also occurs within the proposed Wakehurst Parkway east construction support site (BL13).	4.23

Mapped vegetation[1]	Corresponding plant community type (PCT)	Location within the construction footprint	Area within the construction footprint (ha)
Native vegetation community	Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region (PCT 1786) (consistent with the Duffys Forest endangered ecological community)	This community occurs on sandy soils derived from sandstone geology and was generally found on the upper slopes supporting a diverse range of small trees, shrubs and ground covers. This community was recorded along the Wakehurst Parkway within the construction footprint and subsequently experiences moderate levels of disturbances in the form of walking paths, edge effects associated with the road and minor weed incursions. This community also occurs within the proposed Wakehurst Parkway south construction support site (BL12).	1.38
Native vegetation community	Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin (PCT 1824)	This community is associated with wetter areas on sandy soils derived from sandstone geology. This community was mapped along the Wakehurst Parkway within the construction footprint, and subsequently experiences moderate levels of disturbance in the form of walking paths, edge effects associated with the road and minor weed incursions. This community also occurs within the proposed Wakehurst Parkway east construction support site (BL13).	6.18
Native vegetation community	Smooth-barked Apple - Turpentine - Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region (PCT 1841)	This community occurs on sandy soils with slight loam components derived from Hawkesbury sandstone geology. These areas vary in gradient from gentle to steep and were typically situated within proximity to a watercourse. Within the construction footprint, this community was recorded along Burnt Bridge Creek within the Balgowlah Golf Course, within Flat Rock Drive construction support site (BL2) associated with an existing aboveground watercourse and at the Gore Hill Freeway.	1.79

Mapped vegetation[1]	Corresponding plant community type (PCT)	Location within the construction footprint	Area within the construction footprint (ha)
Native vegetation community	Smooth-barked Apple - Red Bloodwood - Blackbutt tall open forest on shale sandstone transition soils in eastern Sydney (PCT 1845)	This community occurs on sandy soils derived from sandstone geology and was generally found on the upper slopes supporting a diverse range of small trees, shrubs and ground covers. This community was recorded along the northern section of the Wakehurst Parkway within the construction footprint and subsequently experiences moderate levels of disturbance in the form of walking paths, edge effects associated with the road and minor weed incursions.	0.39
Total area of mapped native vegetation communities (PCTs)			**15.05**
Native revegetation	Assigned to the adjoining Smooth-barked Apple - Turpentine - Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region (PCT 1841) for the purpose of assessment using the *Biodiversity Assessment Method* credit calculator	This vegetation type is located within Flat Rock Drive construction support site (BL2). The Flat Rock Drive construction support site (BL2) is located within Flat Rock Reserve, a council reserve containing native revegetation. Flat Rock Reserve supported a municipal waste landfill site until 1985. The site was capped with clay in 1998 and has since been progressively revegetated.	1.29
Native plantings	Not consistent with the definition of any plant community type Miscellaneous ecosystems - highly disturbed with no or limited native vegetation	This vegetation association occurs within highly disturbed areas which have been subject to landscaping following development of infrastructure (eg roads, rail, and electricity easements), recreational facilities (eg sports fields, walking tracks), parking areas as well as residential and commercial areas. These landscaped areas have commonly been planted out with native species using horticultural specimens with unknown genetic origins. This vegetation type occurs at Gore Hill Freeway, within the proposed Flat Rock Drive construction support site (BL2), Balgowlah Golf Course construction support site (BL10) and Wakehurst Parkway east construction support site (BL13).	0.36

Mapped vegetation[1]	Corresponding plant community type (PCT)	Location within the construction footprint	Area within the construction footprint (ha)
Urban exotic/native	Not consistent with the definition of any plant community type Miscellaneous ecosystems - highly disturbed with no or limited native vegetation	This vegetation type occurs as garden, park and road verge plantings within existing disturbed areas of the construction footprint. These areas generally contain planted native and exotic horticultural specimens or isolated remnant trees within otherwise planted areas. This vegetation type occurs at Gore Hill Freeway, within the proposed Punch Street construction support site (BL3), Balgowlah Golf Course construction support site (BL10) and Wakehurst Parkway south construction support site (BL12).	4.89
Weeds and exotics	Not consistent with the definition of any plant community type Miscellaneous ecosystems - highly disturbed with no or limited native vegetation	This vegetation type occurs throughout the construction footprint as cleared lands dominated by weeds and/or exotic species. These areas generally occur as exotic grasslands or dense thickets of woody weeds within parks and road verges.	0.23
Total vegetation within construction footprint (including native vegetation communities)			**21.82**

Note 1: Vegetation mapped by project ecologists as part of field surveys for the biodiversity development assessment report

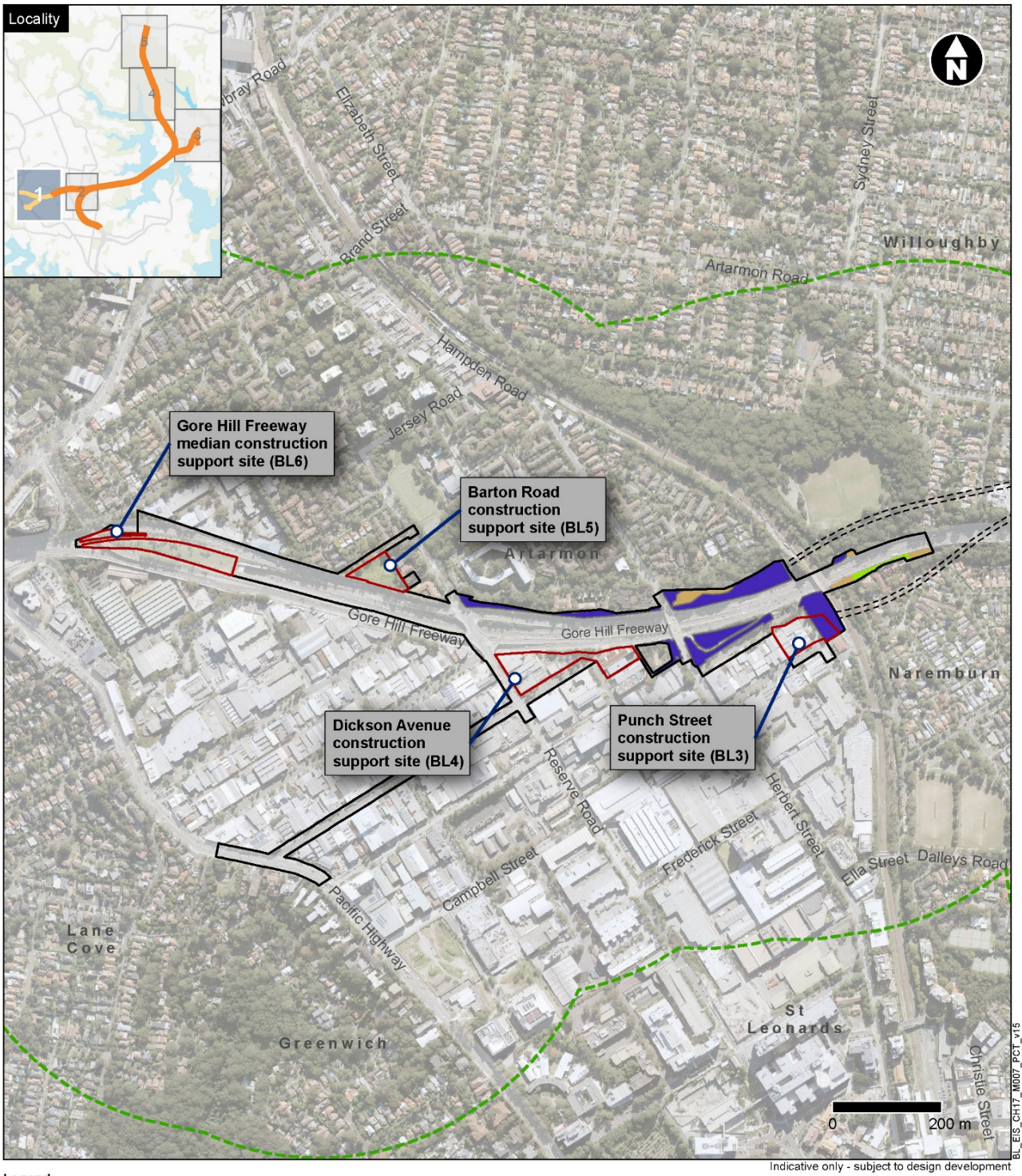


Figure 19-1 Distribution of plant community types and other vegetation (map 1)

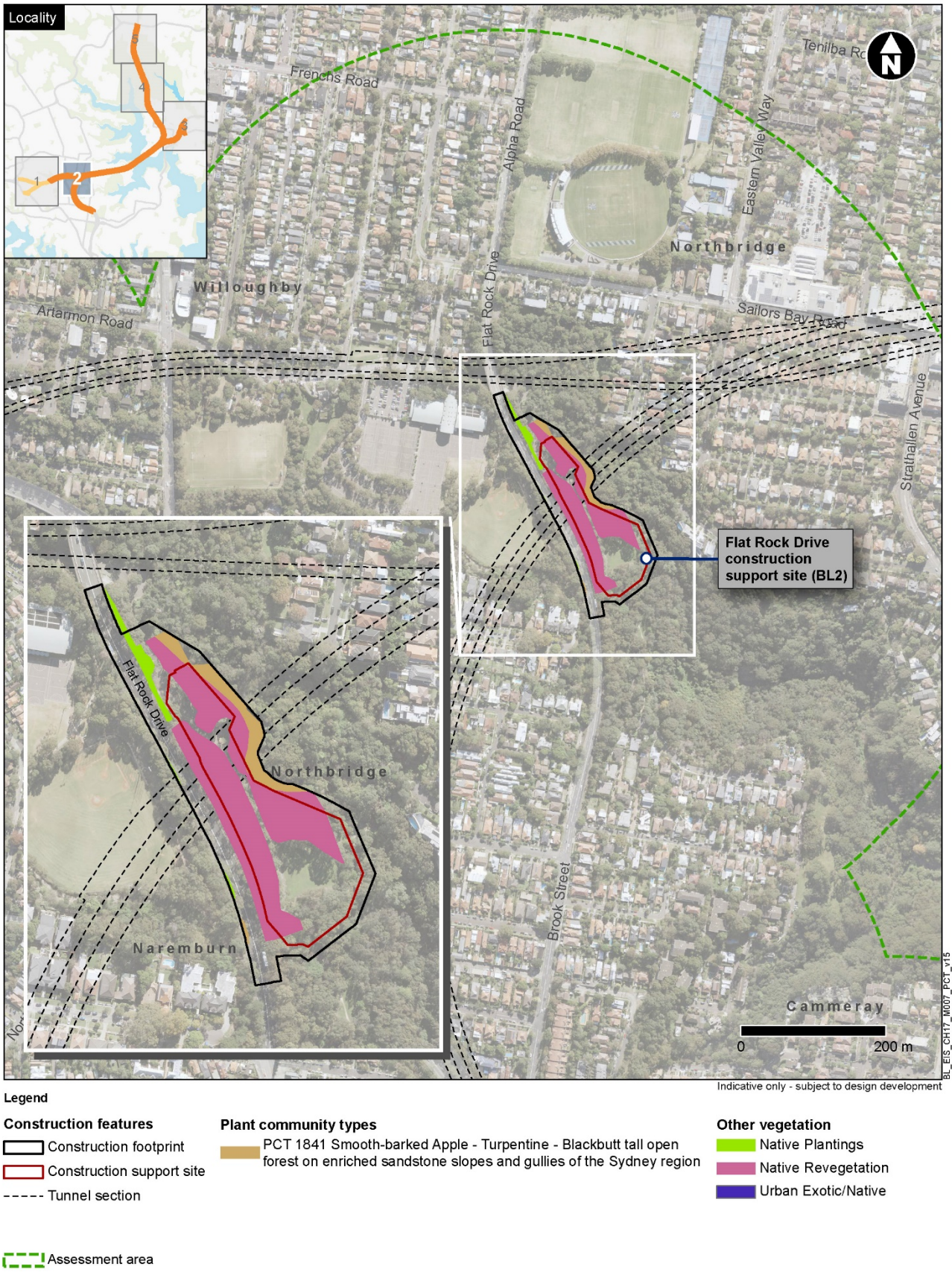


Figure 19-2 Distribution of plant community types and other vegetation (map 2)

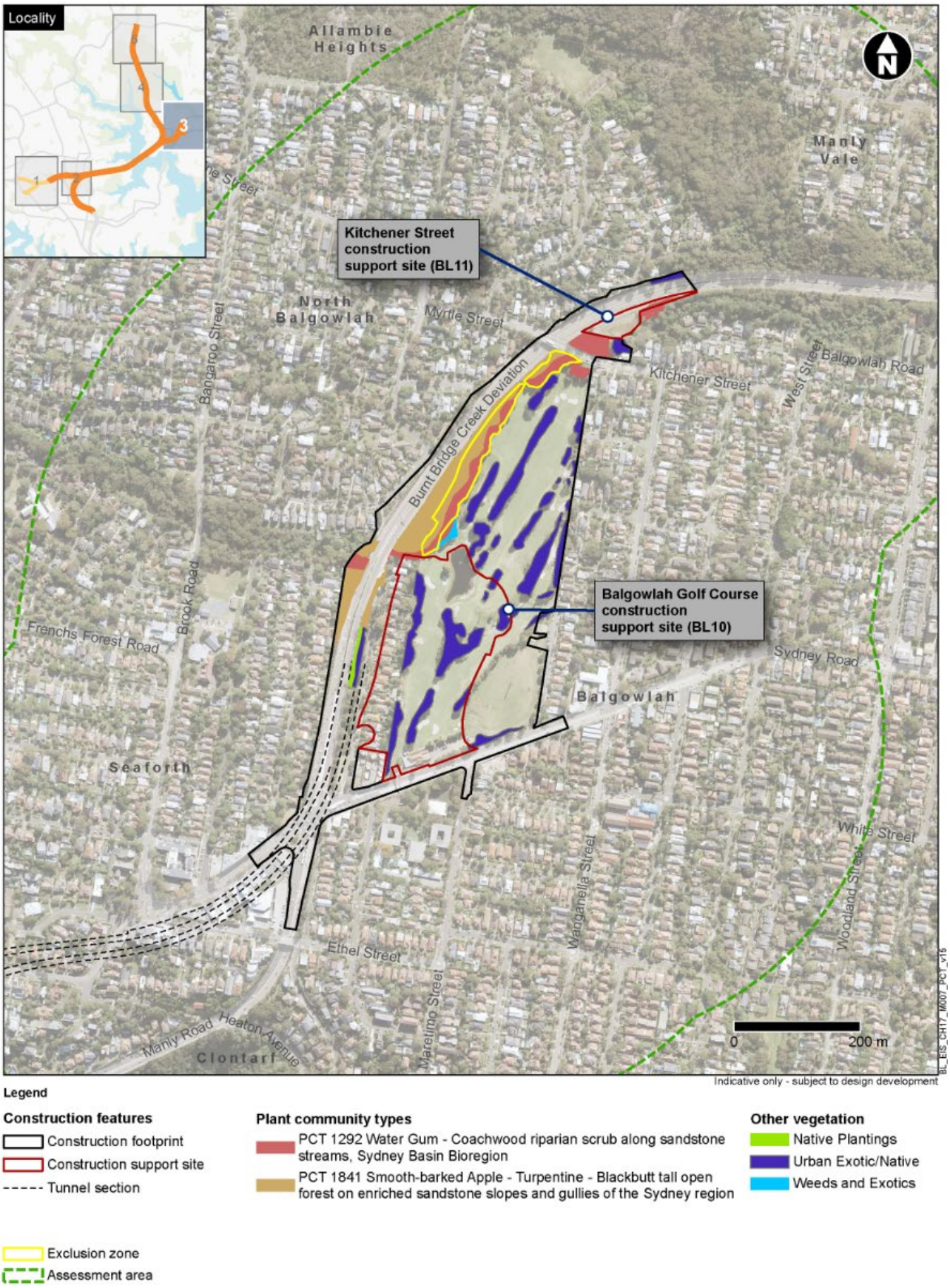


Figure 19-3 Distribution of plant community types and other vegetation (map 3)

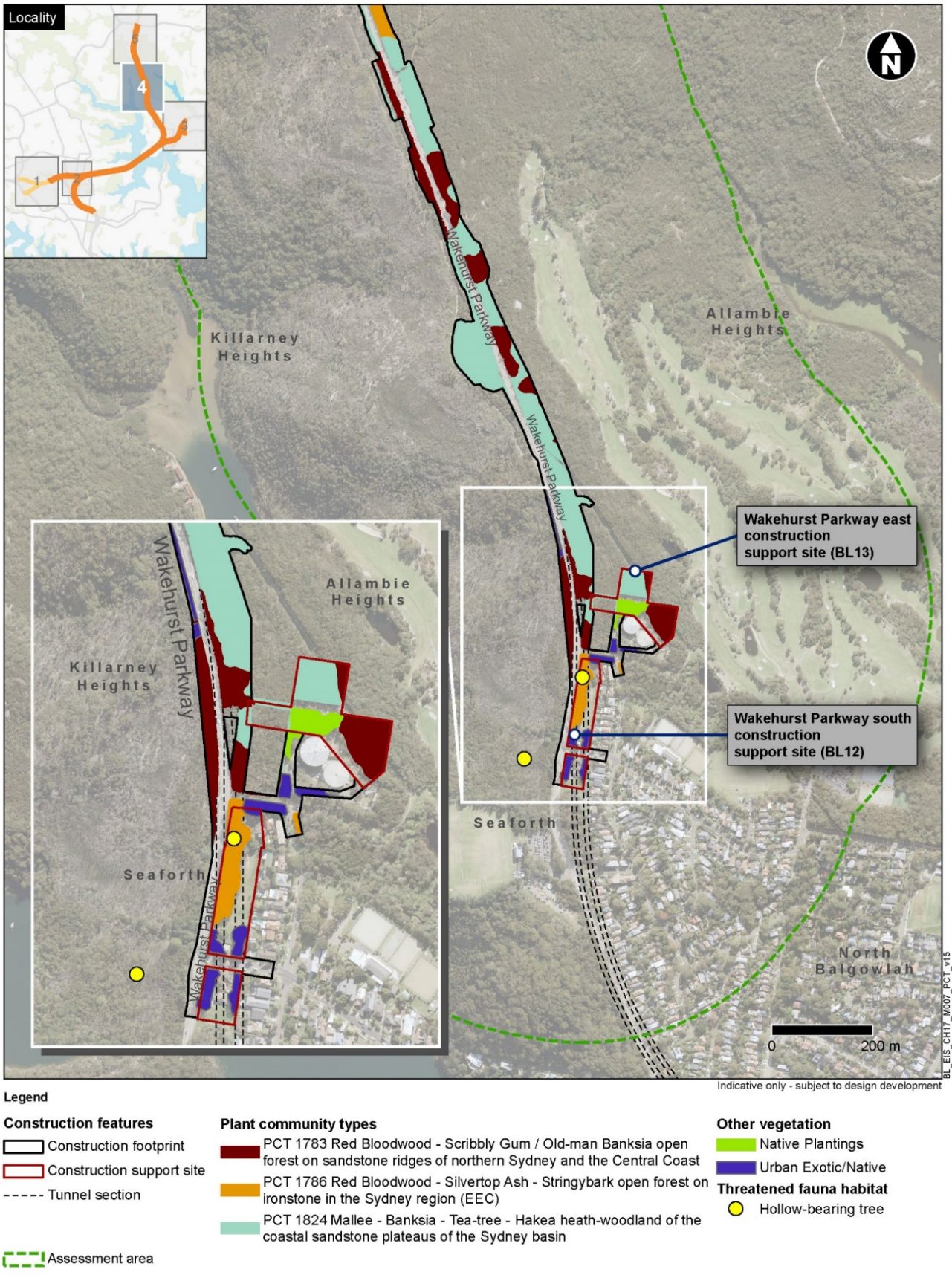


Figure 19-4 Distribution of plant community types and other vegetation (map 4)

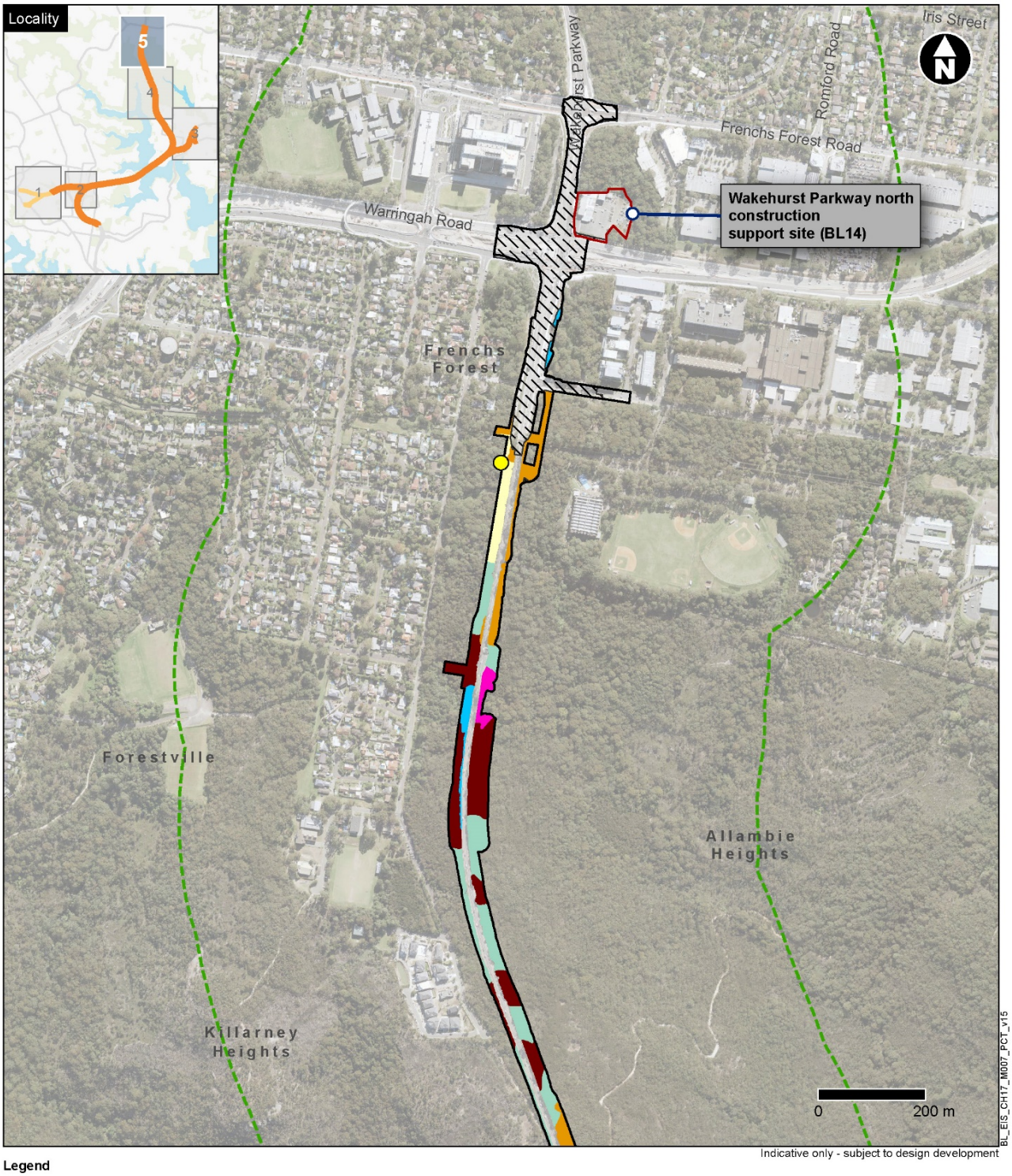


Figure 19-5 Distribution of plant community types and other vegetation (map 5)

Threatened flora

Field surveys carried out for the project identified two listed threatened flora species within the construction footprint:

- Magenta Lilly Pilly (*Syzygium paniculatum*)
- Netted Bottle Brush (Callistemon linearifolius).

Three other threatened flora species, Sunshine Wattle (*Acacia terminalis* subsp. *terminalis*), Glandular Pink-bell (*Tetratheca glandulosa*) and *Epacris purpurascens* var. *purpurascens,* were recorded during the field surveys in proximity to the construction footprint.

In addition, 14 listed threatened species were identified as having moderate likelihood of occurrence within the construction footprint, despite not being identified during field surveys.

Details of these 19 species are provided in Table 19-5, with the locations of species recorded during field surveys for the project shown in Figure 19-6 to Figure 19-11.

Table 19-5 Threatened flora species known or likely to occur in the construction footprint

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Magenta Lilly Pilly (*Syzygium paniculatum*)	Endangered (BC Act) Vulnerable (EPBC Act)	Known to occur in the construction footprint. One in situ remnant individual was recorded next to the construction footprint at the Wakehurst Parkway, located within PCT 1250. The individual is mapped at the edge of the construction footprint, and therefore has been conservatively assessed to be within the construction footprint for the purpose of this assessment. The species is not usually known to be associated with this vegetation type, is considered unlikely to occur at this location and is a widely available and commonly planted horticultural species. However, there is no evidence that this specimen has been planted, and it may be of wild provenance. Eleven planted individuals were recorded at the Burnt Bridge Creek Deviation, only four of which are located within the construction footprint. These planted individuals are not of conservation significance. Two planted individuals were also recorded about 18 metres to the east of the construction footprint at Flat Rock Reserve. Although the reserve has been extensively re-planted, it is possible that these specimens could be of wild provenance.
Netted Bottle Brush (*Callistemon linearifolius*)	Vulnerable (BC Act)	Known to occur in the construction footprint. Four planted individuals were recorded within the construction footprint at the Burnt Bridge Creek Deviation. As they are planted, these individuals are not of conservation significance and are not assessed further under the *Biodiversity Assessment Method*.

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Sunshine Wattle (*Acacia terminalis* subsp. *terminalis*)	Endangered (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. Remnant individuals were recorded in a small fenced area of bushland between the Wakehurst Parkway and the Seaforth Oval car park, associated with PCT 1786, about 145 metres south of the construction footprint. Another five individuals of *Acacia terminalis* subsp. *terminalis* were recorded around 170 metres west of the construction footprint, in vegetation along Burnt Bridge Creek.
Glandular Pink-bell (*Tetratheca glandulosa*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the construction footprint. Recorded in proximity to the construction footprint during field surveys for the project. This species was recorded in bushland next to the Wakehurst Parkway, about 50 metres east of the construction footprint.
Epacris purpurascens var. *purpurascens*	Vulnerable (BC Act)	Moderate likelihood of occurrence in the construction footprint. Recorded in proximity to the construction footprint during field surveys for the project. This species was recorded to the north of the construction footprint at Artarmon Park, where it occurs in several patches. The closest patch is about 60 metres north of the construction footprint.
Angus's Onion Orchid (*Microtis angusii*)	Endangered (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species has been previously recorded within proximity to the construction footprint, including recently near Seaforth Oval. Potential habitat for the species is also known to occur within the construction footprint.
Bauer's Midge Orchid (*Genoplesium baueri*)	Endangered (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.
Bynoe's Wattle (*Acacia bynoeana*)	Endangered (BC Act) Vulnerable (EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Caley's Grevillea (*Grevillea caleyi*)	Critically endangered (BC Act) Endangered (EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.
Camfield's Stringybark (*Eucalyptus camfieldii*)	Vulnerable (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the broader terrestrial biodiversity locality.
Hairy Geebung (*Persoonia hirsuta*)	Endangered (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.
Haloragodendron lucasii	Endangered (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.
Hibbertia puberula	Endangered (BC Act)	Moderate likelihood of occurrence in the construction footprint. Although the species has not been recorded recently within the terrestrial biodiversity locality, potential habitat for the species has been recorded in the terrestrial biodiversity locality.
Lasiopetalum joyceae	Vulnerable (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.
Leptospermum deanei	Vulnerable (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.
Pimelea curviflora var. *curviflora*	Vulnerable (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Seaforth Mintbush (*Prostanthera marifolia*)	Critically endangered (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species and potential habitat for the species has been previously recorded within the terrestrial biodiversity locality.
Somersby Mintbush (*Prostanthera junonis*)	Endangered (BC Act and EPBC Act)	Moderate likelihood of occurrence in the construction footprint. The species has been previously recorded in proximity to the construction footprint including along the Wakehurst Parkway, near Seaforth Oval and near the Wakehurst Golf Club. Habitat for the species has also been previously recorded within the terrestrial biodiversity locality.
Scrub Turpentine (*Rhodamnia rubescens*)	Critically endangered (BC Act)	Moderate likelihood of occurrence in the construction footprint. The species has been recorded within the terrestrial biodiversity locality in urban reserves. Marginal habitat occurs in the construction footprint.

Note 1: BC Act refers to *Biodiversity Conservation Act 2016*
EPBC Act refers to *Environment Protection and Biodiversity Conservation Act 1999*

19.3.2 Terrestrial fauna

Terrestrial fauna habitat

Table 19-6 provides a summary of the terrestrial fauna habitat types within and next to the construction footprint, and the known or potential fauna species occurring within those habitats.

The key terrestrial fauna habitat types identified for the project include:

- Vegetated habitats
- Human-made structures and built environments (including existing buildings, culverts and bridges)
- Marine and intertidal habitats. The assessment of marine and intertidal habitats in relation to marine species is discussed in Section 19.3.6.

Table 19-6 Terrestrial fauna habitats

Habitat type	Location	Known or potential fauna species
Vegetated habitats	Large tracts of native vegetation (consisting of plant community types and revegetation areas) occur at Flat Rock Reserve, within and near Flat Rock Drive construction support site (BL2), and in the northern extent of the construction footprint, on either side of the Wakehurst Parkway at the Wakehurst Parkway south construction support site (BL12) and the Wakehurst Parkway east construction support site (BL13).	Vegetated areas within and near Flat Rock Drive construction support site (BL2) and next to the Wakehurst Parkway provide fauna habitat resources for a range of mammals, birds, reptiles and bats, including the following: Flowering plants that offer potential foraging resources to arboreal mammals and birds such as: Noisy Miner (*Manorina melanocephala*); Rainbow Lorikeet (*Trichoglossus moluccanus*); Red Wattlebird (*Anthochaera carunculata*); Ringtail Possum (*Pseudocheirus peregrinus*); Sugar Glider (*Petaurus breviceps*); Grey-headed Flying-fox (*Pteropus poliocephalus*); Powerful Owl (*Ninox strenua*); Eastern Pygmy-possum (*Cercartetus nanus*); and Square-tailed Kite (*Lophoictinia isura*) Intact native vegetation offers foraging habitat to a diversity of microbat species, that may forage above or below the tree canopy for invertebrates Ground layer plants that offer potential sheltering and foraging habitat to reptiles, small mammals, birds and some amphibians such as: Brown Antechinus (*Antechinus stuartii*); Bush Rat (*Rattus fuscipes*); Australian Brush Turkey (*Alectura lathami*); Rosenberg's Goanna (*Varanus rosenbergi*); and Bibron's Toadlet (*Psueudophryne bibronii*) Three hollow-bearing trees located near the Wakehurst Parkway (two within the construction footprint and one outside) offer potential nesting, roosting and sheltering habitat to hollow-dependent birds (such as Rainbow Lorikeet), arboreal mammals (such as Common Brushtail Possum (*Trichosurus vulpecula*)); and hollow-roosting microbats.

Habitat type	Location	Known or potential fauna species
	Urban and landscaped areas throughout the construction footprint including native and exotic vegetation at the following locations within the construction footprint: • Within and next to the Gore Hill Freeway • Balgowlah Golf Course construction support site (BL10) • Kitchener Street construction support site (BL11).	Landscaped areas provide habitat for highly mobile species which are capable of using small, isolated patches of habitat within disturbed urban environments including: Flowering and fruiting plants that offer potential foraging resources to bats, birds and arboreal mammals, such as: Grey-headed Flying-fox, Australian Magpie (*Cracticus tibicen*), Noisy Miner, Rainbow Lorikeet, Grey Butcherbird (*Cracticus torquatus*), Common Brushtail Possum and Ringtail Possum.
	Riparian vegetation associated with Burnt Bridge Creek.	A Grey-headed Flying-fox camp has been identified at a location in the vegetated area between Balgowlah Road and Burnt Bridge Creek Deviation, about 120 metres from the construction footprint.
	Riparian vegetation associated with unnamed ephemeral watercourses within open forest areas next to the Wakehurst Parkway.	Potential sheltering, foraging and breeding habitat for the Red-crowned Toadlet (*Pseudophryne australis*).
	Rocky habitat associated with Hawkesbury sandstone bedrock, boulders, crevices and ledges located within the construction footprint at Flat Rock Reserve, Burnt Bridge Creek and along the Wakehurst Parkway.	Potential sheltering and foraging habitat for: Large-eared Pied Bat (*Chalinolobus dwyeri*), Brown Antechinus; Bush Rat; Red-crowned Toadlet; Rosenberg's Goanna; and Gully Skink (*Saproscincus spectabilis*).
Human-made structures and built environments	Existing culverts, bridges and buildings within the construction footprint.	Potential artificial microbat roosting habitat for: Little Bent-winged Bat (*Miniopterus australis*), Large Bent-winged Bat (*Miniopterus orianae oceanensis*), Eastern Coastal Free-tailed bat (*Micronomus norfolkensis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Habitat type	Location	Known or potential fauna species
Marine and intertidal habitats	Intertidal sand and mudflats within the construction footprint along the foreshore of Clive Park at Northbridge, Beauty Point at The Spit and Peach Tree Bay at Seaforth.	• Small areas of sand and mudflats provide marginal foraging habitat to threatened shorebird species, where worms, bivalves, crustaceans and other invertebrates occur within soft substrate tidal areas that are exposed during low tide. However, no threatened shorebird species were recorded during targeted surveys, nor were determined as having a high likelihood of occurrence within the construction footprint • No nesting or roosting habitat provided, as these areas are inundated at high tide.
	Intertidal rocky shores along bays and headlands within the construction footprint, including: Peach Tree Bay; Seaforth Bluff; Beauty Point; Quakers Hat; Fig Tree Point; Fig Tree Cove; Clive Park; and Sailors Bay.	• Supports a high abundance of Sydney Rock Oysters (*Saccostrea glomerata*), which offer limited foraging resources for threatened shorebirds. However, no threatened shorebird species were identified during database searches as having a high likelihood of occurrence within the construction footprint • No nesting or roosting opportunities are provided, as these areas are inundated at high tide.
	Open water habitat within Middle Harbour.	• Foraging habitat for a number of threatened bird and bat species that forage for fish or other marine prey species, including: • Little Penguins (*Eudyptula minor*) which have been recorded at several locations within the construction footprint, including at The Spit, Long Bay, Sailors Bay, and in the main channel of Middle Harbour • White-bellied Sea Eagle (*Haliaeetus leucogaster*) due to the presence of preferred prey species (ie fish, turtles and sea snakes) within the construction footprint, as well as potential perching habitat in trees along the foreshore at The Spit, Seaforth and Clontarf • Southern Myotis (*Myotis macropus*) due to the presence of preferred prey species (ie fish) within and near the construction footprint • Not a preferred habitat for wandering seabirds with no wandering seabird species identified as having a high likelihood of occurrence within the construction footprint.

Threatened fauna species and endangered populations

Field surveys carried out for the project identified six listed threatened fauna species, within or next to the construction footprint:

- Grey-headed Flying-fox recorded in a number of locations flying over the construction footprint. In addition, a Grey-headed Flying-fox camp has been identified at a location in the vegetated area between Balgowlah Road and Burnt Bridge Creek Deviation, about 120 metres from the construction footprint
- Rosenberg's Goanna recorded within vegetated areas alongside the Wakehurst Parkway in the construction footprint
- Powerful Owl recorded in bushland off Flat Rock Drive near the Flat Rock Drive construction support site (BL2)
- Large Bent-winged Bat recorded in bushland near the Flat Rock Drive construction support site (BL2)
- Little Bent-winged Bat recorded in bushland near the Flat Rock Drive construction support site (BL2)
- Large-eared Pied Bat recorded about 125 metres from the construction footprint.

Another six listed threatened species were identified as having a high likelihood of occurrence within the construction footprint or assumed to be present, despite not being identified during field surveys. Some species have been identified as a result of recent database searches and surveys carried out for the recently completed Northern Beaches Hospital road upgrade project. These species with a high likelihood of occurrence include:

- Red-crowned Toadlet
- Eastern Pygmy-possum
- Eastern Coastal Free-tailed Bat
- Glossy Black-Cockatoo (*Calyptorhynchus lathami*)
- Varied Sittella (*Daphoenositta chrysoptera*)
- White-bellied Sea Eagle.

Two threatened fauna species, Southern Brown Bandicoot (*Isoodon obesulus obesulus*) and Southern Myotis, are considered likely to occur in areas next to the construction footprint.

In addition, nine species were identified as having a moderate likelihood of occurrence within the construction footprint, despite not being identified during field surveys. These species were:

- Barking Owl (*Ninox connivens*)
- Eastern Osprey (*Pandion cristatus*)
- Little Lorikeet (*Glossopsitta pusilla*)
- Masked Owl (*Tyto novaehollandiae*)
- Spotted-tailed Quoll (*Dasyurus maculatus*)
- Square-tailed Kite
- Swift Parrot (*Lathamus discolor*)
- Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)
- Brown Treecreeper (*Climacteris picumnus victoriae*).

One endangered population is known to occasionally occur in the construction footprint, being the population of Little Penguins in the Manly Point area, about 5.5 kilometres north-east of the project.

Details of these 23 threatened fauna species and one endangered population are provided in Table 19-7, with the locations of species recorded during field surveys for the project shown in Figure 19-6 to Figure 19-11.

Migratory bird species

As identified above, one migratory bird species listed under the *Environment Protection and Biodiversity Conservation Act 1999*, the White-bellied Sea Eagle, has a high likelihood of occurrence due to potential habitat in Middle Harbour.

Migratory freshwater and marine species, such as whales, turtles and fish, are discussed in Section 19.3.3 and Section 19.3.6 respectively.

Table 19-7 Threatened fauna species known or likely to occur in the construction footprint

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Threatened species		
Grey-headed Flying-fox (*Pteropus poliocephalus*)	Vulnerable (BC Act and EPBC Act)	Known to occur in the construction footprint. This species was recorded in a number of locations flying over the construction footprint. A Grey-headed Flying-fox camp has been identified at a location in the vegetated area between Balgowlah Road and Burnt Bridge Creek Deviation, about 120 metres east of the construction footprint. It is highly likely that the Grey-headed Flying-fox would also use land within the construction footprint and surrounds for foraging.
Rosenberg's Goanna (*Varanus rosenbergi*)	Vulnerable (BC Act)	Known to occur in the construction footprint. This species was recorded during field surveys for the project within vegetated areas next to the Wakehurst Parkway. Vegetation in this area offers potential foraging and nesting habitat for the species due to the presence of preferred prey species including birds, reptiles and small mammals, while the presence of sandstone boulders, slabs and rock crevices offer sheltering habitat to the species. Termite mounds recorded in proximity to the Wakehurst Parkway also offer preferred nesting habitat to the species. Rosenberg's Goanna may also forage for roadkill along the margins of the Wakehurst Parkway, where fauna mortality due to vehicle strike is high.
Powerful Owl (*Ninox strenua*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. The Powerful Owl was recorded during field surveys for the project in bushland off Flat Rock Drive, in proximity to the construction footprint. It has also been previously recorded within vegetated areas next to the Wakehurst Parkway. A hollow-bearing tree, which included one large tree hollow (greater than 0.2 metres diameter), was identified in the northern extent of the construction footprint near the Wakehurst Parkway as offering potential nesting habitat; however, no activity was identified during field surveys. These areas within and next to the construction footprint also offer potential foraging habitat for the Powerful Owl due to the presence of preferred prey species that are known and are likely to inhabit the construction footprint.

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Large Bent-winged Bat (*Miniopterus orianae oceanensis*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. This species was recorded during field surveys for the project in bushland near the Flat Rock Drive construction support site (BL2). Native vegetation throughout the construction footprint, particularly larger tracts of native vegetation within and next to the northern extent of the construction footprint along the Wakehurst Parkway, offers potential foraging habitat to the species. Potential artificial roosting habitat (ie culverts and bridges) is also present throughout the construction footprint; however, targeted surveys within concrete culverts at Artarmon and Balgowlah, and a concrete underground walkway at Willoughby did not detect the presence of any roosting Large Bent-winged Bats. Areas surveyed for the project were not identified to support a maternity cave.
Little Bent-winged Bat (*Miniopterus australis*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. This species was recorded during field surveys for the project in bushland near the Flat Rock Drive construction support site (BL2) and has been previously recorded in the northern extent of the construction footprint, along the Wakehurst Parkway. Native vegetation throughout the construction footprint, particularly larger tracts of native vegetation within and next to the northern extent of the construction footprint along the Wakehurst Parkway offers potential foraging habitat to the species. Potential artificial roosting habitat (ie culverts and bridges) are also present throughout the construction footprint; however, targeted surveys for the project at concrete culverts at Artarmon and Balgowlah, and a concrete underground walkway at Willoughby did not detect the presence of any roosting Little Bent-winged Bats.
Large-eared Pied Bat (*Chalinolobus dwyeri*)	Vulnerable (BC Act and EPBC Act)	High likelihood of occurrence in the construction footprint. This species' echolocation call was recorded at a dam approximately 125 metres from the construction footprint. The species has also been recently recorded in the Wakehurst Parkway east construction support site (BL13). All plant community types in the construction footprint are associated with the Large-eared Pied Bat. It is likely that the species uses native vegetation in the construction footprint for foraging and may be roosting in rocky habitat in proximity to the construction footprint along the Wakehurst Parkway.

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. Native vegetation throughout the construction footprint, particularly larger tracts of native vegetation within and next to the northern extent of the construction footprint along the Wakehurst Parkway offers potential foraging habitat to the species. Two hollow-bearing trees were identified within the construction footprint in proximity to the Wakehurst Parkway during field surveys for the project, which may provide roosting habitat. Culverts and bridges within the construction footprint also offer potential roosting habitat for the species. However, targeted surveys carried out for the project did not detect the presence of any roosting Eastern Coastal Free-tailed Bats.
Eastern Pygmy-possum (*Cercartetus nanus*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, database searches show that the species has been recently recorded in the Wakehurst Parkway east construction support site (BL13). Potential foraging and sheltering habitat for this species is present in native vegetation within and adjoining the northern extent of the construction footprint next to Wakehurst Parkway. These vegetated habitats support preferred foraging resources, due to the presence of a variety of banksia, eucalypt and bottlebrush species.
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. Preferred foraging trees species (*Allocasuarina* and *Casuarina* species) occur within areas of native vegetation within and next to the construction footprint. The species was not observed to use a large tree hollow identified in the northern extent of the construction footprint next to the Wakehurst Parkway during field surveys. This tree hollow is located within an area unlikely to support preferred nesting habitat for the species.
Red-crowned Toadlet (*Pseudophryne australis*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, this species was recorded along the Wakehurst Parkway during investigations for the Northern Beaches Hospital road upgrade project. Riparian vegetation associated with unnamed ephemeral watercourses within open forest areas next to the Wakehurst Parkway offer potential sheltering, foraging and breeding habitat for the species.

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Southern Brown Bandicoot (*Isoodon obesulus obesulus*)	Endangered (BC Act and EPBC Act)	High likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, it has previously been recorded in proximity to the construction footprint next to the Wakehurst Parkway. The construction footprint supports potential habitat for the species in native vegetation next to the Wakehurst Parkway.
Southern Myotis (*Myotis macropus*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, potential foraging habitat for this species is present within and next to the construction footprint within Middle Harbour, particularly along sheltered bays such as Sandy Bay and Shell Cove. There is some potential roosting habitat for this species within the construction footprint, due to the presence of human-made structures such as jetties, wharves along the Middle Harbour foreshore, existing culverts, bridges and buildings.
Varied Sittella (*Daphoenositta chrysoptera*)	Vulnerable (BC Act)	High likelihood of occurrence in the construction footprint. The species was not recorded in the construction footprint during field surveys. However, it has previously been recorded in the construction footprint by the Gore Hill Freeway.
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Vulnerable (BC Act) Migratory (EPBC Act)	High likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, this species has been previously recorded throughout Middle Harbour. Potential foraging habitat for the species is present in Middle Harbour within the construction footprint. Potential perching habitat is also present around Middle Harbour in trees along the foreshore at The Spit, Seaforth and Clontarf.
Barking Owl (*Ninox connivens*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. Potential foraging habitat for this species is present within large tracts of native vegetation within and adjoining the northern extent of the construction footprint next to the Wakehurst Parkway. The species was not observed to utilise a large tree hollow identified at this location during field surveys, and the area is unlikely to support preferred nesting habitat for the species.

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Eastern Osprey (*Pandion cristatus*)	Vulnerable (BC Act) Migratory (EPBC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. Potential foraging habitat for this species is present within Middle Harbour. The areas within and next to the construction footprint are not known to support nesting habitat for the species.
Little Lorikeet (*Glossopsitta pusilla*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. Potential foraging habitat for this species is present within landscaped areas throughout the construction footprint. Two hollow-bearing trees were identified within the construction footprint in proximity to the Wakehurst Parkway during field surveys for the project, which may provide roosting habitat.
Masked Owl (*Tyto novaehollandiae*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, potential foraging habitat for this species is present within areas of native vegetation within and next to the construction footprint along the Wakehurst Parkway, due to the presence of prey species. The species was not observed to utilise a large tree hollow identified within this area during field surveys for the project, with the areas within or next to the construction footprint unlikely to support preferred nesting habitat for the species.
Spotted-tailed Quoll (*Dasyurus maculatus*)	Vulnerable (BC Act) Endangered (EPBC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, large tracts of native vegetation within and adjoining the northern extent of the construction footprint next to the Wakehurst Parkway offer potential habitat for the species.
Square-tailed Kite (*Lophoictinia isura*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, potential foraging habitat for this species is present within the areas of native vegetation within and next to the construction footprint along the Wakehurst Parkway.

Species	Conservation significance[1]	Likelihood of occurrence in the construction footprint
Swift Parrot (*Lathamus discolor*)	Endangered (BC Act) Critically Endangered (EPBC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. Nectivorous trees within the construction footprint offer marginal foraging habitat to the species; however, the construction footprint does not support preferred habitat for the species.
Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. Marginal habitat exists along the edge of the Wakehurst Parkway.
Brown Treecreeper (*Climacteris picumnus victoriae*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. Marginal habitat exists along the edge of the Wakehurst Parkway.
Endangered population		
Little Penguin (*Eudyptula minor*)	Endangered population (BC Act) Marine (EPBC Act)	High likelihood of occurrence in the construction footprint. This species was not recorded in the construction footprint during field surveys. However, this species has been previously recorded at several locations within Middle Harbour including at The Spit and Sailors Bay, and in the main channel of Middle Harbour. Potential foraging habitat for the species is present within and next to the construction footprint in Middle Harbour. No nesting habitat is present within the construction footprint, with nesting limited to the Manly area.

Note 1: BC Act refers to *Biodiversity Conservation Act 2016*
EPBC Act refers to *Environment Protection and Biodiversity Conservation Act 1999*

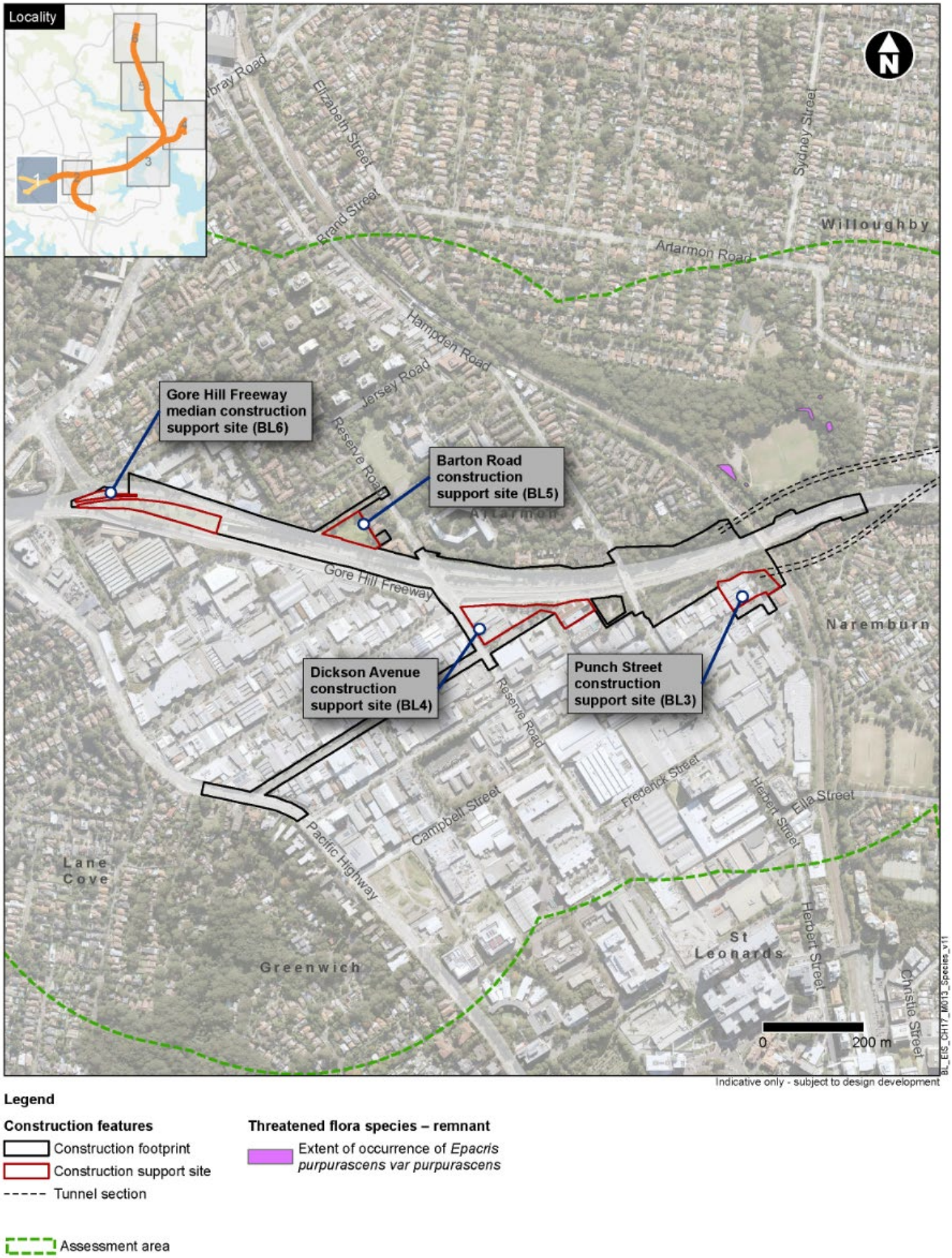


Figure 19-6 Recorded threatened species (map 1)

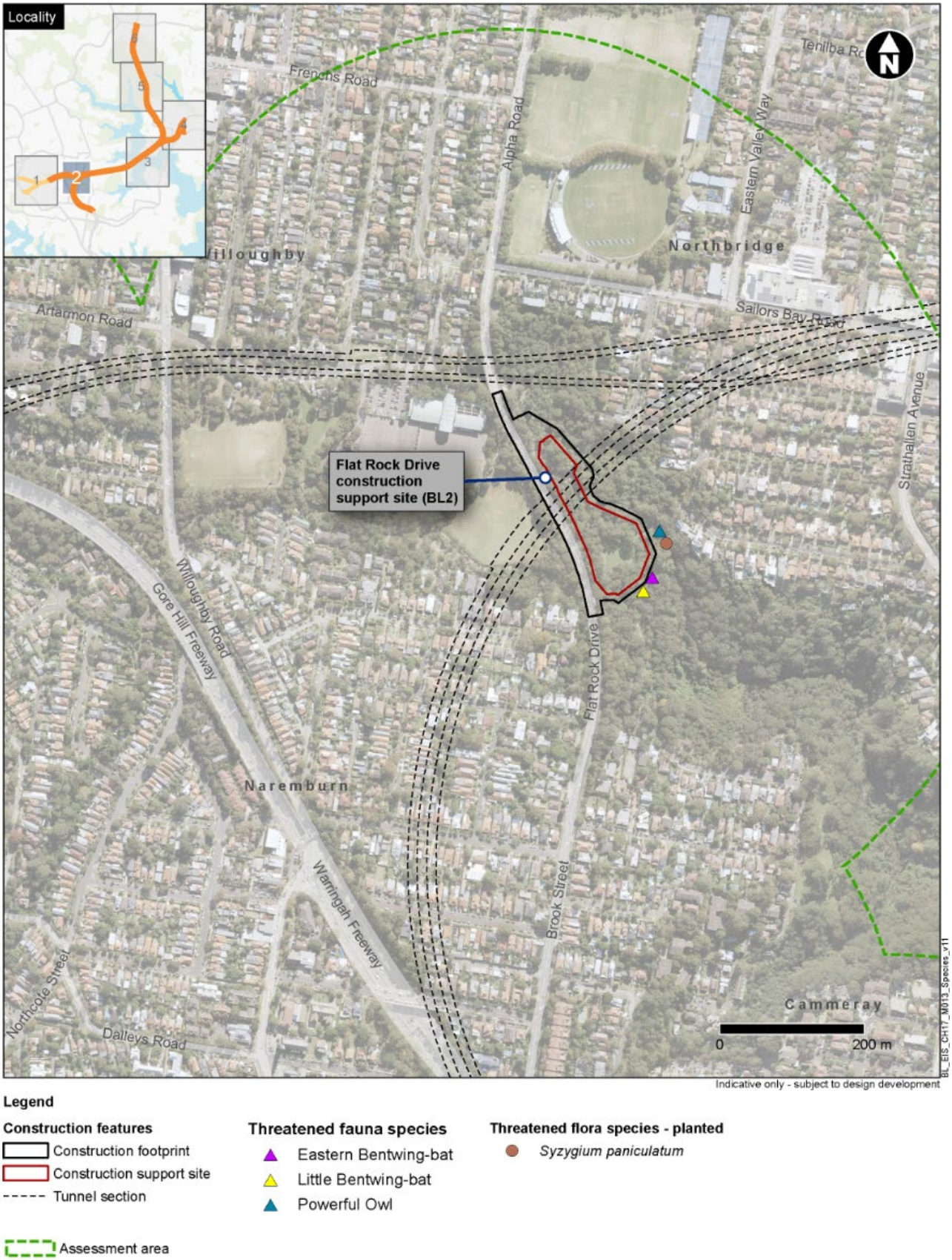
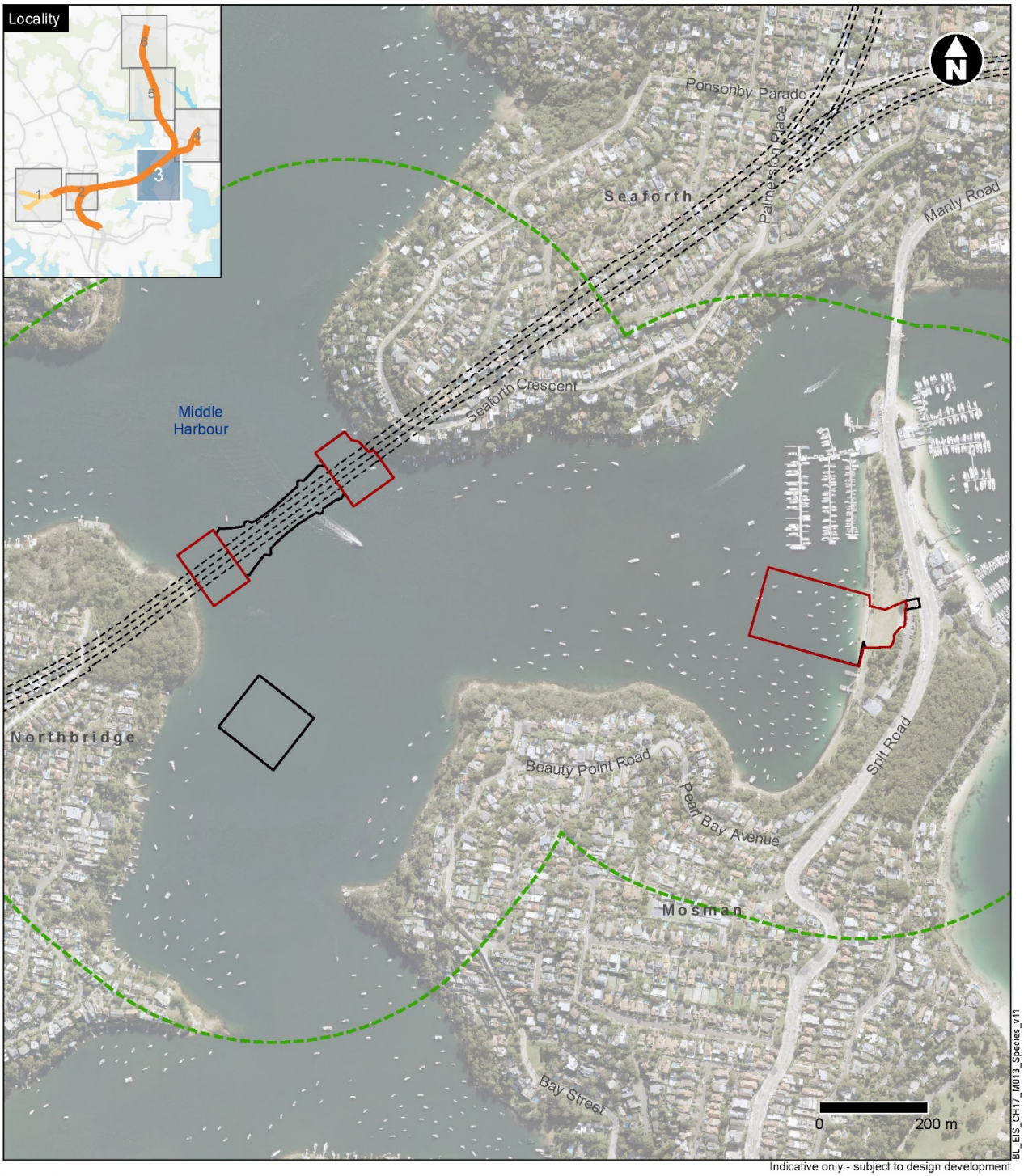


Figure 19-7 Recorded threatened species (map 2)



Legend

Construction features

- Construction footprint
- Construction support site
- ----- Tunnel section

- Assessment area

Figure 19-8 Recorded threatened species (map 3)

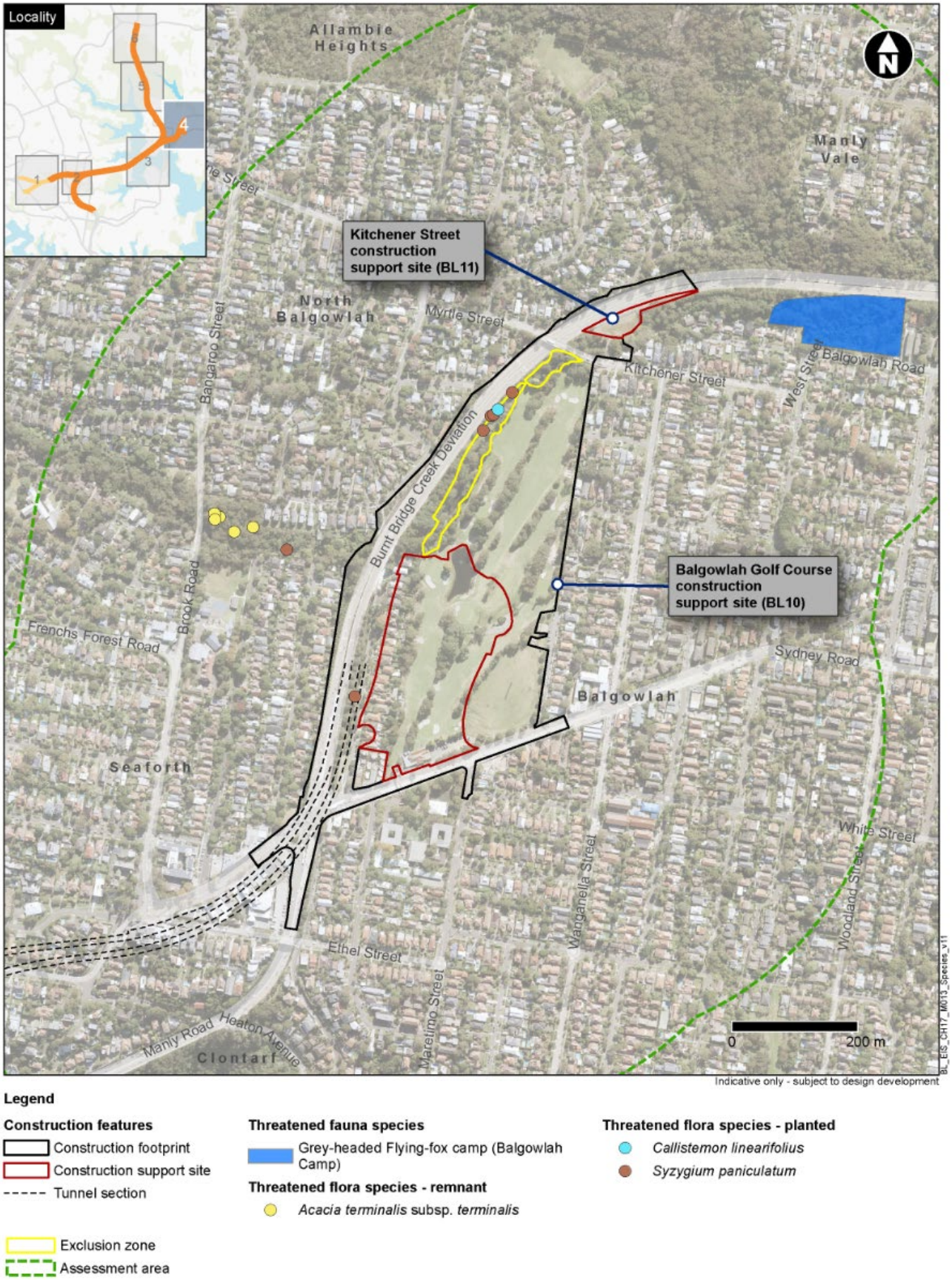


Figure 19-9 Recorded threatened species (map 4)

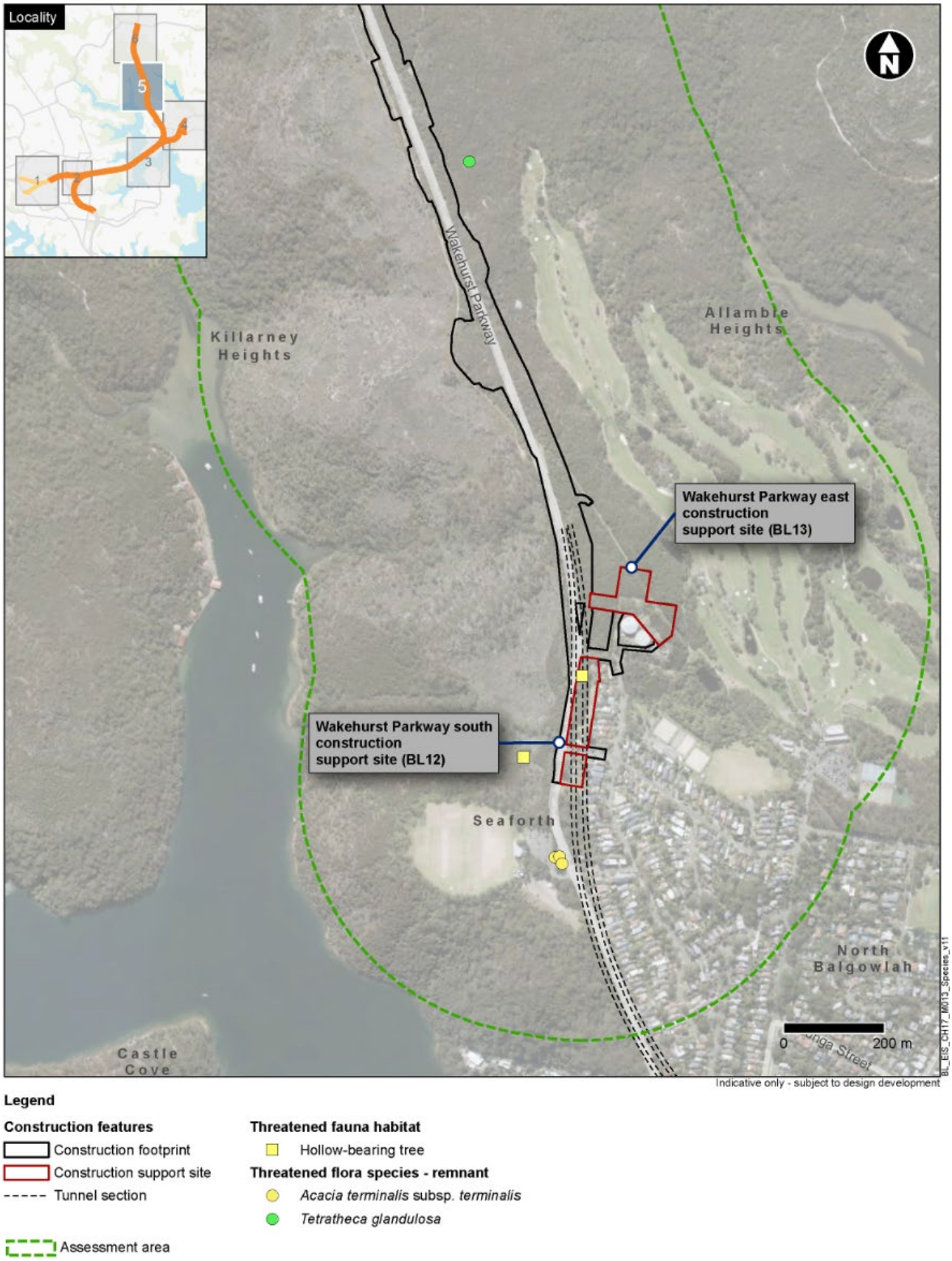


Figure 19-10 Recorded threatened species (map 5)

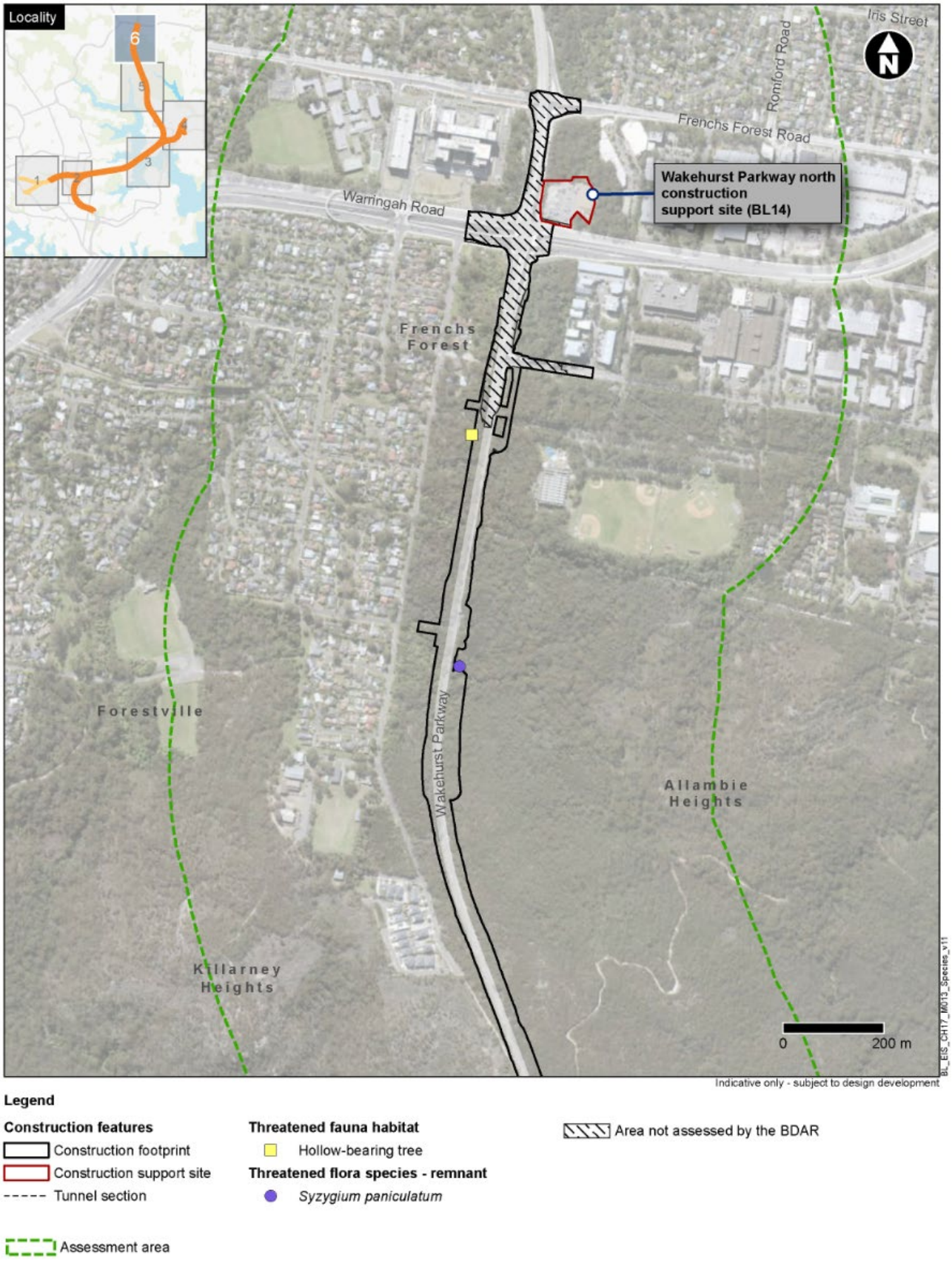


Figure 19-11 Recorded threatened species (map 6)

19.3.3 Aquatic biodiversity

Aquatic habitat

Table 19-8 provides a summary of the aquatic freshwater habitats associated with the waterways within and downstream of the construction footprint. Key fish habitat classification and whether the waterway is considered a sensitive receiving environment is discussed in Annexure D (Freshwater ecology impact assessment) of Appendix S (Technical working paper: Biodiversity development assessment report).

Manly Dam, Manly Creek and the natural reaches of Flat Rock Creek have been identified as Type 1 highly sensitive key fish habitat and sensitive receiving environments. The classification of waterways regarding their status as sensitive receiving environments is discussed in Chapter 17 (Hydrodynamics and water quality) and summarised in Table 19-8.

The quality of these waterways was also assessed as part of the surface water assessment in Appendix O (Technical working paper: Surface water quality and hydrology), the results of which are provided in Chapter 17 (Hydrodynamics and water quality). In general, the waterways potentially impacted by the project are largely influenced by surrounding urban development with occurrences of contaminants such as suspended sediments, heavy metals and persistent organic pollutants including from stormwater, wastewater overflows and leachate from contaminated lands. Some of these waterways have also been substantially modified from natural channels to artificial, concrete-lined channels to accommodate higher volume and velocity flows from an increase in urban, impervious surfaces.

Although no fish or macroinvertebrate sampling was carried out as part of the aquatic assessment, the waterways in the aquatic biodiversity study area are considered suitable for the majority of common and exotic fish species typically found in waterways in the Sydney region. The most suitable habitat are the natural reaches of these waterways (Manly Dam, Manly Creek and some reaches of Flat Rock Creek).

Common native fish species typically found in waterways in the Sydney region include Short-finned and Long-finned Eels (*Anguilla australis* and *A. reinhardtii*), Common Galaxias (*Galaxias maculatus*), Australian Bass (*Macquaria novemaculeata*) and a number of gudgeon species. Exotic fish species are also widespread across the Sydney region.

Sydney's waterways typically support an array of macroinvertebrates including the Sydney Crayfish (*Euastacus australasiensis*) and the Freshwater Shrimp (*Paratya australiensis*) as well as small insects and freshwater mussels. These species depend on healthy waterways and access to diverse habitats including swamps, floodplains, wetlands, streams and rivers, of which only streams occur within the aquatic biodiversity study area.

The Manly Creek catchment, including the middle and lower reaches of Manly Creek, is home to the only confirmed population of Climbing Galaxias (*Galaxias brevipinnis*) in the Sydney area. Although not a threatened or protected species, the community prepared an action plan for its protection in the Manly Creek catchment (Salkavich et al., 2002). The action plan considers water pollution to be among the threats to this population.

Within the eastern side of the Burnt Bridge Creek catchment is the Balgowlah Golf Course stormwater harvesting dam which was completed in 2013. The dam is a four megalitre pond/dam with a maximum nominal water depth of 2.5 metres which is used irrigate the Balgowlah Golf Course. However, given its recent construction and disconnection with natural watercourses, the Balgowlah Golf Course stormwater harvesting dam is unlikely to provide potential habitat for native fish.

Threatened ecological communities, species and endangered populations

No threatened freshwater fauna, flora species or ecological communities or endangered populations listed under the *Fisheries Management Act 1994* and/or the *Environment Protection and Biodiversity Conservation Act 1999* have been identified as likely to occur within the aquatic biodiversity study area.

Freshwater migratory species

No freshwater migratory species listed under the *Environment Protection and Biodiversity Conservation Act 1999* are considered likely to occur within the aquatic biodiversity study area.

Table 19-8 Aquatic freshwater habitats

Location	Habitat features	Key fish habitat classification	Sensitive receiving environment
Willoughby Creek at Cammeray, located about 60 metres east of the Cammeray Golf Course construction support site (BL1)	• The area of the creek next to Primrose Park tennis courts was identified as a semi-natural waterway, partially modified to accept stormwater discharge. Around 10 metres downstream of the survey location, the creek contains entrenched bedrock and a concrete-lined channel. A natural bedrock/boulder waterfall and a shallow plunge pool is located around 50 metres upstream of the survey location • Banks in the upstream section of the creek are vegetated by dense tree cover and shrubs with a groundcover consisting primarily of ferns. Walking tracks and tennis courts are present on the south east bank, and on the opposite bank the riparian vegetation corridor is around 70 metres wide and continuous. Further downstream, the riparian corridor includes Primrose Park sporting fields • Moderate condition riparian vegetation including commonly occurring native tree species are present within remnant riparian vegetation, such as Black Wattle (*Callicoma serratifolia*), Coachwood (*Ceratopetalum apetalum*), Blueberry Ash (*Elaeocarpus reticulatus*) and Cheese Tree (*Glochidion ferdinandi*) • Localised infestations of Large Leaf Privet (*Ligustrum lucidum*) and Lantana (*Lantana camara*) are also known to occur • This riparian vegetation provides shade and potentially other ecological functions (eg a source of food and habitat, in the form of wood debris, for aquatic biota). No instream vegetation or woody debris were identified within the section of the creek inspected. Some rocky features are present.	Type 3 minimally sensitive key fish habitat Class 3 minimal key fish habitat for fish passage.	No

Location	Habitat features	Key fish habitat classification	Sensitive receiving environment
Flat Rock Creek at Naremburn, located directly east of, and within Flat Rock Drive construction support site (BL2) and above the ramp tunnel alignment at Artarmon (from Gore Hill Freeway Connection). Further detail on Flat Rock Creek illustrating the various linings is provided in Figure 17-2 of Chapter 17 (Hydrodynamics and water quality).	• The upper reaches of Flat Rock Creek in Artarmon consist of a covered concrete lined drain and vegetated floodway associated with the Artarmon Reserve detention basin. The creek is a concrete lined channel as it crosses the Gore Hill Freeway for the first time and continues in an open lined channel as it meanders east and crosses back under the Gore Hill Freeway. The creek is installed within an underground box culvert between Willoughby Road, Willoughby and 150 metres east of Flat Rock Drive, Northbridge.	Not key fish habitat.	No
	• Flat Rock Creek was identified as freshwater upstream of its confluence with Quarry Creek • 150 metres east of Flat Rock Drive and upstream of Quarry Creek, the channel consists of a steep gorge with natural bedrock and large boulders. Dense riparian vegetation encroached on the channel is likely due to frequent low flow conditions in the main channel. Riparian vegetation consists of native, tall, woody trees, dense shrubs and groundcover. In the upper reaches, instream woody debris (less than three metres long) provides aquatic habitat.	Type 1 highly sensitive key fish habitat Class 2 moderate key fish habitat for fish passage.	Yes
	• Flat Rock Creek was identified as estuarine downstream of the confluence with Quarry Creek • Downstream of Quarry Creek, the channel is subjected to stormwater discharge with evidence of channel and bank erosion a likely result of high flow events. The south bank consists of dense native and exotic, overhanging riparian vegetation. Fish habitat includes some undercut banks with potential to provide refuge as well as large woody debris (greater than three metres long) and dense instream patches of Common Reed (*Phragmites australis*) present in some sections.	Type 1 highly sensitive key fish habitat Class 1 major key fish habitat for fish passage.	Yes

Location	Habitat features	Key fish habitat classification	Sensitive receiving environment
Existing aboveground watercourse within the northern extent of Flat Rock Reserve in the Flat Rock Drive construction support site (BL2)	• This watercourse drains through a 0.40 metre underground pipe at the Small Street roundabout, but also receives catchment runoff from the escarpment which forms the north eastern bank. This escarpment bank is steep, ranging between three and 10 metres along the watercourse and is generally comprised of sandstone • The natural channel bed is generally bedrock with a layer of sediment and detritus and colonised by exotic grasses and forbs where there is no flow. Concrete or rock is laid on the channel bed in sections exposed to higher flow velocities. Channel banks are steep, and the watercourse width ranges between two and 10 metres. Riffles and pools were also observed • Dense native and exotic riparian vegetation occurs along both banks. The escarpment is well vegetated with a mix of native and exotic woody trees, ferns with a dense midstorey and groundcover.	Not key fish habitat.	No
Burnt Bridge Creek at North Balgowlah, located next to the following temporary construction support sites: Balgowlah Golf Course construction support site (BL10) Kitchener Street construction support site (BL11). Further detail on Burnt Bridge Creek illustrating the various linings is provided in Figure 17-3 of Chapter 17 (Hydrodynamics and water quality).	• The upstream reach of Burnt Bridge Creek, located upstream of the existing Burnt Bridge Creek Deviation culverts, is mostly a natural channel with rocky outcrops and low levels of sedimentation over bedrock. Culvert crossings act as potential barriers to fish passage during low flows. Exotic Parrots Feather plants (*Myriophyllum aquaticum*) and native eels (*Anguilla* spp.) were observed in the deeper pools. Emergent woody debris along the banks have potential to provide habitat for freshwater fish and invertebrates during high flows. The channel receives substantial shading from the native riparian overstorey of She-oaks (*Casuarina* spp.). However, the width of the riparian corridor is limited by residences and landscaped gardens, and exotic vegetation was prevalent in the understorey. There is also a large trunk sewer line installed along the creek alignment which would indicate substantial disturbance during its installation	Type 2 moderately sensitive key fish habitat Class 2 moderate key fish habitat for fish passage.	No

Location	Habitat features	Key fish habitat classification	Sensitive receiving environment
	• To the east of the existing Burnt Bridge Creek Deviation culverts, the downstream reach of Burnt Bridge Creek is a wider channel with modified bedrock and sections of concrete and boulder retaining walls through the golf course with the trunk sewer line noted above installed along the length of the creek in the golf course area. This section of the watercourse is known to experience hazardous flooding velocities (up to five to eight metres per second). A weir has created a deeper pool where organic debris has accumulated and exotic macrophytes have established. A thin corridor of native riparian vegetation is located next to the channel, some of which overhangs instream and provides shading along sections of the reach • Further downstream, the Kitchener Street bridge spans the width of the channel along this reach with two large box culverts perched over bedrock. Flows are restricted to partially connected pools. Erosion and bank undercutting were observed along this reach. The width of riparian corridor along this reach is limited by nearby residences and Burnt Bridge Creek Deviation. The riparian corridor provides moderate shading over the channel, with small woody debris instream.		
Manly Creek (also known as Curl Curl Creek), located about 300 metres east of the northern extent of the construction footprint	• The substratum of Manly Creek comprises mostly sandstone bedrock, boulders and cobbles and is inundated by a series of connected pools, runs and riffles with some unconsolidated materials accumulated in the pools • The banks are low and large snags and boulders provide potential fish habitat at this location • The riparian corridor consists of woody vegetation.	Type 1 highly sensitive key fish habitat Class 1 major key fish habitat for fish passage.	Yes

Location	Habitat features	Key fish habitat classification	Sensitive receiving environment
Manly Dam located to the east of the construction footprint	• Manly Dam contains large areas of emergent, native/exotic aquatic macrophytes including native sedges (*Eleocharis* spp.) and the exotic Yellow Waterlily (*Nymphaea mexicana*) • The dam supports an extensive wetland community, and is located within 100 metres of areas of Coastal Sandstone Gully Forest groundwater dependent ecosystem and Coastal Upland Damp Heath Swamp endangered ecological community • Shallow wetland areas scattered around the dam foreshore support native and exotic emergent macrophytes that offer potential habitat for Common Eastern Froglet (*Crinia signifera*), Eastern Dwarf Tree Frog (*Litoria fallax*) and Eastern Banjo Frog (*Limnodynastes dumerilii*) • Deeper parts of the dam support Eastern Long-necked Turtles (*Chelodina longicollis*), Australian Bass (*Macquaria novemaculeata*) and Silver Perch (*Bidyanus bidyanus*).	Type 1 highly sensitive key fish habitat Class 1 sensitive key fish habitat for fish passage.	Yes
Trefoil Creek, located about 300 metres north of the northern extent of the construction footprint	• Trefoil Creek is a narrow (less than one metre wide), natural, ephemeral channel located within a steep gully characterised by small, disconnected pools with a sandy silt substratum overlaying bedrock. Accumulated debris and log jams are common along the reach and likely to be mobilised during high flows • Riparian vegetation comprises dense, overhanging native and exotic vegetation providing substantial riparian shading over ephemeral and disconnected pools.	Type 2 moderately sensitive key fish habitat Class 3 minimal key fish habitat for fish passage.	Yes

Location	Habitat features	Key fish habitat classification	Sensitive receiving environment
Unnamed small, ephemeral watercourses located within the construction footprint next to the Wakehurst Parkway	• Riparian vegetation includes Sydney Peppermint – Smooth-barked Apple – Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, offering habitat to locally occurring amphibian, reptile and mammal species, due to the diversity of fauna habitat features available (ie rocks and logs, well-developed leaf litter and intact native vegetation) • Standing pools and riffles with an ephemeral flow varying in width and depth are likely to provide sheltering, foraging and breeding habitat for numerous species of amphibian, reptile, mammal, invertebrate and bird including threatened species such as Red-crowned Toadlet given the presence of substantial fauna habitat (ie logs, leaf litter, rock).	Type 3 minimally sensitive key fish habitat Class 3 minimal key fish habitat for fish passage.	No
Wakehurst Golf Course dam, located about 100 metres north-east of the Wakehurst Parkway east construction support site (BL13)	• This dam is a freshwater lagoon, bound by sandstone escarpment to the west and levee banks to its north, east and south and nested within the bushland reserve between the Wakehurst Parkway and Wakehurst Golf Course • Riparian vegetation includes mostly dense, native vegetation with some exotic understorey • Some fringing areas of native emergent macrophytes (*Eleocharis* spp.) and filamentous green algae were recorded • A vegetated drainage line discharges into the dam. Upstream sections were vegetated with shrubs, ferns, grasses and forbs or layered with detritus. No instream macrophytes were observed although moss was observed in some sections.	Not key fish habitat.	No

19.3.4 Groundwater dependent ecosystems

A search of the *National Atlas of Groundwater Dependent Ecosystems* (BOM, 2018) did not identify any groundwater dependent ecosystems within the construction footprint. However, three areas of groundwater dependent ecosystems may rely on subsurface groundwater associated with local waterways within, or close to the construction footprint. These groundwater dependent ecosystems are outlined in Table 19-9 and shown on Figure 19-12.

No high priority groundwater dependent ecosystems (as defined by the Department of Planning, Industry and Environment (Water)) would be located within or next to the construction footprint.

Table 19-9 Groundwater dependent ecosystems mapped by BOM (2018) in proximity to the project

Location of mapped groundwater dependent ecosystem	Distance from the project	Mapped ecosystems
Upper reaches of Flat Rock Creek at Munro Park – moderate to high potential for terrestrial groundwater dependent ecosystem	About 280 metres south-east of the tunnel alignment and the Flat Rock Drive construction support site (BL2)	Coastal Sandstone Gully Forest Sandstone Riparian Scrub Coastal Sand Forest
Bates Creek – moderate to high potential for terrestrial groundwater dependent ecosystem	About 550 metres west of the Wakehurst Parkway surface road works	Estuarine Mangrove Forest Seagrass Meadow Coastal Sandstone Gully Forest
Manly Dam Reserve – moderate potential for terrestrial groundwater dependent ecosystem	About 650 metres east of the Wakehurst Parkway surface road works	Coastal Sandstone Gully Forest Coastal Sandstone Plateau Heath

Coastal Upland Swamp in the Sydney Basin Bioregion, listed as Endangered under the *Biodiversity Conservation Act 2016* and *Environment Protection and Biodiversity Conservation Act 1999*, is mapped near the construction footprint. While it is not mapped as a groundwater dependent ecosystem within the *National Atlas of Groundwater Dependent Ecosystems* (BOM, 2018), this threatened ecological community may also be sensitive to changes to groundwater flows. A review of the regional vegetation mapping by OEH (2016), as well as ground truthing, identified that the closest areas of Coastal Upland Swamp to the construction footprint are two patches 95 metres west of the Wakehurst Parkway in Garigal National Park and one small patch north of Bantry Bay Oval, about 135 metres to the south-east of the construction footprint. The extent of groundwater dependence of both of these areas of Coastal Upland Swamp, or their connectivity to other areas of groundwater, is not known.

19.3.5 Wetlands and conservation areas

No wetlands listed under the State Environmental Planning Policy (Coastal Management) 2018 are located within the aquatic biodiversity study area. There are no wetlands of international importance within the construction footprint. Therefore, impacts to wetlands and conservation areas are not assessed further.

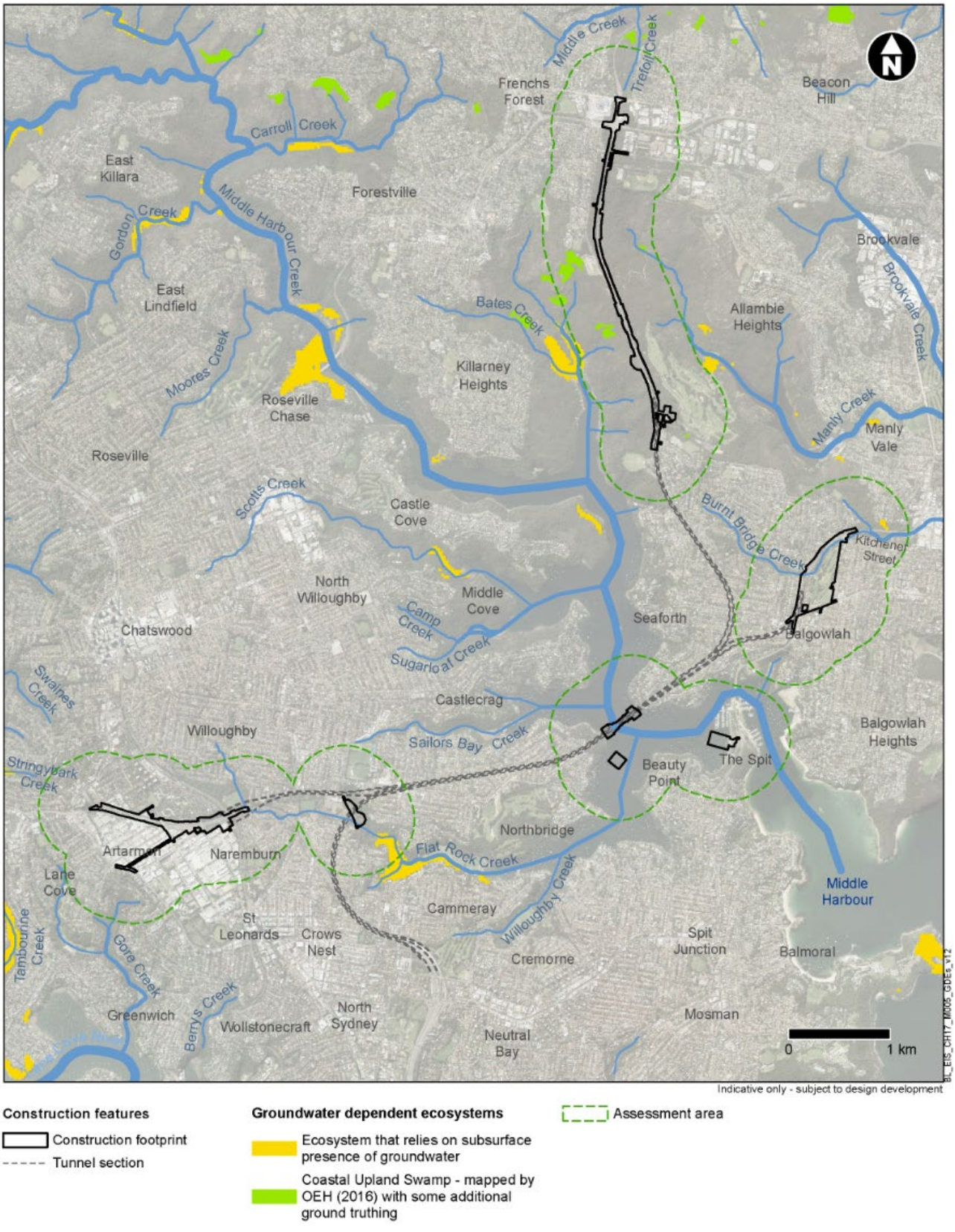


Figure 19-12 Distribution of groundwater dependent ecosystems

19.3.6 Marine biodiversity

Marine habitats

Eight marine habitat types were identified within the marine biodiversity study area and are shown in Figure 19-13. The habitats and relevant key fish habitat classifications as defined in the *Policy and guidelines for fish habitat conservation and management* (NSW DPI, 2013) are summarised in Table 19-10.

No critical habitats listed on State or Commonwealth registers of critical habitat occur within the marine biodiversity study locality.

Table 19-10 Marine habitats within the marine biodiversity study area

Key fish habitat classification	Marine habitat
Highly sensitive key fish habitat (Type 1)	Seagrass
	Saltmarsh
	Subtidal rocky reef
Moderately sensitive key fish habitat (Type 2)	Intertidal rocky shore
	Mangrove
	Intertidal sand and mudflat
Minimally sensitive key fish habitat (Type 3)	Deepwater soft sediment
	Open water

Two natural sills occur within the harbour at The Spit and Grotto Point. These natural sills in some circumstances could interact with hydrology, resulting in natural situations arising where dissolved oxygen levels in the bottom layers at the sills is reduced. Based on average annual rainfall patterns, the conditions leading to dissolved oxygen depletion near the bed of the harbour are likely to occur naturally a few times per year, particularly during the warmer late summer and autumn period.

The occurrence of these events may result in mortality to some benthic (bottom dwelling) infauna (animals which live in the sediments on the floor of a waterbody) and epifauna (animals living on the surface of the bed of a harbour or riverbed) within the deepest parts of Middle Harbour. However, fish and sharks would be able to avoid these environments and any impacts that would otherwise result from these naturally occurring events. Although there would be some naturally occurring mortality of benthic fauna associated with these events, recolonisation would typically occur through natural processes, with these communities likely to be resilient to these types of disturbances.

Threatened marine ecological communities, species and endangered populations

Saltmarsh and seagrass (*Posidonia australis)* meadow communities occur within the marine biodiversity study area. These two marine threatened ecological communities are listed under the *Fisheries Management Act 1994* and the *Environment Protection and Biodiversity Conservation Act 1999* (refer to Table 19-11).

Although the Subtropical and temperate coastal saltmarsh community occurs within and around Middle Harbour, it has not been identified in the project area.

The fragmented patches of seagrass within the marine biodiversity study area at Explosives Reserve, Castlecrag, Clive Park, Beauty Point, Seaforth and Brady Point do not meet the condition thresholds to be considered part of the *Posidonia australis* meadows of the Manning-Hawkesbury ecoregion listed as an endangered ecological community under the *Environment Protection and Biodiversity Conservation Act 1999*. The seagrass patches are, however, consistent with the *Posidonia australis* endangered population listed under the *Fisheries Management Act 1994*.

Table 19-11 Threatened marine ecological communities in the marine biodiversity study area

Marine ecological community	Conservation significance[1]
Seagrass (*Posidonia australis*)	Endangered population (FM Act) Endangered (EPBC Act)
Subtropical and temperate coastal saltmarsh	Protected (FM Act) Vulnerable (EPBC Act)

1. FM Act = *Fisheries Management Act 1994*
EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

Two listed marine fish species were identified as having a high likelihood of occurrence within the project area, Black Rockcod (*Epinephelus daemelii*) and White's Seahorse (*Hippocampus whitei*). These species have a high likelihood of occurrence due to the presence of suitable habitat within the project area. In addition, nine listed marine species were identified as having a moderate likelihood of occurrence within the project area.

White's Seahorse is listed as endangered under the *Fisheries Management Act 1994* and has been nominated for threat-listing under the *Environment Protection and Biodiversity Conservation Act 1999*. A preliminary assessment of significance under the *Environment Protection and Biodiversity Conservation Act 1999* has been carried out for White's Seahorse for completeness.

Details of the 11 listed marine species likely to occur within the project area are provided in Table 19-12.

Fauna passage is not currently affected by the natural sills within the harbour, with fish, sharks, marine mammals and marine turtles able to transit through these shallow waters to deeper waters upstream, including areas within and surrounding the project area.

Migratory marine species

No migratory marine species listed under the *Environment Protection and Biodiversity Conservation Act 1999* have high or moderate likelihood of occurrence in the marine biodiversity study area.

Table 19-12 Threatened marine species known or likely to occur in the project area

Species	Conservation significance[1]	Likelihood of occurrence in the project area
Black Rockcod (*Epinephelus daemelii*)	Vulnerable (FM Act) Vulnerable (EPBC Act)	High likelihood of occurrence in the project area. Suitable habitat for this species is present within the project area. Suitable habitat for this species within the project area includes medium to high relief subtidal rocky reef areas, which are present along the shorelines of Middle Harbour.
White's Seahorse (*Hippocampus whitei*)	Endangered (FM Act) Nominated for threat-listing, marine (EPBC Act)	High likelihood of occurrence in the project area. Suitable habitat for this species is present within the project area, including low, medium and high relief subtidal rocky reef areas and *Halophila*, *Zostera* and *Posidonia* seagrass meadows.
New Zealand Fur-seal (*Arctocephalus forsteri*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the project area. Foraging habitat and suitable rest areas are present within the project area.
Australian Fur-seal (*Arctocephalus pusillus doriferus*)	Vulnerable (BC Act)	Moderate likelihood of occurrence in the project area. Foraging habitat and suitable rest areas are present within the project area.
Loggerhead Turtle (*Caretta caretta*)	Endangered (BC Act) Endangered, migratory, marine (EPBC Act)	Moderate likelihood of occurrence in the project area. This species has been anecdotally recorded within the marine biodiversity study area; however high-quality preferred habitat for this species is not present within the project area.
Green Turtle (*Chelonia mydas*)	Vulnerable (BC Act) Vulnerable, migratory, marine (EPBC Act)	Moderate likelihood of occurrence in the project area. This species has been anecdotally recorded within the marine biodiversity study area, however high-quality preferred habitat for this species is not present within the project area.
Leatherback Turtle (*Dermochelys coriacea*)	Endangered (BC Act) Endangered, migratory, marine (EPBC Act)	Moderate likelihood of occurrence in the project area. This species has been anecdotally recorded within the marine biodiversity study area; however high-quality preferred habitat for this species is not present within the project area.

Species	Conservation significance[1]	Likelihood of occurrence in the project area
Hawksbill Turtle (*Eretmochelys imbricata*)	Vulnerable, migratory, marine (EPBC Act)	Moderate likelihood of occurrence in the project area. This species has been anecdotally recorded within the marine biodiversity study area; however high-quality preferred habitat for this species is not present within the project area.
Flatback Turtle (*Natator depressus*)	Vulnerable, migratory, marine (EPBC Act)	Moderate likelihood of occurrence in the project area. This species has been anecdotally recorded within the marine biodiversity study area; however high-quality preferred habitat for this species is not present within the project area.
Grey Nurse Shark (*Carcharias Taurus*)	Critically endangered (FM Act) Critically endangered (EPBC Act)	Moderate likelihood of occurrence in the project area. Foraging habitat for this species is present within the project area.
White Shark (*Carcharodon carcharias*)	Vulnerable (FM Act) Vulnerable, migratory (EPBC Act)	Moderate likelihood of occurrence in the project area. Foraging habitat for this species is present within the project area.

Note 1: FM Act refers to *Fisheries Management Act 1994*
BC Act refers to *Biodiversity Conservation Act 2016*
EPBC Act refers to *Environment Protection and Biodiversity Conservation Act 1999*

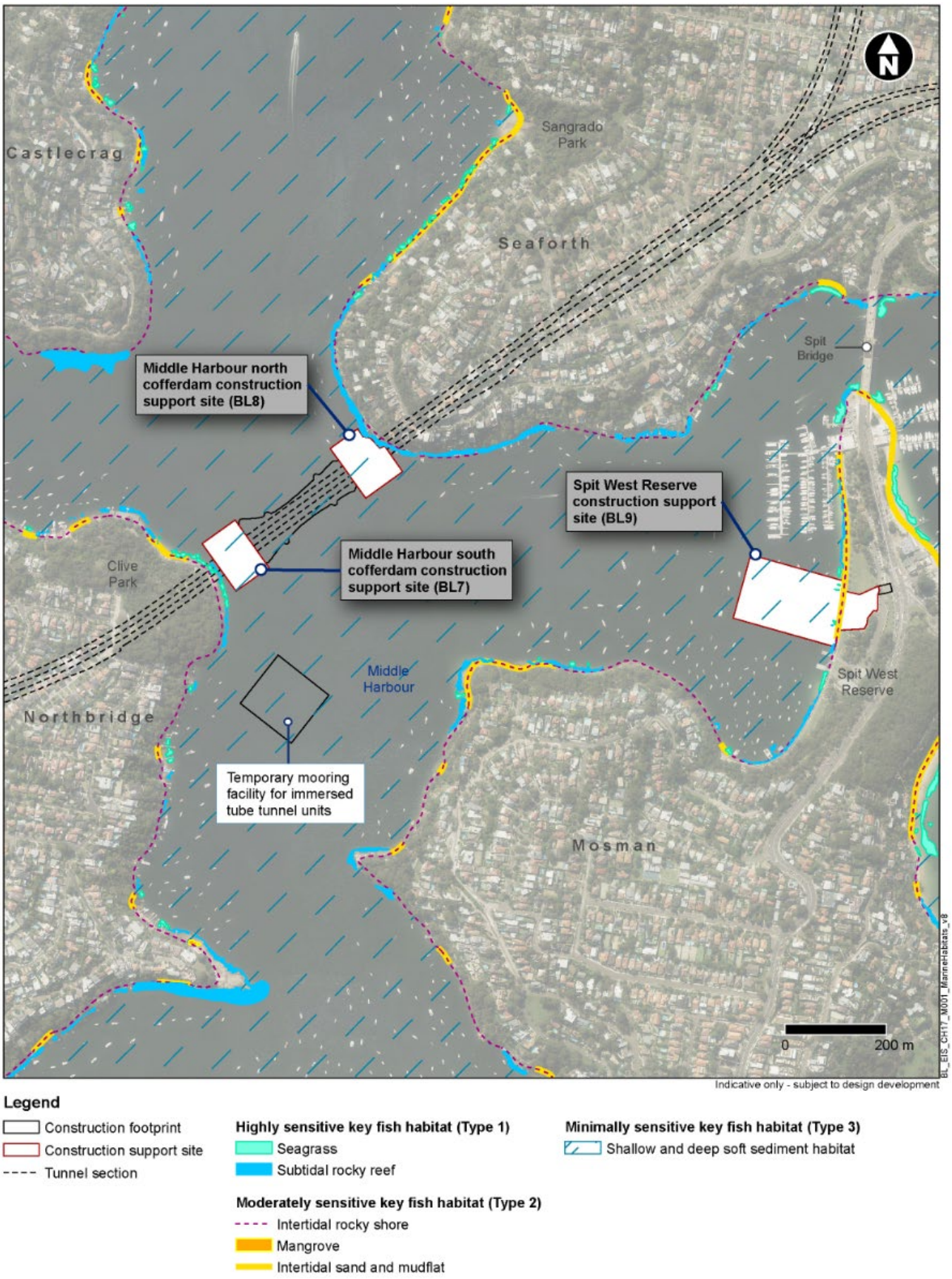


Figure 19-13 Marine habitats within the marine biodiversity study area

19.4 Avoidance and minimisation

Based on the outcomes of the desktop assessment and field surveys, opportunities to avoid or minimise biodiversity impacts were considered as part of the project design development process. Chapter 4 (Project development and alternatives) describes the alternatives that were considered as part of the project development process and explains the selection of the preferred corridor and design.

Five corridor alternatives were considered for the project; four of these included upgrading the Wakehurst Parkway, where there is the potential for greater biodiversity impacts compared to the remainder of the project. The five corridors were evaluated by a multidisciplinary team including design engineers, construction engineers, transport planners and environmental advisors to identify the solution that best balanced technical, community and environmental outcomes while meeting the transport objectives.

The project largely avoids surface impacts to terrestrial biodiversity values by tunnelling, and the preferred corridor avoids impacts associated with other options to the areas around Parriwi Park and Fisher Bay Bushland Reserve, where threatened species have been recorded.

Throughout the refinement of the preferred corridor design, a number of elements have been included to avoid and minimise impacts on biodiversity during construction and in operation of the project, including:

- The Flat Rock Drive construction support site (BL2) was chosen to be located in an area of Flat Rock Reserve which was previously used as a landfill site until 1985. This area contains mostly native revegetation, avoiding impact to surrounding remnant vegetation. Refer to Section 3 of Appendix S (Technical working paper: Biodiversity development assessment report) for further details
- The preferred design for the connection to and from the Burnt Bridge Creek Deviation and surface road works at Balgowlah have reduced impacts to Burnt Bridge Creek to the east and west of Burnt Bridge Creek Deviation, including potentially reduced impact on mature trees in the golf course compared to other options. Furthermore, direct impact of the Burnt Bridge Creek riparian corridor has been reduced by establishing an exclusion zone around riparian native vegetation adjoining the creek
- The preferred design for the connection to Sydney Road from the Burnt Bridge Creek Deviation avoids the need to demolish and replace the Kitchener Street bridge which reduces potential noise impacts and duration of impacts to the Grey-headed Flying-fox camp at Balgowlah compared to other options
- Impacts to terrestrial fauna connectivity have been minimised by providing a number of dedicated fauna crossings spanning the Wakehurst Parkway that would provide fauna connectivity between Garigal National Park to the west and Manly Dam Reserve to the east. Fauna fencing would be provided for the length of the Wakehurst Parkway to reduce the risk of vehicle strike and fauna mortality, and guide fauna towards crossing structures
- Impacts to the Duffys Forest endangered ecological community have been avoided as far as possible by optimising the location of the tunnel portals and permanent tunnel support facilities
- Tunnelling has largely avoided impacts to areas supporting groundwater dependent ecosystems, apart from some vegetation at Flat Rock Creek/Quarry Creek that would be subject to potential water table drawdown impacts
- The project design and construction works have been developed to largely avoid direct impacts to seagrass and other sensitive marine habitat areas in Middle Harbour
- The construction methodology for the crossing of Middle Harbour and immersed tube tunnel alignment have been designed to reduce the construction footprint and avoid dredging of the sandbar at the entrance to Middle Harbour or dredging in the vicinity of the Spit West Reserve construction support site (BL9). The sandbar is considered one of the more sensitive marine habitat areas within Middle Harbour.

Further discussion on the avoidance and minimisation of biodiversity impacts is included in Section 4 of Appendix S (Technical working paper: Biodiversity development assessment report).

19.5 Assessment of potential impacts

This section assesses the potential impacts during construction and operation of the project on:

- Terrestrial flora, including removal of vegetation and loss of threatened flora species, edge effects, spread of weeds and pathogens (Section 19.5.1)
- Terrestrial fauna, including potential removal or degradation of fauna habitat, fauna injury and mortality, noise, vibration, dust and light spill impacts (Section 19.5.2)
- Aquatic biodiversity, including potential loss of aquatic habitat and water quality impacts (Section 19.5.3)
- Groundwater dependent ecosystems, including groundwater drawdown impacts (Section 19.5.4)
- Marine biodiversity, including potential loss of marine habitat, marine water quality impacts, and underwater noise impacts (Section 19.5.5).

Vegetation removal including the clearing of fauna habitat would be further minimised during further design development and detailed construction planning, where feasible and reasonable. Appendix W (Technical working paper: Arboricultural impact assessment) provides a preliminary assessment of trees that could be retained subject to further design development and construction planning.

In addition, the final layout of the new and improved open space and recreation facilities at Balgowlah, including the retention and/or removal of trees, would be subject to the outcome of the dedicated community consultation process. This consultation would be jointly led by Transport for NSW and Northern Beaches Council and would be separate to the consultation for the Beaches Link environmental impact statement. This process would start after the environmental impact statement public exhibition period and well in advance of construction starting. Further information on the new and improved open space and recreation facilities at Balgowlah is included in Section 5.2.1.3 of Chapter 5 (Project description).

19.5.1 Assessment of potential impacts to terrestrial flora

Removal of native vegetation

Construction of the project would require removal of about 15.44 hectares of native vegetation and native revegetation (refer to Table 19-13). This includes around 1.38 hectares of Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region (PCT 1786), located along the Wakehurst Parkway at Frenchs Forest (refer to Figure 19-4 and Figure 19-5), which is consistent with the Duffys Forest endangered ecological community listed under the *Biodiversity Conservation Act 2016*.

As described in Section 19.4, to reduce impacts on native vegetation, an exclusion zone is proposed to be established around riparian vegetation adjoining Burnt Bridge Creek adjacent to the surface road works at Balgowlah where reasonable and feasible. The exclusion zone would be about 0.90 hectares in area and would contains 0.48 hectares of PCT 1292: Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion and 0.42 hectares of PCT 1841: Smooth-barked Apple - Turpentine - Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region.

Biodiversity offsets would be provided for these impacts, as outlined in Section 19.6.1.

During further design development and construction planning, vegetation removal would be further minimised where feasible and reasonable. Refer to environmental management measures in Table 19-18.

Table 19-13 Vegetation to be removed as part of the project

Plant community type (PCT)	Condition	Area removed (ha)
PCT 1250: Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion	Moderate/ good	0.20
PCT 1292: Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion	Moderate/ good	0.40
PCT 1783: Red Bloodwood - Scribbly Gum/Old-man Banksia open forest on sandstone ridges of northern Sydney and the Central Coast	Moderate/ good	4.23
PCT 1786: Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region (consistent with the Duffys Forest endangered ecological community)	Moderate/ good – Good	1.01
PCT 1786: Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region (consistent with the Duffys Forest endangered ecological community)	Moderate/ good – Moderate	0.37
PCT 1824: Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin	Moderate/ good	6.18
PCT 1841: Smooth-barked Apple - Turpentine - Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region	Moderate/ good	1.37
PCT 1845: Smooth-barked Apple - Red Bloodwood - Blackbutt tall open forest on shale sandstone transition soils in eastern Sydney	Moderate/ good	0.39
Native revegetation	Highly disturbed	1.29
Total		**15.44**

Removal of threatened flora species

Potential impacts to threatened flora species as a result of the project are summarised in Table 19-14, including impacts to both native remnant and planted individuals of Magenta Lilly Pilly (*Syzygium paniculatum*) and planted individuals of Netted Bottle Brush (*Callistemon linearifolius*). These impacts are indicative based on the current level of design development and would be confirmed during further design development.

Table 19-14 Summary of threatened flora species impacts

Species	Conservation significance	Habitat or individuals to be impacted
Magenta Lilly Pilly (*Syzygium paniculatum*)	Endangered (BC Act) Vulnerable (EPBC Act)	One remnant individual and up to four planted individuals
Netted Bottle Brush (*Callistemon linearifolius*)	Vulnerable (BC Act)	Up to four planted individuals

The project would not have a significant impact on any of these threatened flora species based on the very low numbers of remnant individuals to be removed, and the fact that other individuals are planted. Biodiversity offsets would be provided for the impacted remnant individual, as outlined in Section 19.6.1. Offsets are not required for planted individuals impacted by the project, as these are not considered to be of conservation significance.

Edge effects on native vegetation

The project would result in indirect impacts to some areas of native vegetation adjoining the construction footprint, mainly due to fragmentation of vegetation and creation of new edges, which may result in edge effects. However, most of the construction footprint adjoins small, fragmented areas of vegetation within urban areas. This vegetation is often already situated adjacent to an existing cleared edge, such as a road, and is subject to ongoing disturbance and edge effects.

The assessment of potential edge effects found:

- A total of 0.23 hectares of native vegetation would be subject to increased edge effects to the extent they would become unviable due to the small size and isolation of the remaining patches
- A total of 8.20 hectares of native vegetation would be subject to increased edge effects as a result of the project due to the creation of one or more new edges within previously unfragmented vegetation. These new edges could be subject to degradation by the establishment and spread of weeds, enriched runoff from road pavement and dumping of rubbish. However, the project would include the provision of drainage infrastructure that would appropriately manage surface water flows. Fauna fencing to be installed along the Wakehurst Parkway would likely prevent the dumping of rubbish along the roadside.

Of the 8.43 hectares of native vegetation subject to edge effects, about 1.36 hectares meets the criteria for Duffys Forest endangered ecological community. There are no areas of indirect impact that meet the criteria for any *Environment Protection and Biodiversity Conservation Act 1999* listed threatened ecological community.

Invasion and spread of weeds, pathogens and disease

An increase in the movement of people, vehicles, machinery, vegetation waste and soil during and following construction activities may facilitate the introduction or spread of exotic grasses and other weed species. Areas along the Wakehurst Parkway would be particularly susceptible to weed establishment due to earthworks being carried out to widen the road. Areas around the Flat Rock Drive construction support site (BL2) would also be potentially highly susceptible to weed establishment from construction works.

In addition, the soil-borne pathogen *Phytophthora cinnamomi* (Phytophthora) is known to occur within the construction footprint. This pathogen is associated with damage and death to native plants. Construction of the project has the potential to increase the spread of this pathogen which could be dispersed by vehicles, animals, walkers and the movement of soil, or over large distances in flowing water, such as storm runoff.

Management measures would be implemented where feasible and reasonable to minimise the risk of introduction and spread of weeds and pathogens during construction of the project (refer to Section 19.6).

19.5.2 Assessment of potential impacts to terrestrial fauna

Removal of fauna habitat

Table 19-15 provides a summary of the potential impacts to terrestrial fauna habitats and associated threatened species for the following habitat types:

- Vegetated habitats
- Human-made structures and built environments (including existing culverts, bridges and buildings)
- Marine and intertidal habitats. The assessment of potential impacts to marine species is discussed in Section 19.5.5.

Vegetated habitats that would be removed are primarily located next to the Wakehurst Parkway, within the Flat Rock Drive construction support site (BL2), Balgowlah Golf Course construction support site (BL10), Wakehurst Parkway south construction support site (BL12) and Wakehurst Parkway east construction support site (BL13).

The removal of flowering and fruiting trees, shrubs and ground layer vegetation, and rocky habitat would result in the loss of potential foraging and sheltering habitat to a number of threatened fauna species known or considered likely to occur in the construction footprint. However, these impacts would be negligible since the habitat to be removed does not comprise a significant proportion of habitat available to species in the surrounding terrestrial biodiversity locality or wider bioregion.

Two hollow-bearing trees would also be removed as part of construction works along the Wakehurst Parkway. One has a hollow diameter of 0.10 to 0.15 metres, and the other has a hollow diameter more than 0.20 metres.

The realignment and upgrade of the Wakehurst Parkway would increase existing fragmentation of the nearby vegetation, which would potentially adversely affect the movement patterns of a number of threatened terrestrial fauna species known or likely to occur in the area such as Rosenberg's Goanna, Eastern Pygmy-possum, Red-crowned Toadlet and Southern Brown Bandicoot. Fauna exclusion fencing, fauna underpasses and rope crossings would be upgraded/replaced or constructed as part of the realignment and upgrade of the Wakehurst Parkway to facilitate the safe crossing of fauna beneath or over the road. The proposed fauna exclusion fencing along both the eastern and western edge of the realigned and upgraded Wakehurst Parkway, would prevent fauna from accessing the road and being subjected to vehicle strike. Therefore, impacts due to increased habitat fragmentation as a result of the project would be minimised. Locations of the upgraded/replaced or new fauna underpasses and rope crossings is provided in Chapter 5 (Project description).

Direct impacts to human-made structures and the built environment would be limited to the alteration of existing bridges and culverts at the surface connections at Artarmon, surface road works at Balgowlah and the realignment and upgrade of the Wakehurst Parkway, which offer limited and marginal potential roosting habitat for some bat species. These species include the Large Bent-winged Bat, Little Bent-winged Bat, and Southern Myotis. These works would be temporary and are unlikely to adversely impact such species.

No marine or intertidal habitats that provide potential habitat for terrestrial fauna would be directly impacted by the project.

Table 19-15 Potential impacts to threatened fauna habitats and associated threatened species

Habitat type	Known or potential threatened fauna species	Potential impacts
Vegetated habitats	• Grey-headed Flying-fox • Powerful Owl • Rosenberg's Goanna • Large Bent-winged Bat • Eastern Coastal Free-tailed Bat • Large-eared Pied Bat • Eastern Pygmy-possum • Spotted-tailed Quoll • Southern Brown Bandicoot • Glossy Black-Cockatoo • Little Bent-winged Bat • Red-crowned Toadlet • Barking Owl • Little Lorikeet • Masked Owl • Square-tailed Kite • Swift Parrot • Varied Sittella • Dusky Woodswallow • Brown Treecreeper.	• Impacts to fauna due to the loss of potential foraging and sheltering habitat associated with vegetation or rocky habitat features to be removed, including Rosenberg's Goanna, Eastern Pygmy-possum, Large-eared Pied Bat and Red-crowned Toadlet. However, the habitat does not comprise a substantial portion of foraging habitat available in the surrounding terrestrial biodiversity locality or wider bioregion. Habitat removal would also be further minimised where feasible and reasonable. Further environmental management measures to minimise this impact are provided in Section 19.6 • The realignment and upgrade of the Wakehurst Parkway would increase existing fragmentation of the nearby vegetation. However, mitigation measures such as fauna exclusion fencing, fauna underpasses and rope crossings would be implemented to minimise impacts • Potential edge effects to vegetated habitats next to the Wakehurst Parkway are not expected to result in any associated habitat impacts, including downstream riparian areas which provide potential sheltering, foraging and breeding habitat for the Red-crowned Toadlet.
Human-made structures and built environments	• Large Bent-winged Bat • Little Bent-winged Bat • Eastern Coastal Free-tailed Bat • Yellow-bellied Sheathtail-bat • Greater Broad-nosed Bat • Southern Myotis	• Direct impacts would be limited to the alteration of existing bridges and culverts at Artarmon, Balgowlah and the Wakehurst Parkway which offer limited and marginal potential roosting habitat and is unlikely to adversely impact threatened bat species.

Habitat type	Known or potential threatened fauna species	Potential impacts
Marine and intertidal habitats	• Southern Myotis • White-bellied Sea Eagle • Eastern Osprey • Little Penguin	• Construction activities within Middle Harbour have the potential to decrease the surrounding water quality and impact the occurrence and behaviour of fish and other prey for threatened fauna species. However, these impacts would be temporary and localised and species would be able to forage in other parts of the harbour.

Fauna injury and mortality

Terrestrial fauna injury or mortality may occur during vegetation clearing activities (particularly during the felling of trees) or may result from collisions with work vehicles or plant, or accidental entrapment in plant, trenches or other works. Vehicle strike, particularly where construction vehicles would be in operation near tracts of fauna habitat along the Wakehurst Parkway, would not only directly impact the fauna species killed or injured, but would potentially impact predatory species likely to feed on the roadkill. For example, Rosenberg's Goanna has been known to feed on roadkill, and was recorded along the Wakehurst Parkway during field surveys carried out in 2017. Threatened fauna species with a high likelihood or known occurrence in the construction footprint could be subject to injury and mortality.

The majority of fauna species recorded within the construction footprint are highly mobile bird and mammal species that are likely to be able to move away from vegetation clearing and other construction activities quite readily. Fauna species susceptible to injury or mortality include less mobile species such as amphibians, reptiles, invertebrates and juvenile/nesting birds/mammals and small mammals. Threatened fauna species at highest risk of injury or mortality include:

- Red-crowned Toadlet
- Eastern Pygmy-possum
- Rosenberg's Goanna.

Marine fauna injury or mortality may occur during construction of the crossing of Middle Harbour or could result from collisions with watercraft or barges carrying out construction within Middle Harbour. This could include the threatened Little Penguin; however, this species typically forages in shallow waters at the shoreline, which the project largely avoids. Middle Harbour is subject to high levels of water traffic and the species may be adapted to avoiding water vessels. Notwithstanding, an observer qualified to spot Little Penguins would be used during marine construction activities. A stop-work procedure would also be developed by a suitably qualified and experienced ecologist and implemented upon evidence of any Little Penguin in the proximity of the works area.

Noise, vibration, dust and light spill impacts

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

Realignment and upgrade of the Wakehurst Parkway may indirectly affect threatened fauna species that have been previously recorded in nearby native vegetation, including:

- Red-crowned Toadlet
- Eastern Pygmy-possum
- Large Bent-winged Bat
- Little Bent-winged Bat
- Large-eared Pied Bat
- Grey-headed Flying-fox
- Powerful Owl
- Eastern Coastal Free-tailed Bat
- Southern Myotis
- Rosenberg's Goanna
- Glossy Black-Cockatoo.

Construction activities including the realignment and upgrade of the Wakehurst Parkway around the cut and cover and trough structures of the ramp tunnels and widening of the Wakehurst Parkway, and establishment and operation of temporary construction support sites, could result in noise, vibration, light spill and dust impacts on nearby habitat throughout the duration of construction. Excavation along the Wakehurst Parkway is required (eg at cuttings) and would require the use of rock hammers. Controlled blasting has also been identified as an opportunity in a few selected locations to minimise the duration of excavation. Areas likely to require controlled blasting would be confirmed during further design development and construction planning, and would be managed in accordance with requirements in Appendix G (Technical working paper: Noise and vibration).

Fauna can be sensitive to elevated noise, changing their behaviour and impacting their physiology. Rock hammering and blasting have potential to impact fauna inhabiting vegetation and rock habitat next to the Wakehurst Parkway. Fauna may initially desert the immediate area at the start of excavation activities due to increased noise and vibration levels. Native vegetation and rocky habitats in the adjacent Garigal National Park and Manly Dam Reserve would provide refuge for any displaced individuals with mobility. Fauna could then gradually reinhabit, potentially developing a tolerance to the high noise levels during construction. However, due to the extent of adjoining habitat, the initial displacement from the immediate area could become permanent. For less mobile species or breeding individuals, the effects of the high noise levels may be more acute.

There is potential for indirect impacts to Large-eared Pied Bat habitat areas more than 100 metres from the construction footprint due to noise and vibration, light and dust. The works in the vicinity of potential roost and foraging habitat would be minimised by implementing environmental management measures included in Section 19.6. While there is the potential for impacts from controlled blasting to Large-eared Pied Bat habitat areas, this method would minimise the duration of excavation, which would reduce the exposure to other indirect impacts such as light and dust.

Potential typical noise impacts to the Grey-headed Flying-fox camp are expected to be similar to or less than existing background noise levels at this location during most construction activities. The background noise levels are currently dominated by road traffic noise from the Burnt Bridge Creek Deviation. Some noise generating construction activities are predicted in worst case to exceed existing day time road traffic noise levels on the Burnt Bridge Creek Deviation. These activities include surface works on Burnt Bridge Creek Deviation and oversized deliveries associated with the Kitchener Street construction support site (BL11) and would likely be short term in duration.

Grey-headed Flying-foxes occupying the Balgowlah camp appear to be accustomed to background traffic noise and have persisted at the camp despite regular maintenance of the gross pollutant trap by Northern Beaches Council directly near core roosting habitat. Accordingly, typical noise levels of key noise-generating construction activities during the day are not anticipated to adversely impact the Grey-headed Flying-fox camp. Some noise-generating construction activities would result in worst case noise levels that would exceed existing day time road traffic noise levels on Burnt Bridge Creek Deviation. However, reasonable and feasible noise management measures would be implemented when construction activities are occurring near the Grey-headed Flying-fox camp, as outlined in Section 19.6.

Grey-headed Flying-foxes may not be sensitive to construction noise at night time (ie related to construction activities proposed to occur outside of standard construction hours), as most individuals would be engaging in nocturnal foraging activities throughout the surrounding locality.

Construction activities in Middle Harbour resulting in impulsive or continuous underwater noise may lead to changed behaviour of the Little Penguin. The species may avoid foraging in areas subjected to continuous or high levels of sound. Sudden or high levels of sound may have the potential to result in hearing loss or damage to auditory tissues in the Little Penguin. The potential for an impact to occur and the scale or nature of impact would depend on an individual penguin's proximity to construction activities, lessening as distance from construction activities increases. Given the level of construction activity proposed in the harbour, it is expected that individuals of the species would avoid the area reducing the risk of hearing loss and/or auditory damage occurring. Notwithstanding, an observer qualified to spot Little Penguins would be used during marine

construction activities. A stop-work procedure would also be developed by a suitably qualified and experienced ecologist and implemented upon evidence of any Little Penguin in the proximity of the works area.

Water quality impacts on terrestrial fauna

Runoff from the Wakehurst Parkway during construction and operation of the project has the potential to result in soil erosion and sedimentation impacts downstream if not appropriately managed. This may impact the potential sheltering, foraging and breeding habitat of the Red-crowned Toadlet. The project would include the provision of temporary and permanent water quality control measures along the Wakehurst Parkway, including new or modified drainage and water quality basins. As discussed further in Section 19.5.3, the results of water quality modelling indicates that during operation, the project would not decrease the water quality of nearby ephemeral and unnamed freshwater waterways at the Wakehurst Parkway (refer to Appendix O (Technical working paper: Surface water quality and hydrology) for further details).

Given that potential construction impacts on Red-crowned Toadlet habitat would be managed by the implementation of standard environmental management measures as outlined in Chapter 16 (Geology, soils and groundwater) and Chapter 17 (Hydrodynamics and water quality) and that water quality of the Red-crowned Toadlet habitat is unlikely to decrease during operation of the project, adverse impacts on potential Red-crowned Toadlet habitat are unlikely.

Construction works within Middle Harbour have the potential to result in water quality impacts (eg during piling and dredging activities) which could result in potential adverse impacts to foraging habitat for threatened fauna species such as the Little Penguin and White-bellied Sea Eagle. However, the selected methodology for the project has considered dredging methods and controls to limit the potential for turbidity impacts and mobilisation of sediment, to minimise the impact on the surrounding marine environment. This includes, but is not limited to, the installation of floating silt curtains and the use of a closed environmental clamshell bucket for dredging the upper layers of sediment to minimise the spread of excavated material into the water column. Accordingly, any potential increase in turbidity and sedimentation of marine waters near construction activities would be likely minimal, localised and temporary.

19.5.3 Assessment of potential impacts to aquatic biodiversity

Loss of aquatic habitat

Instream works would be required along an existing aboveground watercourse within Flat Rock Reserve and Burnt Bridge Creek.

The existing aboveground watercourse within Flat Rock Reserve would be diverted for around 100 metres through a newly constructed culvert at the north eastern perimeter of the Flat Rock Drive construction support site (BL2). Aquatic habitat impacts associated with these drainage works are anticipated to be minor.

Burnt Bridge Creek would undergo localised adjustment to facilitate an extension of the existing box culvert crossing of the Burnt Bridge Creek Deviation further into Balgowlah Golf Course. Scour protection would also be installed at the downstream limit of the culvert works. This may result in the loss of some small invertebrates as well as some instream habitat, including instream macrophytes and some unconsolidated sediments. However, the instream works are anticipated to have a minimal and localised impact to instream freshwater habitats.

A small area of riparian vegetation would be removed for the localised adjustment and drainage works at Burnt Bridge Creek. This has the potential to impact bank stability and surface water quality if not appropriately managed. Riparian vegetation directly affected during construction would be restored where practicable in accordance with the environmental management measures included in Section 19.6 and Chapter 22 (Urban design and visual amenity), to ensure that impacts to downstream aquatic habitats are minimised.

Due to the instream works within Burnt Bridge Creek there would be a net loss of about 60 square metres of Type 2 moderately sensitive key fish habitat. Offsets for aquatic habitat are discussed in Section 19.6.1.

The instream works would be carried out during low flows with fish passage to be maintained throughout the works. Where practical, native freshwater fauna, including fish and crayfish, would be relocated to a similar habitat along the same waterway prior to the start of the instream works. The adjusted Burnt Bridge Creek would be designed to be a low flow channel which maintains connectivity during low flows, and to promote fish passage. Therefore, significant or long-term impacts to freshwater ecology are not expected as a result of the project.

The project would also impact the Balgowlah Golf Course stormwater harvesting dam as part of constructing the new access road between Sydney Road and Burnt Bridge Creek Deviation. The Balgowlah Golf Course stormwater harvesting dam would initially be retained and maintained for construction water and for irrigation of Balgowlah Oval by Northern Beaches Council. As construction progresses, the stormwater harvesting dam would be dewatered and filled in. As discussed in Section 19.3.3, the stormwater harvesting dam is unlikely to provide habitat for native fish. Notwithstanding, dewatering procedures would be implemented in the event that native aquatic fauna are encountered to ensure any potential impacts are minimised.

Hydrological impacts

During construction and operation, there would be potential that baseflow reductions to Flat Rock Creek, Quarry Creek and Burnt Bridge Creek could affect surface environmental water availability and flows to these waterways. Estimates for maximum baseflow reduction include:

- A 20 per cent reduction in baseflow at the end of construction and 39 per cent after 100 years of operation at Flat Rock Creek
- A 23 per cent reduction in baseflow at the end of construction and 69 per cent after 100 years of operation at Quarry Creek
- A 79 per cent reduction in baseflow at the end of construction and 96 per cent after 100 years of operation at Burnt Bridge Creek.

During construction, baseflows would not be reduced completely and given the changes to baseflows during the construction period would be expected to be within natural ranges, there would be minor impacts only to aquatic biodiversity. Further, it is expected that the additional creek flows from treated water from the construction wastewater treatment plants could partially feed the surrounding groundwater system.

Reductions to baseflows during operation could be considered significant, in particular for Burnt Bridge Creek and Quarry Creek. However, they are unlikely to result in a complete loss of aquatic habitat. Pools would be retained in these waterways and there would still be high flows immediately after rainfall events. Between rainfall events there would still be some (low) flow along the waterways. Outside of the pool areas, substantially reduced flows between rainfall events would be expected to alter assemblages of freshwater biota in these creeks to generally include only those species that are most tolerant to low flows. Potential operational impacts to reductions in baseflows at Flat Rock Creek are likely to be offset by discharges to the creek from the Gore Hill Freeway operational wastewater treatment plant.

While the potential impacts to baseflow reductions may be overestimated due to conservative modelling, additional monitoring of surface water flows and groundwater levels in the vicinity of Flat Rock Creek, Quarry Creek and Burnt Bridge Creek would be carried out to support a refined assessment of impacts and develop suitable design mitigation measures during further design development. Refer to Chapter 16 (Geology, soils and groundwater) and Chapter 17 (Hydrodynamics and water quality) for further discussion on baseflow reductions and environmental management measures to manage potential impacts.

Water quality impacts on aquatic biodiversity

Construction activities and temporary construction support sites in the vicinity of waterways could result in potential soil erosion, siltation and off-site movement of eroded sediments by stormwater into downstream waterways, accidental fuel and chemical spills, as well as potential changes to water quality and flow in nearby waterways if not appropriately managed. Impacts from construction activities, including wastewater treatment and discharge, are discussed in Chapter 17 (Hydrodynamics and water quality).

Potential impacts of construction activities on water quality would be managed by the implementation of standard environmental management measures as outlined in Chapter 17 (Hydrodynamics and water quality), including erosion and sediment controls for all work sites and surface work areas. With the implementation of appropriate measures during construction, impacts to water quality would be temporary and manageable. Water treatment devices, such as construction sediment basins, would be provided to manage sediment-laden runoff from disturbed areas during construction.

During operation, there would be an increase in impervious surfaces as a result of the project, which would result in an increased volume of runoff with the potential for increased scouring, erosion and sedimentation in downstream waterways. Runoff may also transport increased sediment loads and nutrients such as nitrogen and phosphorus to these waterways. The project would include the provision of water quality control measures during operation, including new and modified drainage infrastructure along the Gore Hill Freeway, Burnt Bridge Creek Deviation, Wakehurst Parkway and on surrounding roads directly affected by the project. In addition, new or modified permanent water quality basins would be provided at:

- Gore Hill Freeway – extension of the existing water quality basin at Punch Street
- Burnt Bridge Creek Deviation – within the new and improved open space and recreation facilities (subject to further consultation)
- Wakehurst Parkway – a new water quality basin to the west of the widened Wakehurst Parkway, adjacent to Garigal National Park and three new water quality basins to the east of the widened Wakehurst Parkway about 800 metres to 900 metres south of the intersection with Warringah Road.

Groundwater captured in the tunnels would be treated to comply with (ANZECC/ARMCANZ, 2000) and ANZG (2018) guidelines and spill controls and water quality monitoring would be implemented to manage operational impacts on ambient water quality within the receiving waterways. For locations where stormwater would be discharged (ie Gore Hill Freeway, Balgowlah and the Wakehurst Parkway), water quality treatment to meet existing conditions would be provided, at a minimum, such that impacts on surface water quality would be minimal.

Due to the presence of sensitive receiving environments along the Wakehurst Parkway, there is potential for impacts on aquatic biodiversity due to reduced water quality during operation. In particular, the population of Climbing Galaxias has been noted as being is susceptible to water pollution. However, MUSIC model results for the Wakehurst Parkway stormwater catchments presented in in Appendix O (Technical working paper: Surface water quality and hydrology) show that during operation, the project would result in an overall beneficial water quality outcome with a reduction in annual suspended solid and phosphorous loads, but an increase in total annual nitrogen loading of 188 kilograms per year for the overall combined Wakehurst Parkway catchments.

Based on these results, it was concluded that the operation of the project at the Wakehurst Parkway would not decrease the water quality of nearby ephemeral and unnamed freshwater waterways, nor Garigal National Park drainage lines, Bantry Bay, Manly Dam or Manly Creek.

With the implementation of appropriate management measures (refer to Chapter 17 (Hydrodynamics and water quality)), the likelihood of impacts to aquatic biodiversity as a result of the project would be low.

19.5.4 Impacts to groundwater dependent ecosystems

No direct impacts on groundwater dependent ecosystems would occur as a result of the project. Some areas of Coastal Sandstone Gully Forest, Sandstone Riparian Scrub and Coastal Sand Forest adjoining Flat Rock Creek would be subject to impacts from groundwater drawdown, with groundwater drawdown impacts of up to four metres predicted by 2028 and 11 metres by 2128. The level of groundwater dependency of this vegetation is unknown; however, it is likely that it is able to draw on surface water in Flat Rock Creek and soil moisture to prevent drying out of the community, except in dry periods where there is no recharge from rainfall or surface runoff. Groundwater drawdown as a result of the project may contribute to trees dying or becoming stressed during periods of prolonged drought.

Appendix N (Technical working paper: Groundwater) details that the maximum predicted baseflow impact to Flat Rock Creek after 100 years of operation of the project is a reduction of 84.7 kilolitres per day, equating to a flow reduction of 39 per cent. The maximum predicted baseflow impacts to Quarry Creek after 100 years of operation would be a reduction of 11.4 kilolitres per day, equating to a flow reduction of 69 per cent. Operational wastewater treatment plant discharges to Flat Rock Creek could offset this impact.

It is noted that groundwater modelling provides a conservative assessment which excludes the designed tunnel linings. Additional modelling carried was carried out for a scenario in which the section of tunnel beneath Flat Rock Creek is lined. With the linings assumed, the predicted water table drawdown after 100 years of operation was predicted to be up to eight metres less than the drawdown predicted without the lining, demonstrating that implementation of tunnel lining would help mitigate potential groundwater drawdown impacts and that potential baseflow impacts would be lower than predicted (refer to Chapter 16 (Geology, soils and groundwater) and Appendix N (Technical working paper: Groundwater)).

Coastal Upland Swamp may also be sensitive to changes to groundwater flows, and two areas mapped as Coastal Upland Swamp may be impacted by groundwater drawdown as a result of the project. The extent of groundwater dependence of both of these areas of Coastal Upland Swamp, or their connectivity to other areas of groundwater, is not known and therefore the impacts from groundwater drawdown are uncertain.

The closest mapped patch of Coastal Upland Swamp is located about 95 metres to the west of the Wakehurst Parkway in Garigal National Park. Groundwater drawdown is predicted to be less than one metre (by 2028 and 2128). It is unlikely that groundwater drawdown of less than one metre would result in impacts to most of the area of this Coastal Upland Swamp; it is possible that some areas at the upslope edges of the patches could be affected in the event of prolonged low rainfall periods.

Another small (0.07 hectare) area of Coastal Upland Swamp was identified north of Bantry Bay Oval, about 135 metres south-east of the construction footprint, with predicted groundwater drawdown of less than one metre by 2028 and 2128 (see Appendix N (Technical working paper: Groundwater)). Due to its small size, urbanised context and modified floristics, including numerous weedy exotic species, impacts to this area of Coastal Upland Swamps are not considered to be significant.

Appropriate environmental management measures would be implemented to manage potential drawdown impacts to groundwater dependent ecosystems and baseflow reduction impacts (refer to Chapter 16 (Geology, soils and groundwater)).

19.5.5 Assessment of potential impacts to marine biodiversity

Impacts to key fish habitat

A risk assessment relating to the potential hazards to Type 1, 2 and 3 key fish habitats within the marine biodiversity study area is summarised in Table 19-16, including the removal of habitat, altered hydrodynamics, elevated turbidity and sedimentation from dredging, mobilisation of contaminants, introduction of marine pests and underwater noise from dredging and piling.

Removal of medium/high relief rocky reef habitat would occur during the installation of the Middle Harbour north cofferdam (BL8). This has the potential to provide habitat for Black Rockcod and White's Seahorse. As the removal of this habitat would be limited to less than 0.01 hectares, impacts would be small relative to the extent of the habitats in Middle Harbour so as to not compromise the functionality, long-term connectivity or viability of habitats, or ecological processes beyond the affected areas. No offsets would be required as this area of rocky reef would be reinstated after construction and there would therefore be no net loss of habitat.

Dredging for the installation of the immersed tube tunnels would result in the removal of about 3.50 hectares of deep water soft sediment habitat. This would include an unavoidable loss of about 1.41 hectares of deep water soft sediment habitat where the immersed tube tunnel units at the crossing would be placed. However, the hard surfaces of the immersed tube tunnels would be colonised through natural processes of recruitment and immigration by sessile invertebrates and some algae and provide habitat for some fish. The immersed tube tunnels would provide more surface area than the deep water soft sediment habitat it would replace, such that there would be no net loss to key fish habitat.

There is also potential for scour from vessel movements and shading from construction infrastructure to result in the removal of seagrass habitat near the Middle Harbour south (BL7) and Middle Harbour north (BL8) cofferdams and Spit West Reserve construction support site (BL9). With appropriate management of construction activities, including vessel movements, direct impacts to seagrass habitats would be minimal.

Alteration of hydrodynamics associated with the construction and operation of the immersed tube tunnels, including cofferdams, silt curtains and temporary wharves would impact currents around Type 1 key fish habitats and the flushing of deep water environments. Modelling of temporary changes to current speeds carried out for the project construction phase indicated that while the temporary changes would be relatively large in some locations at some parts of the tidal cycle, substantial impacts are not expected for the key fish habitats within the marine biodiversity study area. These habitats, including Type 1 seagrass and rocky reef habitats, thrive in many other parts of the marine biodiversity study area where natural currents are within the expected modified range. The temporary changes in hydrodynamics are not expected to impact deep water habitats.

Permanent alteration of hydrodynamics would occur due to the installation of the immersed tube tunnel, which would create a sill-like feature of about 9.2 metres high above the bed of the harbour at the deepest part of the Middle Harbour crossing location. The presence of the additional sill has the potential to impact on water quality within the marine biodiversity study area by reducing natural flushing of upstream environments, which could result in increased residence times of the deeper waters upstream of the sill from 1.6 days to 2.4 days. Longer residence time of the deeper waters could promote conditions more favourable to the depletion of dissolved oxygen in the bottom boundary layer and may lead to longer periods of low dissolved oxygen concentrations in the near-bed waters upstream of the. When dissolved oxygen concentrations are reduced there may be mortality to some benthic infauna and epifauna in soft sediment habitat in the deepest parts of the harbour, but fish and sharks would generally be able to avoid these bottom layers. It would be expected that recolonisation of affected deep water soft sediment habitat would occur through natural processes of recruitment of planktonic larvae and from movement of fauna from shallower unaffected areas of soft sediment.

Based on average annual rainfall patterns, the conditions leading to dissolved oxygen depletion to about 50 per cent saturation concentrations are likely to naturally occur a few times per year, particularly during the warmer late summer and autumn period. Due to the presence of existing low dissolved oxygen events, deep water communities are expected to be resilient to similar disturbances and would be able to rapidly recolonise following episodes of altered hydrodynamics. While the project would potentially result in low dissolved oxygen events lasting slightly longer at a slightly lower dissolved oxygen concentration than the present system, as currently occurs, any depletion of dissolved oxygen in deeper waters would be rapidly mixed vertically resulting in the project having a negligible effect on dissolved oxygen in surface waters and nearshore environments in which Type 1 and Type 2 key fish habitats are located.

The sill created by the immersed tube tunnels would likely increase the rate of siltation in the deepest water upstream of the crossing by three to four millimetres per decade. This rate is within the range of sedimentation rates within Sydney Harbour and forms a negligible contribution to overall sedimentation. Investigations of the existing water quality variability carried out for the project indicated that while the operation of the project has the potential to impact on the hydrodynamics for deep water habitats, the conditions would be similar to the existing disturbances caused by the two other natural sills within Middle Harbour (refer to Section 19.3.6).

Turbidity and sedimentation caused by dredging during the construction of the project has the potential to impact on about 0.02 hectares of medium relief subtidal rocky reef habitat around the Middle Harbour north cofferdam (BL8). Turbidity and sedimentation from dredging operations also has the potential to impact on seagrass and rocky reef habitats in the vicinity of the Middle Harbour south cofferdam (BL7) and Spit West Reserve construction support site (BL9). The modelling of the predicted sedimentation load carried out for the project indicated that the project is unlikely to substantially impact these habitats. Temporary increases in turbidity during construction may result in temporary shifts in the composition of fish communities. However, changes in fish community compositions would be expected to be within the natural variability observed within the marine biodiversity study area. Impacts associated with turbidity and sedimentation would be temporary and limited to the construction phase of the project and would not adversely impact the broader ecological functioning of marine communities.

Underwater noise would be caused by dredging and piling during the construction of the project in Middle Harbour. Construction related underwater noise may be impulsive or continuous and has the potential to impact fish and shark species within the marine biodiversity study area, including in seagrass, rocky reef, deep water and open water habitats. Potential impacts may include physical or behavioural impacts to marine species, such as temporary impacts to hearing or organs, changes to foraging behaviour, and changes in the distribution of marine species to avoid underwater noise generated by the project. Modelling carried out for the project indicated that underwater noise impacts would be largely limited to the immediate location of piling and dredging activities, but may extend to about 300 metres from the noise source, with the potential to impact up to 0.09 hectares of seagrass habitat, 1.54 hectares of rocky reef habitat, and 128.73 hectares of deep water and open water habitat. As different species have different tolerance thresholds to underwater noise, there would be a range of potential responses to these impacts. It is expected that any impacts to marine species would not affect the broader ecological functioning or viability of local populations due to the temporary nature of underwater noise impacts, with any changes in species assemblages recovered through natural processes of recruitment and immigration.

Piling methods proposed are similar to methods used currently throughout Sydney Harbour for ongoing wharf upgrades and other marine infrastructure construction and maintenance work, and potential impacts would be managed through well-established marine industry methodologies.

Overall, the impacts on key fish habitats during construction and operation of the project are not considered to be significant and would be adequately managed by the measures identified in Section 19.6.

Table 19-16 Risk assessment for key fish habitats

Hazard	Highly sensitive key fish habitat (Type 1)			Moderately sensitive key fish habitat (Type 2)			Minimally sensitive key fish habitat (Type 3)	
	Seagrass	Saltmarsh	Subtidal rocky reef	Intertidal rocky shore	Mangrove	Intertidal sand and mudflat	Deepwater soft sediment	Open water
Removal of habitat	High	Moderate	Moderate	Moderate	Moderate	Moderate	High	High
Turbidity	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate
Sedimentation	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	N/A
Mobilisation of contaminants	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low
Introduction/spread of marine pests	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate
Altered hydrodynamics	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate
Underwater noise	Moderate	N/A	Moderate	N/A	Low	Low	Moderate	Moderate
Boat strike to marine mammals and reptiles	Moderate	N/A	Moderate	N/A	N/A	N/A	Moderate	Moderate
Spill of contaminants	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Impacts to marine threatened species and ecological communities

A risk assessment relating to the potential hazards to threatened species and ecological communities within the marine biodiversity study area is summarised in Table 19-17.

Threatened or protected species, populations or endangered ecological communities listed under the *Fisheries Management Act 1994*, *Biodiversity Conservation Act 2016* or *Environment Protection and Biodiversity Conservation Act 1999* that are most likely to be affected by the project are those that would reside, forage or transit through habitat that would be affected during construction activities. This includes the Black Rockcod and White's Seahorse because of their potential to reside in high and medium relief rocky reef, although only a few individuals of these species would occur in the small areas of these habitats where individuals would potentially be harmed.

Some marine mammals, marine turtles and sharks could also occur in the project area because of their potential to either forage on or transit through seagrass, rocky reef or deep water soft sediment habitats, but their potential to occur in the small parts of these habitats where species could be harmed by the project would be low given that these habitats are generally considered suboptimal for these species. As marine mammals and marine turtles can be observed above the water, impacts due to boat strikes to marine mammals and turtles would be manageable.

As the potential for impacts during the construction phase of the project would be largely limited to the temporary disturbance of individuals of marine species, the potential for significant impacts to any threatened species would be minor and would not affect the viability of local populations of listed species. Notwithstanding, as a safeguard for White's Seahorse that may occur within affected areas, pre-construction surveys of potentially affected areas would be carried out by suitably qualified and experienced marine ecologists to search for and relocate White's Seahorse individuals (and other Syngnathids) to nearby unaffected habitat.

During operation of the project, the sill formed by the immersed tube tunnels would be steeper than the natural sills that occur within Middle Harbour (refer to Section 19.3.6). However, the tunnels would be confined to much deeper waters than the natural sills. As such, it is considered that the additional sill created by the tunnel structure would not be an impediment to fish passage during operation.

In summary, the project is not expected to have a significant impact on any marine threatened species, populations or endangered ecological communities.

Table 19-17 Risk assessment for threatened marine species and ecological communities

Hazard	Threatened marine species (grouped)			
	Fish (specifically Black Rockcod and White's Seahorse)	Mammals	Reptiles	Sharks
Removal of habitat	Moderate	Moderate	Moderate	Moderate
Turbidity	Moderate	Moderate	Moderate	Moderate
Sedimentation	Moderate	N/A	Moderate	Moderate
Mobilisation of contaminants	Moderate	Low	Low	Low
Introduction/spread of marine pests	Moderate	N/A	Low	Low
Altered hydrodynamics	Moderate	Moderate	Moderate	Moderate
Underwater noise	Moderate	Moderate	Moderate	Moderate
Boat strike to marine mammals and reptiles	N/A	Moderate	Moderate	N/A
Spill of contaminants	Moderate	Low	Low	Low

19.5.6 Matters of national environmental significance

Matters of national environmental significance were considered for the assessments carried out as part of Appendix S (Technical working paper: Biodiversity development assessment report) and Appendix T (Technical working paper: Marine ecology).

Threatened species and ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* that are known or considered highly likely to occur in the construction footprint and project area/marine biodiversity study area include:

- *Syzygium paniculatum*
- Large-eared Pied Bat
- Grey-headed Flying-fox
- White-bellied Sea Eagle
- Subtropical and temperate coastal saltmarsh
- *Posidonia australis* seagrass meadows of the Manning-Hawkesbury ecoregion
- Black Rockcod
- White's Seahorse.

The Significant Impact Assessments completed for these matters of national environmental significance concluded that the project would not have a significant impact on these species. As such, the project does not require referral to the Australian Government Minister for the Environment.

An additional Matter of National Environmental Significance, Coastal Upland Swamps in the Sydney Basin Bioregion, does not occur within the construction footprint but may be impacted by groundwater drawdown as a result of the project. The Significant Impact Assessment for Coastal Upland Swamps in the Sydney Basin Bioregion concluded that the project would not have a significant impact on this threatened ecological community. As such, the project does not require referral to the Australian Government Minister for the Environment.

19.6 Environmental management measures

Environmental management measures relating to biodiversity impacts are outlined in Table 19-18.

The required biodiversity offsets for the project are outlined in Section 19.6.1 below.

Additional measures relevant to the management of biodiversity impacts are also outlined in other chapters of the environmental impact statement, including:

- Chapter 10 (Construction noise and vibration)
- Chapter 16 (Geology, soils and groundwater)
- Chapter 17 (Hydrodynamics and water quality)
- Chapter 22 (Urban design and visual amenity).

Table 19-18 Environmental management measures –biodiversity

Ref	Phase	Impact	Environmental management measure	Location
B1	Design	Removal of native vegetation and threatened species habitat	The area required and layout of Flat Rock Drive construction support site (BL2) will be refined during further design development and construction planning to avoid direct impacts on PCT 1841, where feasible and reasonable.	BL
B2	Design	Injury and mortality of fauna	Connectivity measures will be designed during further design development in accordance with the *Wildlife Connectivity Guidelines: Managing wildlife connectivity of road projects* (Draft) (Roads and Maritime, 2011c) and consider measures to facilitate the crossing of native fauna species including the Eastern Pygmy-possum, Red-crowned Toadlet, Southern Brown Bandicoot and Rosenberg's Goanna. Maintenance requirements for underpasses and rope crossings will be developed during further design development and incorporated into an Operational Environmental Management Plan or existing Environmental Management System as relevant.	BL
B3	Design	Injury and mortality of fauna	Fauna exclusion fencing would be designed to exclude small fauna species from the road corridor such as Eastern Pygmy-possum and will be installed for the full extent of the Wakehurst Parkway within the construction footprint. The design specifications of the fauna exclusion fence will be developed during further design development including the need for access gates to manage any fauna on the roadside of the fauna exclusion fence based on best available knowledge from other Transport for NSW projects.	BL

Ref	Phase	Impact	Environmental management measure	Location
B4	Design and operation	Noise, vibration and light impacts	Artificial light impacts on native fauna in the operational phase of the project will be minimised where feasible and reasonable through further design development, where the project adjoins tracts of fauna habitat (eg along the Wakehurst Parkway) consistent with the requirements of *Australian Standards and Guidelines 4282 – 2019 Control of the obtrusive effects of outdoor lighting*.	BL/GHF
B5	Pre-construction	Impacts to marine species	Pre-construction surveys of potentially affected marine habitat areas will be carried out as close as practicable to 24 hours prior to commencement of works by suitably qualified and experienced marine ecologists to search for White's Seahorses (and other Syngnathids) and relocate them to nearby habitat.	BL
B6	Pre-construction	Removal of native vegetation and threatened species habitat	Vegetation removal including the clearing of native vegetation and fauna habitat will be further minimised during further design development and construction planning, where feasible and reasonable.	BL/GHF
B7	Pre-construction and construction	Impacts on the Large-eared Pied Bat	Activity-specific controls will be developed to manage impacts from high noise and vibration generating activities (eg controlled blasting and rock hammering) on Large-eared Pied Bat along the Wakehurst Parkway. The controls will be prepared by a suitably qualified and experienced microbat specialist and implemented during surface road works as required.	BL
B8	Pre-construction	Impact to aquatic environments	Any dewatering activities will be undertaken in accordance with the *Technical Guideline: Environmental Management of Construction Site Dewatering* (RTA, 2011), in a manner that prevents pollution of waters. Dewatering of the stormwater harvesting dam at Balgowlah Golf Course will be carried out with consideration of native fauna and appropriate measures will be implemented to relocate native aquatic fauna as required.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
B9	Pre-construction and construction	Underwater noise impacts to marine species	Prior to commencement of impact piling appropriate management measures to minimise noise impacts on fish and aquatic organisms will be developed by a suitably qualified and experienced marine ecologist and implemented during impact piling works. The measures will include investigation and contingency actions should distressed or dead fish be observed within or adjacent to the construction footprint during piling works.	BL
B10	Construction	Removal of native vegetation and threatened species habitat	Vegetation removal along the Wakehurst Parkway will be timed to avoid the winter breeding period for the Eastern Pygmy-possum (May to July), where feasible and reasonable.	BL
B11	Construction	Removal of native vegetation and threatened species habitat	Vegetation removal will be carried out in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).	BL/GHF
B12	Construction	Removal of native vegetation and threatened species habitat	The unexpected species find procedure included in *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) will be followed if threatened ecological communities, flora or fauna species, not assessed in the biodiversity development assessment report, are identified in the construction footprint.	BL/GHF
B13	Construction	Removal of native vegetation and threatened species habitat	Vegetation will be re-established within the construction footprint, where feasible, in accordance with *Guide 3: Re-establishment of native vegetation* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).	BL/GHF
B14	Construction	Removal of native vegetation and threatened species habitat	Pre-clearing surveys for threatened fauna species will be carried out in accordance with *Guide 1: Pre-clearing process* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011). This will include inspections of hollows and dead timber for Eastern Pygmy-possum.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
B15	Construction	Removal of threatened flora species	Prior to clearing, the location of the individual of *Syzygium paniculatum* next to the Wakehurst Parkway will be confirmed. If the individual is outside the construction footprint, but in close proximity to the boundary, the need for a site-specific exclusion zone will be investigated to minimise potential indirect impacts. Should the individual be within the construction footprint, further design investigation will be carried out to determine if impacts can be avoided where reasonable and feasible.	BL
B16	Construction	Removal of threatened flora species	Pre-clearing surveys for threatened flora species will be carried out in accordance with *Guide 1: Pre-clearing process* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).	BL/GHF
B17	Construction	Noise, vibration and light impacts	Mitigation measures such as quieter construction methods or the use of temporary noise barriers in close proximity to the construction activities will be used wherever feasible and reasonable to minimise noise impacts to the Grey-headed Flying-fox camp. For the Kitchener Street construction support site (BL11), the arrangement of the site layout should maximise acoustic shielding (ie locations of site sheds, offices and fixed structures) to minimise noise impacts from within the site to the direction of the Grey-headed Flying-fox camp.	BL
B18	Construction	Noise, vibration and light impacts	Where feasible and reasonable, noise intensive works with the potential of impacting the Grey-headed Flying-fox camp (ie demolition involving rock hammering or resurfacing works) should be programmed to avoid September to February.	BL

Ref	Phase	Impact	Environmental management measure	Location
B19	Construction	Noise, vibration and light impacts	A person experienced in flying-fox behaviour (ie able to identify each stage of the reproductive cycle, ABLV-vaccinated and trained to rescue flying-foxes if required) will monitor disturbance levels within the Grey-headed Flying-fox camp at Balgowlah during construction activities that result in noise levels at the camp that exceed the pre-construction ambient noise levels. Monitoring would occur at representative periods (eg fortnightly) while pups are being carried (August-February).	BL
B20	Construction	Noise, vibration and light impacts	Adaptive management measures to minimise impacts on Grey-headed Flying-foxes will be developed in consultation with Department of Planning, Industry and Environment (Environment, Energy and Science) and an appropriately qualified expert in Grey-headed Flying-fox biology and behaviour, if Grey-headed Flying-fox behaviour during monitoring suggests that disturbance levels are high.	BL
B21	Construction	Noise, vibration and light impacts on fauna	Controlled blasting, rock hammering and other potential high noise generating activities along the Wakehurst Parkway will be managed to minimise noise and vibration levels to adjacent fauna habitat where practicable, including but not limited to: • Use of noise suppression devices on plant and equipment in accordance with the manufacturer's specifications • Regularly maintain plant and equipment to minimise noise levels when in use • Substituting plant or processes to reduce noise.	BL
B22	Construction	Injury and mortality of fauna	Fauna will be managed in accordance with *Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
B23	Construction	Injury and mortality of fauna	Pre-clearing surveys for non-threatened fauna species will be carried out in accordance with *Guide 1: Pre-clearing process* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011). Surveys will also include human made structures that have been identified as potentially providing habitat for microbats and are subject to demolition or modification.	BL/GHF
B24	Construction	Injury and mortality of fauna	An observer qualified to spot Little Penguins will be used during marine construction activities. A stop-work procedure will be developed by a suitably qualified and experienced ecologist and implemented upon evidence of the species in the proximity of the works area.	BL
B25	Construction	Invasion and spread of weeds, pests, pathogens and disease	Weed species will be managed in accordance with *Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).	BL/GHF
B26	Construction	Invasion and spread of weeds, pests, pathogens and disease	Pathogens will be managed in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).	BL/GHF
B27	Construction	Removal of aquatic habitat	Aquatic habitats will be protected in accordance with *Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) and the *Policy and guidelines for fish habitat conservation and management* (NSW DPI, 2013). This will include flow and sufficient fish passage to be maintained similar to current conditions during instream works where reasonable and feasible.	BL/GHF
B28	Construction	Impacts to marine vegetation and sensitive habitat	Transit routes for vessels entering and departing from construction support sites will be marked out with consideration for propeller wash and distances to sensitive marine habitats.	BL

Ref	Phase	Impact	Environmental management measure	Location
B29	Construction	Impacts to marine vegetation and sensitive habitat	Exclusion zones will be implemented to avoid disturbance to sensitive marine habitats not proposed to be directly impacted by the project. These include any intertidal sand and mudflats, intertidal rocky shore, subtidal rocky reef and seagrass habitats with potential to occur within or next to transit routes and vessel movements. Routine inspections and maintenance of exclusion measures will be carried out.	BL
B30	Construction	Impacts to marine vegetation and sensitive habitat	Scour protection measures including possible velocity reduction from wastewater treatment plant discharge will be implemented where reasonable and feasible to avoid scour impacts on the marine environment.	BL
B31	Construction	Impacts to marine vegetation and sensitive habitat	To minimise the potential impact of turbidity (suspended sediment) on sensitive marine vegetation and habitats silt curtains will be installed around seagrass patches and subtidal rocky reef contained within the Zone of Influence as described in the Appendix T (Technical working paper: Marine ecology).	BL
B32	Construction	Impacts to marine vegetation and sensitive habitat	Silt curtains will be monitored for effectiveness particularly following inclement weather and maintenance carried out when required. Records of monitoring and maintenance will be kept.	BL
B33	Construction	Impacts to marine vegetation and sensitive habitat	To avoid direct damage to seagrass and subtidal rocky reef from silt curtain movement, there will be a suitable buffer distance between marine habitat and the silt curtain to account for curtain movement due to tides and currents and to prevent shading of the marine vegetation from the silt curtain. The silt curtain will be anchored to bare sediment where practicable to avoid movement.	BL
B34	Construction	Impacts to marine vegetation and sensitive habitat	Subtidal rocky reef habitat removed along the shoreline at the Middle Harbour north cofferdam (BL8) and intertidal rocky shore, sand and mudflat habitats removed at the Spit West Reserve construction support site (BL9) will be rehabilitated and restored as close as possible to pre-construction conditions where feasible and reasonable.	BL

Ref	Phase	Impact	Environmental management measure	Location
B35	Construction	Invasion and spread of marine pests, pathogens and disease	Locally sourced vessels and equipment will be used where feasible and reasonable. Any vessels sourced internationally will be inspected for potential marine pests prior to departing from their previous port. Construction contractors will need to demonstrate that due diligence has been taken to avoid introducing marine pests, pathogens or disease from internationally sourced vessels and/or construction equipment prior to departure.	BL
B36	Construction	Invasion and spread of marine pests, pathogens and disease	A targeted survey will be conducted of the dredge footprint to locate any areas of the marine algal pest *Caulerpa taxifolia*. If *Caulerpa taxifolia* is identified within the dredging footprint, surface sediments from these areas will be disposed of onshore rather than in the marine environment.	BL
B37	Construction	Impacts to marine species	A stop work procedure will be developed in accordance with the recommendations in Appendix T (Technical working paper: Marine ecology) to mitigate potential impacts to marine mammals and reptiles within the vicinity of impact piling works.	BL
B38	Construction	Impacts to marine species	Salvage of live fish and other native marine organisms (eg large, mobile macroinvertebrates) will occur during cofferdam dewatering and will be carried out by suitably qualified and experienced marine ecologists. All salvaged organisms will be immediately relocated to similar habitat nearby.	BL

19.6.1 Biodiversity offsets

The required ecosystem credits for the project in relation to native vegetation to be removed (direct impacts) is summarised in Table 19-19.

Offsets for indirect impacts are in addition to *Biodiversity Assessment Method* credit obligations and are at the discretion of the Minister for Planning and Public Spaces (DPIE, 2019). For indirect impacts resulting in isolated patches, offsets were calculated by reducing vegetation integrity values for these areas to zero, effectively treating these areas as direct impacts. The potential required ecosystem credits for indirect impacts from the project in relation to native vegetation is summarised in Table 19-20.

Species credits would be required as part of the biodiversity offsets for the project, as outlined below. Species that require species credits are listed in the Threatened Biodiversity Data Collection (DPIE (EES), 2020a). Offsets are identified and a preliminary strategy is provided in Appendix S (Technical working paper: Biodiversity development assessment report).

Offsets required for the potential threatened species impacted by the project that require species credits are summarised in Table 19-21.

The *Policy and guidelines for fish habitat conservation and management* (NSW DPI, 2013) specify that significant environmental impacts (direct and indirect) are to be offset by environmental compensation on a minimum 2:1 basis for all key fish habitat lost. A greater compensation ratio may be considered if offsets cannot be sourced in the vicinity of the impact or are not of the same habitat type as that impacted.

The project would potentially impact about 15 metres of Burnt Bridge Creek as a result of the culvert extension works and scour protection. Assuming an average bed width of about four metres in the affected area, this would equate to about 60 square metres of Type 2 key fish habitat. According to the *Policy and guidelines for fish habitat conservation and management* (NSW DPI, 2013) this would result in an offset requirement of about $6900. Final offset calculations would be carried out following further design development. Refer to Annexure D (Freshwater ecology impact assessment) of Appendix S (Technical working paper: Biodiversity development assessment report) for further discussion on aquatic offsets.

Table 19-19 Native vegetation offsets – ecosystem credits (direct impacts)

Zone	Plant community type (PCT) name	Area impacted (ha)	Ecosystem credits required
1250 Moderate/ Good	Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion	0.20	6
1292 Moderate/ Good	Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion	0.40	10
1783 Moderate/ Good	Red Bloodwood - Scribbly Gum / Old-man Banksia open forest on sandstone ridges of northern Sydney and the Central Coast	4.23	100
1786 Moderate/ Good - Good	Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region (Duffys Forest endangered ecological community)	1.01	35
1786 Moderate/ Good - Moderate		0.37	7
1824 Moderate/ Good	Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin	6.18	154
1841 Moderate/ Good	Smooth-barked Apple - Turpentine - Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region	1.37	39
1841 Revegetation		1.29	21
1845 Moderate/ Good	Smooth-barked Apple - Red Bloodwood - Blackbutt tall open forest on shale sandstone transition soils in eastern Sydney	0.39	19
Total ecosystem credits required			**391**

Table 19-20 Native vegetation offsets – ecosystem credits (indirect impacts)

Zone	PCT name	Area impacted (ha)	Ecosystem credits required
Isolated patches			
1783 Moderate/ Good	Red Bloodwood - Scribbly Gum/Old-man Banksia open forest on sandstone ridges of northern Sydney and the Central Coast	0.05	1
1786 Moderate/ Good - Good	Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region (Duffys Forest endangered ecological community)	0.17	6
1824 Moderate/ Good	Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin	0.01	1
New edges			
1250 Moderate/ Good	Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion	0.22	1
1783 Moderate/ Good	Red Bloodwood - Scribbly Gum/Old-man Banksia open forest on sandstone ridges of northern Sydney and the Central Coast	2.59	12
1786 Moderate/ Good - Good	Red Bloodwood - Silvertop Ash - Stringybark open forest on ironstone in the Sydney region (Duffys Forest endangered ecological community)	1.19	8
1824 Moderate/ Good	Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin	4.20	21
Total ecosystem credits required			**50**

Table 19-21 Threatened species offsets – species credits

Species	Vegetation zone name	Individuals/ Area (ha)	Species credits
Magenta Lilly Pilly (*Syzygium paniculatum*)	1250_Mod_Good	1 individual	2
Red-crowned Toadlet (*Pseudophryne australis*)	1250_Mod_Good 1783_Mod_Good 1824_Mod_Good	0.98 ha	24
Eastern Pygmy-possum (*Cercartetus nanus*)	1250_Mod_Good 1783_Mod_Good 1786_Mod_Good-Good 1786_Mod_Good-Moderate 1824_Mod_Good 1845_Mod_Good	12.38 ha	403
Large-eared Pied-bat (*Chalinolobus dwyeri*)	1250_Mod_Good 1292_Mod_Good 1783_Mod_Good 1786_Mod_Good-Good 1786_Mod_Good-Moderate 1824_Mod_Good 1841_Mod_Good 1845_Mod_Good	13.68 ha	670
Total species credits required			**1099**

The impacts of a development and gains in biodiversity values at biodiversity stewardship sites are measured in biodiversity credits.

NSW GOVERNMENT

Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Chapter 20

Land use and property

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DECEMBER 2020

20 Land use and property

This chapter considers the potential impacts of the project on land use and property from the construction and operation of the project and identifies measures which address these impacts.

The Secretary's environmental assessment requirements as they relate to land use and property, and where in the environmental impact statement these have been addressed, are in Table 20-1.

Avoiding or minimising impacts has been a key consideration throughout the design and development process for the Beaches Link and Gore Hill Freeway Connection project. A conservative approach has generally been used in the assessments, with potential impacts presented before implementation of environmental management measures. The environmental management measures proposed to minimise the potential impacts in relation to land use and property are included in Section 20.5.

Table 20-1 Secretary's environmental assessment requirements – land use and property

Secretary s requirement	Where addressed in EIS
Environmental impact statement	
1. The EIS must include, but not necessarily be limited to, the following: b. a description of the project and all components and activities (including ancillary components and activities) required to construct and operate it, including: – land use changes as a result of the proposal and the acquisition of privately owned, Council and Crown lands, and impacts to Council and Crown lands	Impacts to properties, including property acquisitions and future land uses during construction and operation is discussed in **Section 20.4**.
Socio-economic, Land Use and Property	
1. The proponent must assess social and economic impacts (of all phases of the project) in accordance with the current guidelines (including cumulative construction and operational impacts of the proposal and major projects in the vicinity of the project) and in consultation with relevant land owners (such as the Ports Authority of NSW and those land owners whose property is being acquired).	Socio economic impacts as a result of the project are presented in **Section 21.4** and **Section 21.5** of **Chapter 21** (Socio-economics). **Chapter 27** (Cumulative impacts) assesses the cumulative construction and operational impacts of the proposal and major projects in the vicinity of the project. A summary of consultation conducted for the project is provided in **Chapter 7** (Stakeholder and community engagement) and **Section 21.2.3** of Chapter 21 (Socio-economics).
2. The proponent must assess impacts from construction and operation on potentially affected properties, businesses, recreational users and land and water users, including amenity impacts (including from cumulative and extended construction time frames and construction fatigue), property acquisitions/adjustments, future land uses,	Impacts to properties, including property acquisitions and future land uses during construction and operation is discussed in **Section 20.4**. **Section 21.4** and **Section 21.5** present the socio-economic impacts as a result of the project.

Secretary s requirement	Where addressed in EIS
access, relevant statutory rights, and community severance and barrier impacts resulting from the project.	**Chapter 27** (Cumulative impacts) assesses the cumulative construction and operational impacts of the proposal and major projects in the vicinity of the project.
3. Where an immersed tube method (IMT) of construction is proposed for use in Middle Harbour, the Proponent must: a. provide details of how reductions to current harbour depths will be avoided	**Section 5.2.3** of **Chapter 5** (Project description) describes how, due to the profile of the harbour bed of Middle Harbour, the immersed tube tunnel units would sit both partially within a trench and on the bed of the Middle Harbour. **Section 9.4.4** or **Chapter 9** (Operational traffic and transport) indicates that shallow water depths at the entrance to Middle Harbour control navigation in the vicinity of the proposed tunnel crossing. The tops of the immersed tube tunnels would not interfere or restrict with maritime activities.
b. provide details confirming the level of protection for the IMTs will be similar to or better than that of the existing Sydney Harbour Tunnel	As discussed in **Chapter 6** (Construction work) an additional concrete layer would be provided to protect the top of the completed tunnel units from marine activities during operation, including falling or dragging anchors. **Section 23.3.4** of **Chapter 23** (Hazards and risks) details the risks associated with interactions between maritime traffic and the immersed tube tunnels. **Chapter 4** (Project development and alternatives) provides a justification for selection of the immersed tube tunnel method for the crossing of Middle Harbour.
c. identify impacts to ship scheduling in consultation with the Harbour Master; and	Due to depths constraints at the entrance to Middle Harbour, shipping does not occur in locations where construction works are proposed. **Chapter 8** (Construction traffic and transport) and **Chapter 9** (Operational traffic and transport) outline marine traffic impacts related to the construction and operation of the immersed tube tunnel respectively. **Chapter 8** (Construction traffic and transport) specifies the consultation requirements with the Harbour Master to minimise impacts during construction. Impacts of closures in Middle Harbour on businesses are discussed in **Section 21.4** and **Section 21.5.6** of **Chapter 21** (Socio-economics) and **Appendix U** (Technical working paper: Socio-economic assessment), including Annexure B.

Secretary s requirement	Where addressed in EIS
d. provide details of full mission simulation which takes in account, movement of tunnel units past the Spit Bridge and within Middle Harbour.	Outcomes of the simulation report are outlined in **Section 8.4.3** of **Chapter 8** (Construction traffic and transport).
4. The Proponent must assess potential impacts on utilities (including communications, electricity, gas, fuel and water and sewerage) and the relocation of these utilities.	**Chapter 5** (Project description) outlines utilities and services management for the project and **Appendix D** (Utilities management strategy) provides a detailed description of utilities likely to be impacted and a framework for utility installations, relocations, adjustments and protection.
5. Where the project is predicted to impact on utilities the Proponent must undertake a utilities management strategy, identifying management options, including relocation or adjustment of the utilities.	**Appendix D** (Utilities management strategy) provides a detailed description of utilities likely to be impacted and a framework for utility installations, relocations, adjustments and protection.
6. A draft Community Consultation Framework must be prepared identifying relevant stakeholders, procedures for distributing information and receiving/responding to feedback and procedures for resolving stakeholder and community complaints during construction and operation. Key issues that must be addressed in the draft Framework include, but are not limited to: a. traffic management (including property access, pedestrian access) b. landscaping/urban design matters c. construction activities including out of hours work; and d. noise and vibration mitigation and management.	**Chapter 7** (Stakeholder and community engagement) provides the content for the framework and a Community consultation framework is provided in **Appendix E** (Community consultation framework).

20.1 Legislative and policy framework

The assessment of land use and property impacts has been carried out taking into account the following legislation, policies, guidelines and strategic planning documents:

- The *Native Title Act 1993* (Cwlth) and *Aboriginal Land Rights Act 1983* provide a framework for the protection of native title rights on certain Crown lands. There are no Crown lands subject to a native title claim within the project footprint
- *Greater Sydney Region Plan: A Metropolis of Three Cities – Connecting People* (Greater Sydney Commission, 2018a)
- *Our Greater Sydney 2056: North District Plan – Connecting Communities* (Greater Sydney Commission, 2018b)
- *Our Greater Sydney 2056: Eastern City District Plan – Connecting Communities* (Greater Sydney Commission, 2018c)
- *Guidelines for developments adjoining land and water managed by the Office of Environment and Heritage* (Office of Environment and Heritage (OEH), 2013).

The above policies and strategic planning documents are further described in Chapter 3 (Strategic justification and project need). The *Guidelines for developments adjoining land and water managed by the Office of Environment and Heritage* are discussed in Section 20.4.2.

The following local strategic planning statements and plans are also relevant to current and future land use in the project footprint:

- *North Sydney Local Strategic Planning Statement* (North Sydney Council, 2020a)
- *Draft Local Strategic Planning Statement* (Willoughby City Council, 2019)
- *Mosman Local Strategic Planning Statement: Enhancing Mosman* (Mosman Council, 2020)
- *Towards 2040 – Local Strategic Planning Statement* (Northern Beaches Council, 2020)
- *Northern Beaches Sportsground Strategy* (Northern Beaches Council, 2017a)
- *Northern Beaches Hospital Precinct Structure Plan* (Northern Beaches Council, 2017b).

Local strategic planning statements have been developed by councils in response to new legislative requirements introduced by the NSW Government in 2018, for all councils to respond to the priorities and actions identified in the NSW Government's regional and district plans. The statements outline the 20 year vision for land-use in the local area, the special character and values that are to be preserved and how change will be managed into the future for each council.

North Sydney Local Strategic Planning Statement provides a 20 year vision for land use planning within the North Sydney local government area. North Sydney Council aims to ensure that the North Sydney local government area continues to be an attractive place for residents, businesses, workers and visitors, and North Sydney residents to continue to enjoy high levels of amenity and liveability with good access to transport, job opportunities and areas of unique scenic and recreational quality. North Sydney Council is carrying out a planning study for the Military Road Corridor in response to the significant level of development interest within the precinct in recent years which seek to challenge existing planning controls.

Willoughby City Council's *Local Strategic Planning Statement* identifies 20 planning priorities and sets out a 20 year vision for land use planning in Willoughby local government area, considering both economic and social needs of the community.

The *Mosman Local Strategic Planning Statement: Enhancing Mosman* sets out a 20 year vision for land use planning in Mosman outlining how growth and change will be managed to maintain the high levels of environmental amenity, liveability and landscape quality that characterises Mosman. Fourteen planning priorities are identified, including a priority to improve access to, from and within Mosman, and to encourage active transport. The congestion of Spit-Military Roads is identified as a significant issue.

Towards 2040 – Local Strategic Planning Statement sets out a 20 year vision for land use planning in the Northern Beaches, with thirty planning priorities are identified. The connectivity of the Northern Beaches local government area is constrained by limited access into and out of the Northern Beaches, particularly by public transport, which is limited in most areas. Northern Beaches Council identifies coordination of land use with transport as essential to achieving the aims of the strategy.

The *Northern Beaches Sportsground Strategy* is a 15 year plan to provide a single approach to the management and long term planning of sporting facilities on the Northern Beaches. The Strategy has been informed by the *Northern Beaches Sportsgrounds and Golf Courses Discussion Paper* (Northern Beaches Council, 2017c) which was prepared in response to independent analyses commissioned by Council to review sportsgrounds supply and demand, and assess the feasibility of golf courses on the Northern Beaches. The strategy is further discussed in Section 20.4.2.

The *Northern Beaches Hospital Precinct Structure Plan* has been prepared by Northern Beaches Council in response to the NSW Government's significant investment in public infrastructure in Frenchs Forest including the new Northern Beaches Hospital. The area around the new Northern Beaches Hospital in Frenchs Forest has been identified by the NSW Government as a Planned

Precinct with a focus on providing priority infrastructure including schools, parks, transport, hospitals and road upgrades. The plan presents the strategic land use planning framework for the Frenchs Forest precinct and is further discussed in Section 20.4.2.

20.2 Assessment methodology

The assessment methodology for impacts on land use and property included the following key tasks:

- Reviewing key strategic planning polices and documents relevant to the project footprint and nearby areas to identify future land uses, planning controls and developments
- Reviewing the local environment and identifying existing land uses and properties within and around the project footprint
- Assessing the potential impacts on properties including those that would need to be acquired to construct and operate the project
- Assessing the potential impacts on existing and likely future land uses during construction and operation of the project
- Identifying measures to avoid, minimise and manage impacts on land use and property
- Identifying potential future uses of land required for construction but not required for operation.

20.3 Existing environment

20.3.1 Overview

The project would traverse the Lower North Shore and Northern Beaches region of metropolitan Sydney within the North Sydney, Willoughby, Mosman and Northern Beaches local government areas. A diverse range of development types and land use zones are currently located within and around the project footprint including residential, commercial, mixed uses, industrial and maritime, infrastructure and recreational open space.

The land use zones within the project footprint are defined under the following environmental planning instruments and are shown in Figure 20-1 to Figure 20-5:

- North Sydney Local Environmental Plan 2013 (North Sydney LEP 2013)
- Willoughby Local Environmental Plan 2012 (Willoughby LEP 2012)
- Mosman Local Environmental Plan 2012 (Mosman LEP 2012)
- Warringah Local Environmental Plan (Warringah LEP 2011) (now part of the Northern Beaches local government area)
- Manly Local Environmental Plan 2013 (Manly LEP 2013) (now part of the Northern Beaches local government area)
- Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 (Sydney Harbour SREP).

Low and medium density residential land use zones are prominent in the suburbs of Cammeray, Naremburn, Northbridge, Seaforth and Balgowlah. Medium and high density residential land uses are generally located in the suburbs of Naremburn, Artarmon and Willoughby.

Industrial land use is concentrated around the Gore Hill Freeway in Artarmon. Local centres occupy parts of Northbridge and Balgowlah.

Environmental conservation and environmental management land use zones exist along the foreshore areas of Middle Harbour in Northbridge, Seaforth and Mosman, including the shoreline of Beauty Point and Pearl Bay, Seaforth Bluff and Clive Park.

There are a number of private and public recreation areas within and near the construction footprint. The largest of these are located in Artarmon (Artarmon Park), Cammeray (Cammeray Park and Cammeray Golf Course), Willoughby (Bicentennial Reserve), Northbridge (Flat Rock Reserve), Mosman (Spit West Reserve) and Balgowlah (Balgowlah Golf Course). Parts of Middle Harbour within and around the construction footprint are also used for recreation activities, and there are existing moorings within Middle Harbour and Pearl Bay, directly west of the Spit West Reserve foreshore.

Social infrastructure in the vicinity of the project is discussed in more detail in Chapter 21 (Socio-economics).

20.3.2 Cammeray to Northbridge

Existing land use

Existing land use in the area from Cammeray to Northbridge is characterised by areas of high and medium density residential development in Cammeray and Crows Nest, while Northbridge comprises mostly of general and low density residential development. ANZAC Park Public School and KU Cammeray Preschool are located to the east and west of the project respectively (refer to Figure 20-1).

Major road infrastructure located in this area includes the Warringah Freeway.

Local and neighbourhood centres are concentrated along Miller Street in Cammeray and Sailors Bay Road in Northbridge (refer to Figure 20-1).

Public recreation areas within the construction footprint between Cammeray and Northbridge include:

- Cammeray Golf Course at Cammeray
- Flat Rock Reserve at Northbridge.

Recreation areas located near the construction footprint between Cammeray and Northbridge include:

- ANZAC Park, Cammeray Park, Cammeray Croquet Club, Cammeray Tennis Club, Cammeray-Neutral Bay Skate Park, St Thomas' Rest Park at Cammeray and Crows Nest
- Flat Rock Baseball Diamond (also referred to as Bicentennial Reserve Baseball Diamond), Willoughby Leisure Centre and Northern Suburbs Netball Association at Willoughby.

Refer to Figure 20-1 for the location of the above recreation areas relative to the construction footprint.

Land use zoning

Land use zones in the area from Cammeray and Northbridge are defined under the North Sydney LEP 2013 and Willoughby LEP 2012, are shown in Figure 20-1.

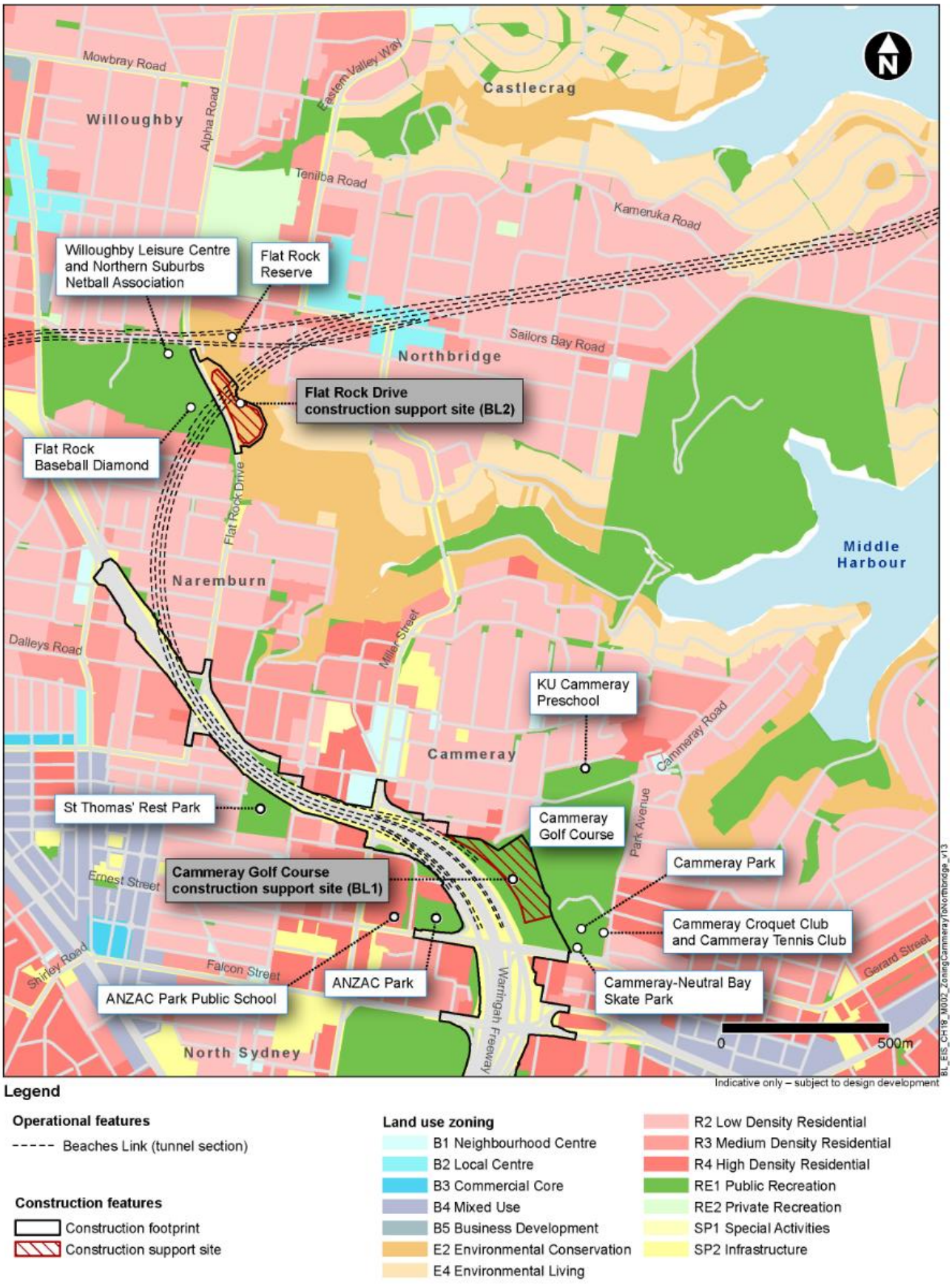

Figure 20-1 Land use and zoning – Cammeray to Northbridge

20.3.3 Gore Hill Freeway and surrounds

Existing land use

There is a clear distinction in land uses on either side of the Gore Hill Freeway. The south side of the freeway (within the Artarmon industrial area) is characterised by general and light industrial development, while medium and high density residential development dominates the north side of the freeway. Community land uses are located on both sides of the Gore Hill Freeway including several child care centres, Artarmon Public School, Artarmon NSW Ambulance Superstation and the Royal North Shore Hospital.

Public recreation areas located within the construction footprint around the Gore Hill Freeway Connection in Artarmon include Artarmon Park (refer to Figure 20-2). Artarmon Reserve, Thomson Park, Cleland Park and Naremburn Park are located in the vicinity of the construction footprint at Artarmon.

Significant road and rail infrastructure located in this area includes the Gore Hill Freeway, Lane Cove Tunnel and the T1 North Shore and Western and T9 Northern rail lines between St Leonards and Artarmon train stations and the Sydney Metro City & Southwest which is currently under construction (refer to Figure 20-2).

Land use zoning

Land use zones in the area around the Gore Hill Freeway are defined under the Willoughby LEP 2012, and are shown in Figure 20-2).

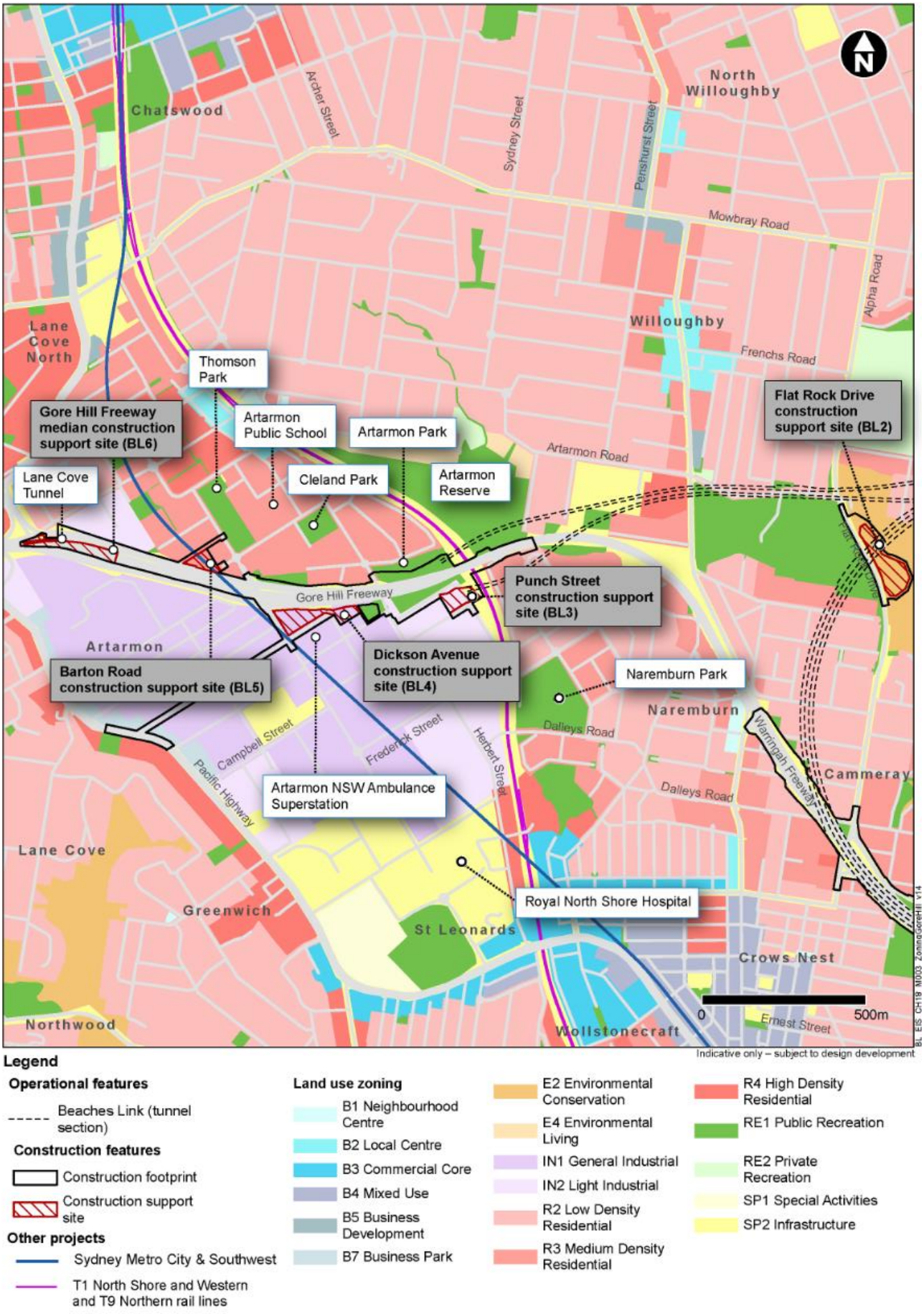

Figure 20-2 Land use and zoning – Gore Hill Freeway and surrounds

20.3.4 Northbridge to Seaforth

Existing land use

The area between Northbridge and Seaforth includes Middle Harbour and its foreshores. This area also encompasses the Spit West Reserve in Mosman (refer to Figure 20-3).

Land use zones along the foreshore of Middle Harbour in Northbridge mostly comprise environmental conservation and public recreation, including Clive Park. The foreshore of Middle Harbour in Seaforth mostly comprises low density residential development, including several properties that have jetties in Middle Harbour. Middle Harbour is used for recreation activities and by groups such as the Northbridge Sailing Club, Mosman Rowing Club and Middle Harbour Yacht Club.

Land at the Spit West Reserve in Mosman is used for public recreation and open space (refer to Figure 20-3). The D'Albora Marina and Mosman Rowing Club are both located at the Spit West Reserve. A number of commercial and private recreation land use zones are located on the eastern side of The Spit adjacent to Spit West Reserve, including restaurants, cafes, and yacht and sailing clubs. There are also several restaurants directly south of the Spit Bridge near to D'Albora Marina.

The major item of road infrastructure in this area is Spit Road, including the Spit Bridge. The Spit Bridge has scheduled daily openings to allow boats above the clearance height to pass through (refer Chapter 8 (Construction traffic and transport) for further details).

There are numerous Transport for NSW moorings licensed to private boat owners in Middle Harbour and Pearl Bay, directly west of the Spit West Reserve foreshore. The Spit West Reserve car park located off Spit Road and south of the Spit Bridge currently provides car parking spaces for the various marine and recreational uses that exist within and around the Spit West Reserve. There is also an existing off-road shared path that extends along the foreshore of Middle Harbour adjacent to the Spit West Reserve.

Land use zoning

Land use zones in the area between Northbridge and Seaforth are defined under the Willoughby LEP 2012, Manly LEP 2013 and Mosman LEP 2012 and are shown in Figure 20-3.

Figure 20-3 Land use and zoning – Northbridge to Seaforth

20.3.5 Seaforth to Balgowlah

Existing land use

Land use in the area from Seaforth to Balgowlah is predominantly low density residential development. This area includes educational facilities, such as Northern Beaches Secondary – College Balgowlah Boys Campus, St Cecilia's Catholic Primary School and Seaforth Public School (refer to Figure 20-4).

Major road infrastructure located in this area includes Burnt Bridge Creek Deviation, Manly Road, Condamine Street and Sydney Road. Both Sydney Road and Burnt Bridge Creek Deviation border the Balgowlah Golf Course. The Burnt Bridge Creek shared path extends between Sydney Road and Condamine Street adjacent the southbound lanes of Burnt Bridge Creek Deviation and along the western boundary of the Balgowlah Golf Course.

Balgowlah Golf Course is the only public recreation area within the construction footprint between Seaforth and Balgowlah. Balgowlah Oval is directly adjacent to the construction and operational footprints of the project (refer to Figure 20-4).

Land use zoning

Land use zones in the area between Seaforth and Balgowlah are defined under the Manly LEP 2013 and Warringah LEP 2011, and are shown in Figure 20-4.

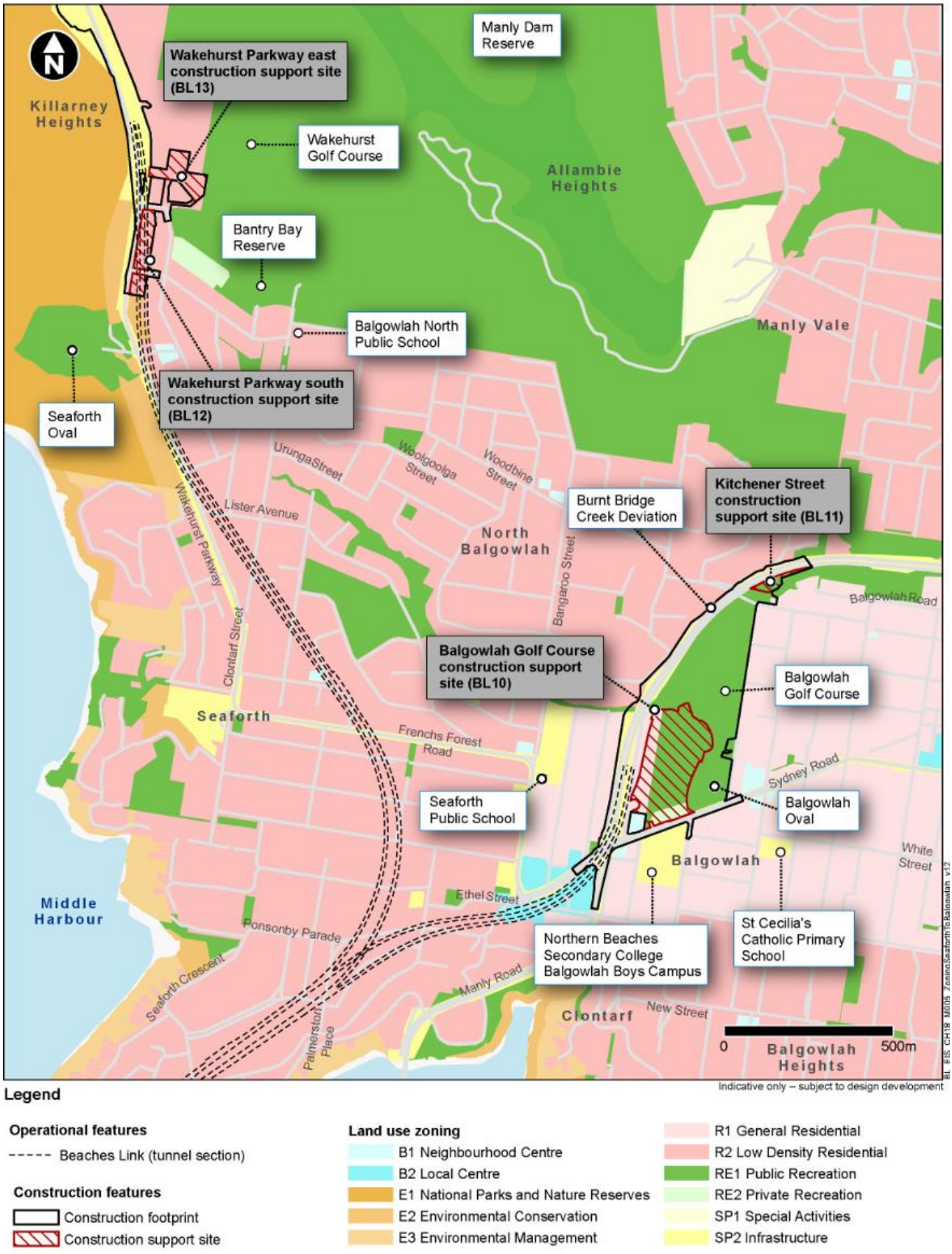

Figure 20-4 Land use and zoning – Seaforth to Balgowlah

20.3.6 Seaforth to Frenchs Forest

Existing land use

Land use zones adjoining the Wakehurst Parkway in the area around Seaforth mostly comprise low density residential development on the eastern side of the Wakehurst Parkway. Further to the north, land use zones adjoining the Wakehurst Parkway comprise environmental conservation, national parks and nature reserves to the west including the Garigal National Park and Manly Warringah War Memorial Park known as Manly Dam Reserve (refer to Figure 20-5).

Major road infrastructure located in this area includes Frenchs Forest Road and the Wakehurst Parkway, of which the latter is classified as a regional road by Transport for NSW. The infrastructure land use zoning for the Wakehurst Parkway includes space on both sides of the road corridor to accommodate road widening (refer to Figure 20-5). The land between Seaforth and Frenchs Forest, which includes the suburbs of Killarney Heights and Allambie Heights, is mostly zoned and used for public recreation. These include the Wakehurst Golf Course and Manly Dam Reserve to the east of the Wakehurst Parkway, and the Garigal National Park to the west (refer to Figure 20-5). There is a Sydney Water site on the eastern side of the Wakehurst Parkway at Killarney Heights.

Land use adjoining the Wakehurst Parkway in the area around Frenchs Forest mostly comprises low density residential and areas for public recreation on the western side, while on the eastern side there is Frenchs Forest business hub and public recreation areas. Land use at the corner of the Wakehurst Parkway and Warringah Road has changed to incorporate the Northern Beaches Hospital (refer to Figure 20-5). The area surrounding the hospital has been identified as a Planned Precinct by the NSW Government within the *Northern Beaches Hospital Precinct Structure Plan.*

A Transport for NSW owned site compound previously used for the Northern Beaches Hospital road upgrade project is located within the road reserve at the north eastern corner of the Warringah Road and the Wakehurst Parkway intersection. The Northern Beaches Hospital road upgrade project was completed in August 2020 and revegetation works were carried out within the eastern section of the site as part of decommissioning. This included planting with species consistent with the Duffys Forest endangered ecological community. The project proposes to re-use this site as the Wakehurst Parkway north construction support site (BL14) and for tunnel support facilities during operation. The revegetated area would remain fenced off and protected from disturbance.

Public recreation areas near the construction footprint on either side of the Wakehurst Parkway include Seaforth Oval, Seaforth Bowling Club, Bantry Bay Reserve, Wakehurst Golf Course, Manly Dam Reserve, Ararat Reserve, Brick Pit Reserve, Warringah Aquatic Centre and Aquatic Reserve (including skate park).

Land use zoning

Land use zones in the area between Seaforth and Frenchs Forest are defined under the Manly LEP 2013 and Warringah LEP 2011, and are shown in Figure 20-5.

Figure 20-5 Land use and zoning – Seaforth to Frenchs Forest

20.4 Assessment of potential impacts

The project has the potential to impact on properties and land use in the following ways:

- Occupation of surface properties, including temporary use during construction and permanent acquisition for operational infrastructure
- Acquisition of substratum (below ground) land for the project tunnels
- Return of residual land (full or partial lots) required for construction but not for operation of the project
- Disruption of existing activities and limitations on the development potential of directly affected properties
- Changes in public open space availability
- Ground movement impacts to properties during construction and operation of the project.

Further assessment of impacts to boat moorings and jetties are discussed in Chapter 8 (Construction traffic and transport) and Chapter 21 (Socio-economics).

20.4.1 Property

Acquisition and temporary use of surface properties

The project has been designed and developed to minimise property acquisitions and has prioritised the use of Transport for NSW land where possible. Notwithstanding this, some temporary use and permanent acquisition of properties would be required. All property acquisitions required for the project would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, and in accordance with the land acquisition reforms announced by the NSW Government in 2016. Temporary use of properties would be managed through leasing or licensing arrangements or property acquisition where lease arrangements are not practical (refer to Table 20-3 for details). Where required, discussions would be held with affected landowners concerning the purchase, lease or license of land. Landowners and tenants of landowners affected by acquisition would be supported by access to counselling services throughout the process and a community relations support toll-free telephone line would be established to respond to any community concerns.

It is anticipated that the project would require full and partial acquisitions of 54 properties (excluding land owned by Transport for NSW). The anticipated properties required are summarised in Table 20-2. As of 15 September 2020, eight of these (private residential properties Balgowlah and Seaforth) had been acquired. The remaining 46 properties include:

- Twenty eight private residential properties
- Twelve private commercial properties
- Six government-owned properties.

Properties anticipated to be acquired by the project are shown in Figure 20-6 to Figure 20-10. Impacts of property acquisition are further discussed in Chapter 21 (Socio-economics).

Transport for NSW currently owns a number of properties at Seaforth between the Wakehurst Parkway, Kirkwood Street and Judith Street that were acquired in the 1970s and 1980s for the Warringah Transport Corridor that was proposed at the time. The properties are vacant lots. These properties would be utilised to facilitate this project, but as they are historical acquisitions and were not acquired specifically to facilitate this project, they are not included in Table 20-2. The acquisition of land for construction activities may result in residual land that would not be required for operational infrastructure or activities. The future use of this land is discussed below.

Part of Cammeray Golf Course would be occupied by temporary construction support sites and permanent operational infrastructure for the Western Harbour Tunnel and Beaches Link program of

works. Due to proposed construction staging, the temporary and permanent land take at the golf course required for the Beaches Link component would occur as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project. Consequently, this property is not included in Table 20-2.

Table 20-2 Anticipated property acquisition required for the project

Location	Ownership	No. of property acquisitions[1]		Properties acquired for Beaches Link (as of 15 September 2020)
		Full property acquisition	Partial property acquisition	
Beaches Link component				
Artarmon	Private – commercial	8	-	-
	Government	-	1	-
Balgowlah	Private – residential	28	-	7
	Government	-	2	-
Seaforth and Killarney Heights	Private - residential	-	-	1
	Government	1	-	-
Frenchs Forest	Government	-	1	-
Total for Beaches Link component		**37**	**4**	**8**
Gore Hill Freeway Connection component				
Artarmon	Private – commercial	4	-	-
	Government	-	1	-
Total for Gore Hill Freeway Connection component		**4**	**1**	**-**
Total		**41**	**5**	**8**

Notes:
1. Multiple parent lots and strata titles may exist within each property.

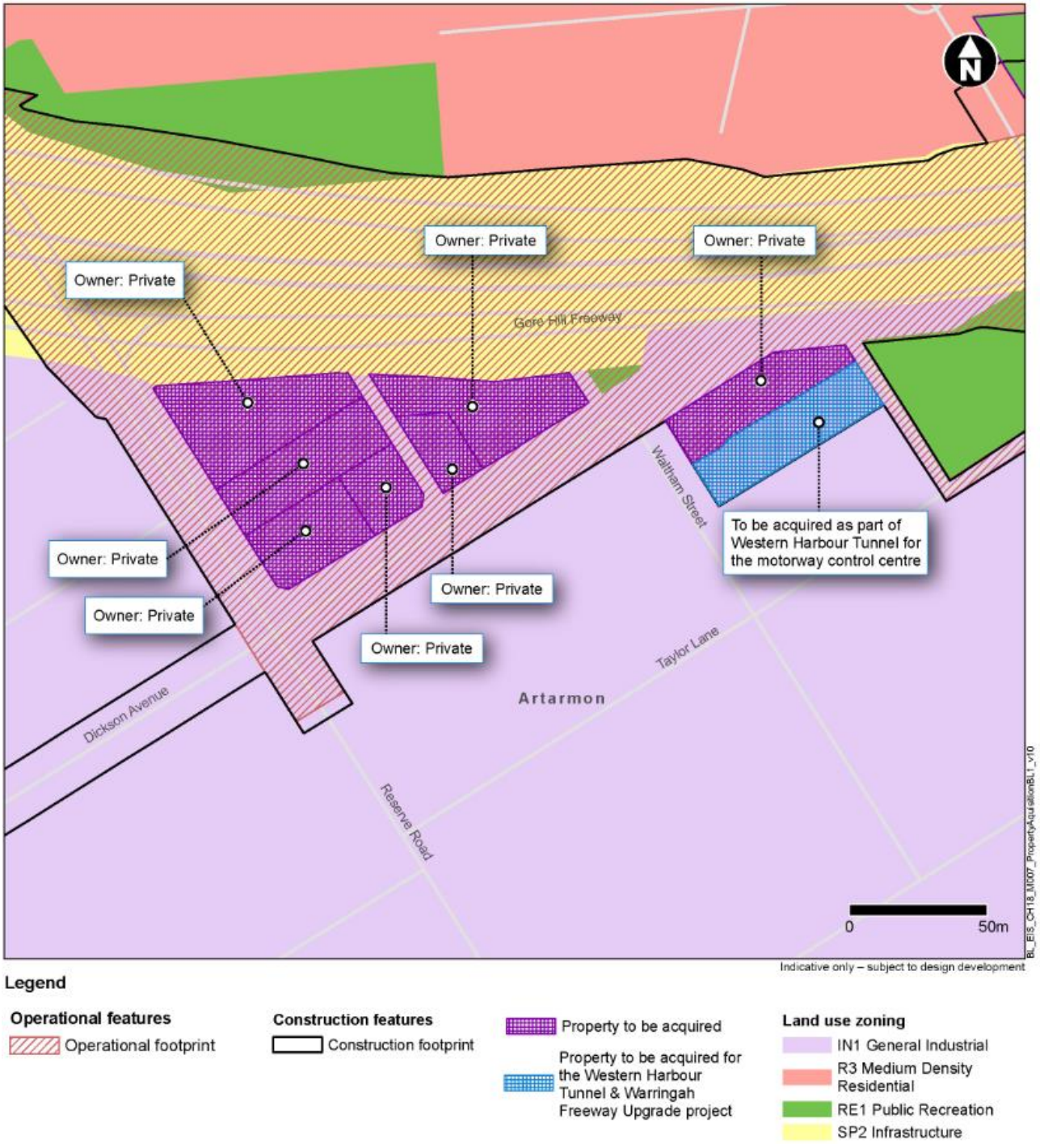

Figure 20-6 Property acquisitions for the project at Artarmon (around Dickson Avenue)

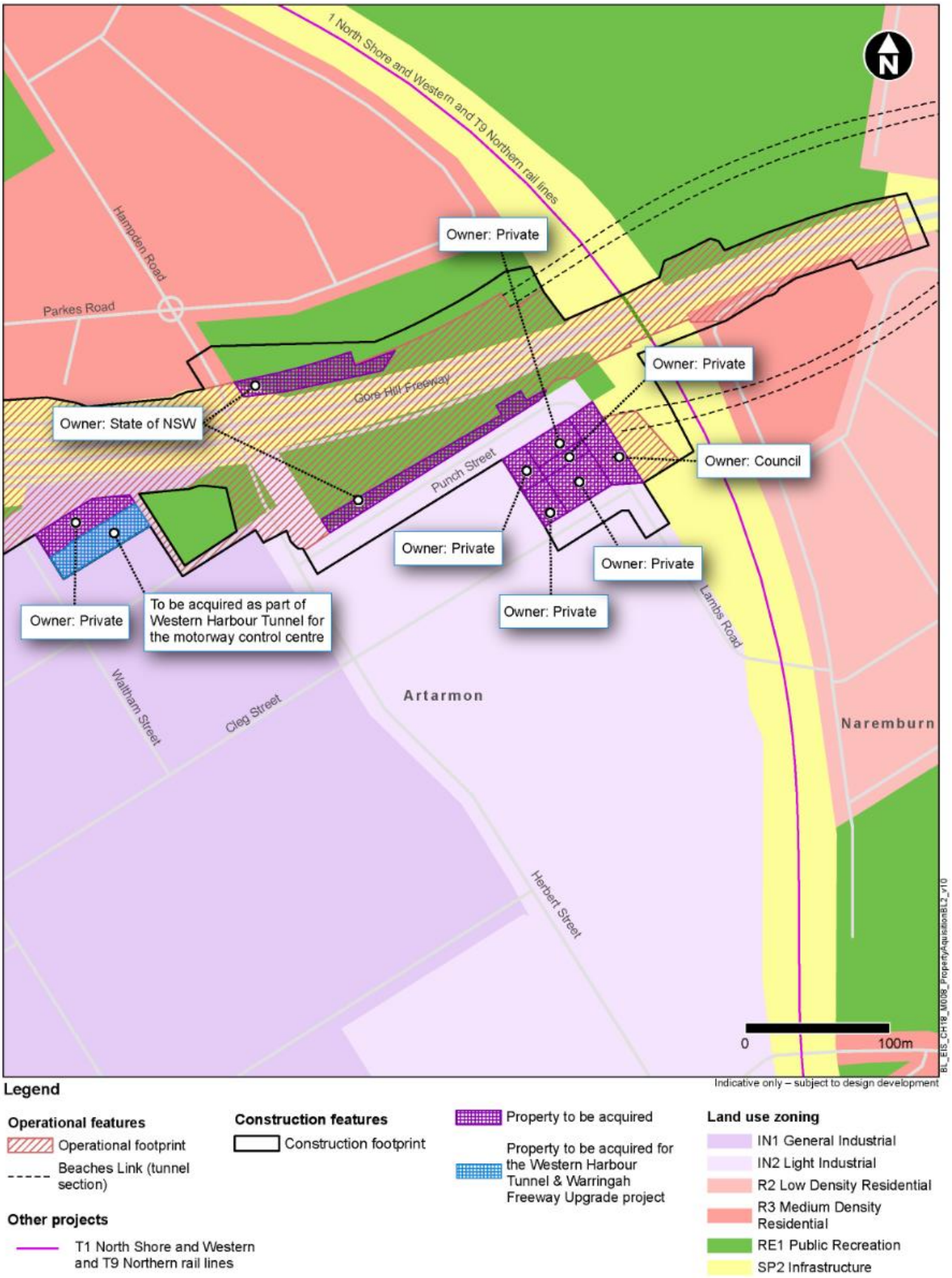

Figure 20-7 Property acquisitions for the project at Artarmon (around Punch Street)

Figure 20-8 Property acquisitions for the project at Balgowlah

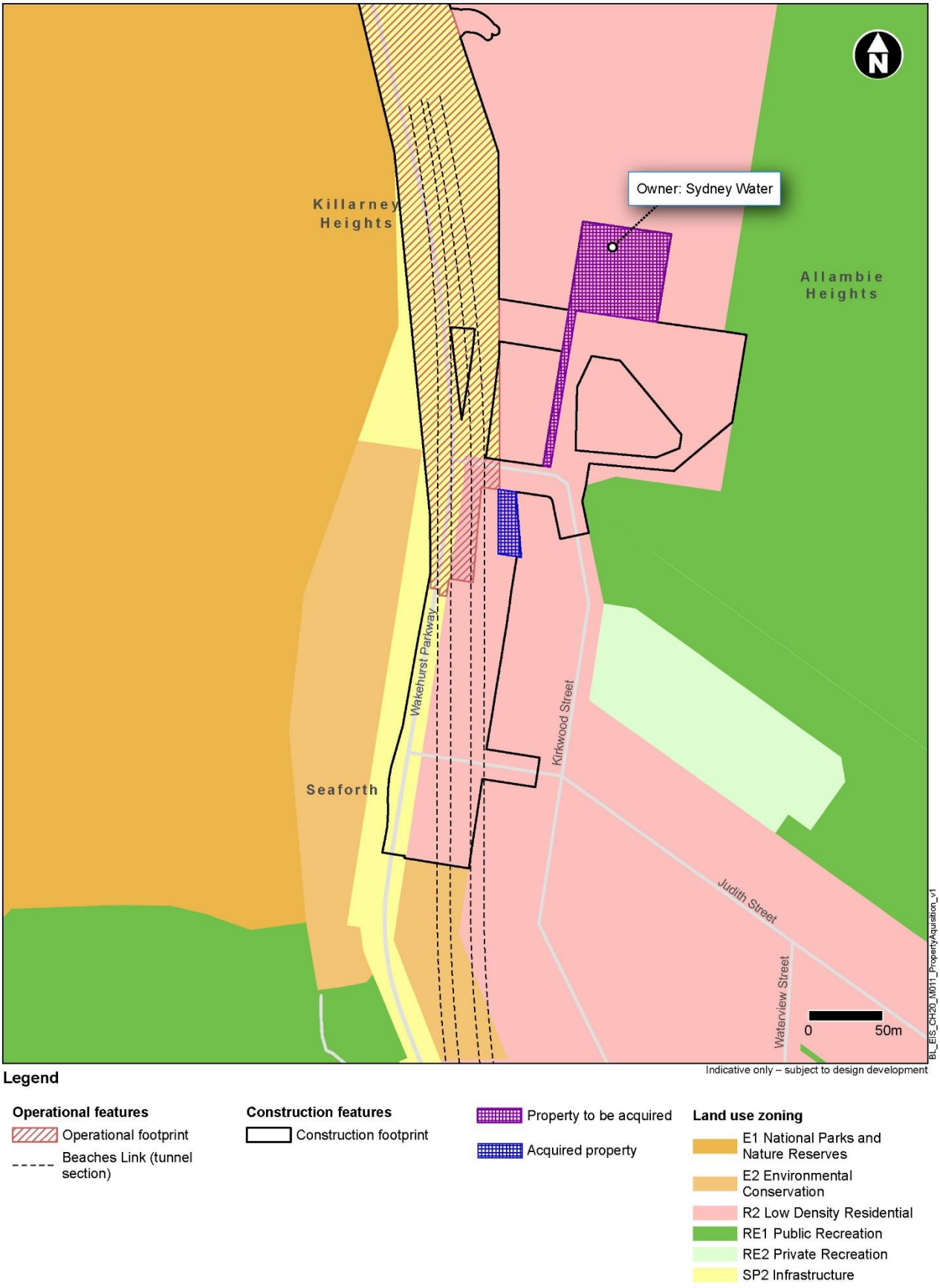

Figure 20-9 Property acquisitions for the project at Seaforth and Killarney Heights

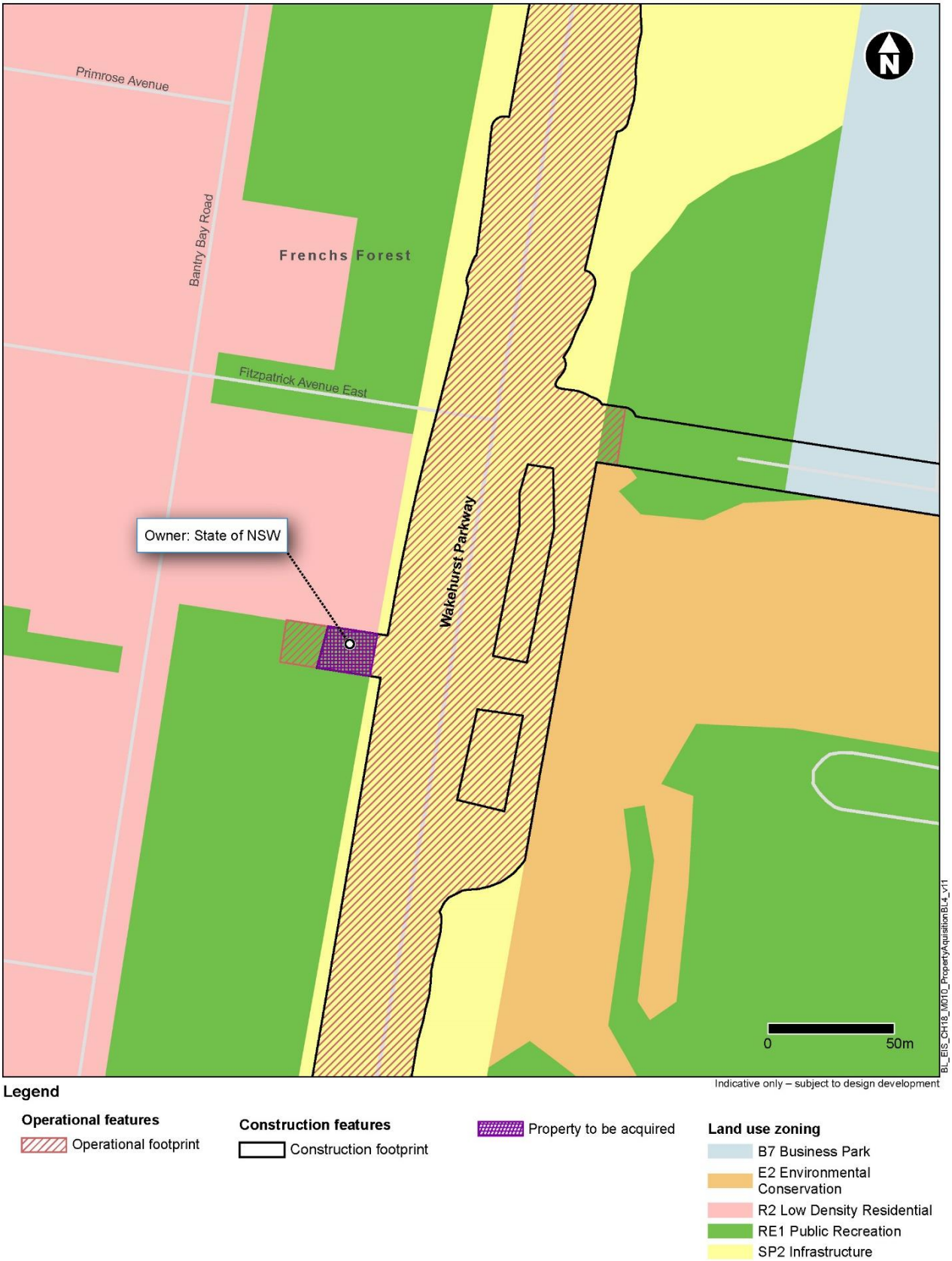

Figure 20-10 Property acquisitions for the Beaches Link component at Frenchs Forest

Temporary leases

Lease agreements identified in Table 20-2 would mainly be required for temporary construction support sites. Leased land would be rehabilitated in consultation with the relevant landowners, which are councils and government agencies, and returned as soon as practicable at the completion of construction. It is expected that following construction, sites would generally continue to be used consistent with their existing use. Table 20-3 provides a summary of the property leases associated with temporary construction support sites.

Table 20-3 Summary of anticipated property leases required for the project

Location	Construction support site	Pre construction land use	Current land use zoning	Council/ government agency
Beaches Link component				
Northbridge	Flat Rock Drive construction support site (BL2)	Flat Rock Reserve	E2 Environmental Conservation SP2 Infrastructure	Willoughby City Council
Mosman	Spit West Reserve construction support site (BL9)	Spit West Reserve	RE1 Public Recreation[1]	Mosman Council
Balgowlah	Balgowlah Golf Course construction support site (BL10)	Balgowlah Golf Course	RE1 Public Recreation RE2 Private Recreation	Northern Beaches Council
Killarney Heights	Wakehurst Parkway east construction support site (BL13)	Manly Dam Reserve	R2 Low density residential	Northern Beaches Council
	Wakehurst Parkway east construction support site (BL13)	Sydney Water site	R2 Low density residential	Sydney Water
Gore Hill Freeway Connection component				
Artarmon	Barton Road construction support site (BL5)	Vacant land	R3 Medium Density Residential	Willoughby City Council
	Temporary works site for construction of on ramp	Artarmon Park	RE1 Public Recreation	Willoughby City Council

Notes:
1. Land use zoning relevant to the project. Other land use zonings apply to this lot but would not be impacted by the project.

Residual land

Residual land comprises lots that are created either when a property is only partially acquired to construct or operate the project or when land acquired to facilitate construction of the project is not required for the operational footprint.

Local environmental plans place minimum lot size requirements and other restrictions on parcels of land to be used for specified types of development. As such, the creation of a residual lot has the potential to affect the development potential of the land. Minimum lot sizes most often apply to land zoned for residential purposes but can also apply to other land use zonings. Residual land that would be created as a result of the project and its anticipated future treatment is summarised in Table 20-4.

Any future development of residual land beyond that included in the project description in Chapter 5 (Project description) would be subject to separate assessment and approval in accordance with the *Environmental Planning and Assessment Act 1979* and is beyond the scope of this project.

Table 20-4 Anticipated residual land created by the project

Location	Pre construction land use	Current land use zoning	Project use and anticipated future treatment
Beaches Link component			
Cammeray	Cammeray Golf Course	RE1 Public Recreation	Part of Cammeray Golf Course would be occupied by temporary construction support sites and permanent operational infrastructure for the Western Harbour Tunnel and Beaches Link program of works. The land required for the project would be acquired and/or leased as part of the Warringah Freeway Upgrade component of the Western Harbour Tunnel and Warringah Freeway Upgrade project. Works to restore the golf course would be completed as part of the project. Both the Beaches Link and Gore Hill Freeway Connection project and the Western Harbour Tunnel and Warringah Freeway Upgrade project have been designed and developed to minimise impacts to Cammeray Golf Course. The configuration of the temporary construction support sites and the permanent operational infrastructure for both projects, whether implemented at the same time or at different times, would allow the site to continue to be used as a golf course. Amendments to the configuration of the golf course would be required to achieve this outcome, which would be carried out during construction of the projects. Golfing activities would be disrupted during the reconfiguration works. Transport for NSW have engaged and consulted with the golf course operator and landowner and this would continue to during further design development and implementation of the project to ensure the operation of the golf course during construction and operation of the project is possible.
Balgowlah	Private – residential	R1 General Residential	Thirty four residential properties on Dudley Street at Balgowlah would be required for use during construction as part of the Balgowlah Golf Course construction support site (BL10) and the connection to and from Burnt Bridge Creek Deviation. Six of the properties have been acquired as of 15 September 2020, with the remaining 28 properties proposed to be acquired prior to construction. During construction, the land to the east and north of the proposed access road not required for construction would be repurposed as part of the new open space and recreation facilities at Balgowlah. Land required as part of Balgowlah Golf Course construction support site (BL10) but not required permanently for operational

Location	Pre construction land use	Current land use zoning	Project use and anticipated future treatment
			infrastructure would be repurposed as soon as practicable at the completion of construction. This land would form part of new and improved open space and recreation facilities at Balgowlah described further in Section 20.4.2. Refer to Figure 20-11 for further detail on anticipated treatment of the residual land as part of the new and improved open space and recreation facilities.
Killarney Heights	Sydney Water site	R2 Low density residential	This site is currently a non-operational part of the Sydney Water Bantry Bay Reservoir site. Transport for NSW would acquire this parcel of land from Sydney Water for use as part of the Wakehurst Parkway east construction support site (BL13). The site would be rehabilitated and revegetated as soon as practicable after construction completion and would be handed over to Northern Beaches Council to manage for use by the community as part of the Manly Dam Reserve. This would add about 4000 square metres of new public space to the Manly Dam Reserve.

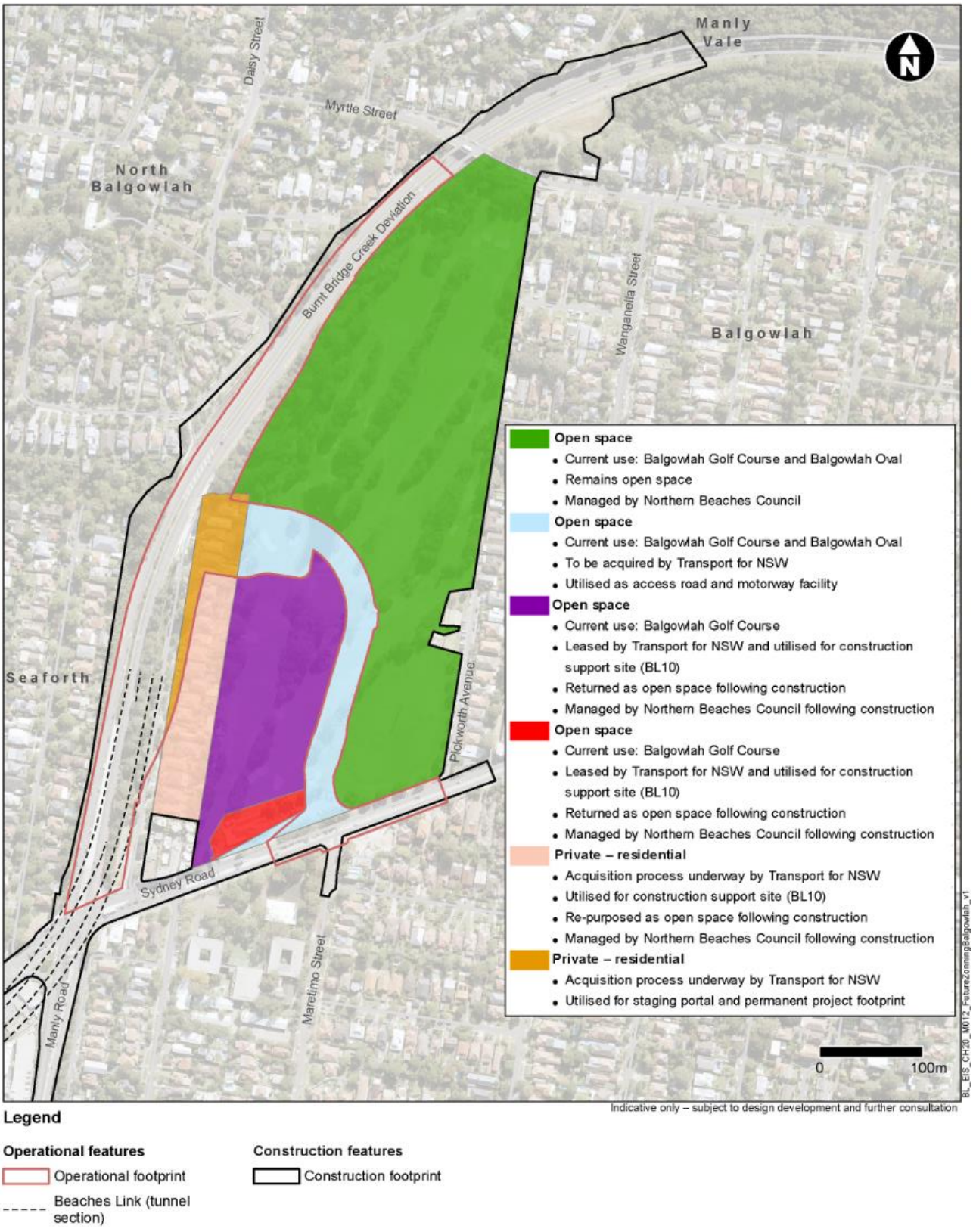

Figure 20-11 Property acquisition, temporary leases and use of residual land associated with the open space and recreation facilities at Balgowlah

Acquisition of substratum

The construction and operation of the project would require the acquisition of land below the surface of the ground where the mainline and ramp tunnels would be located. This is called substratum acquisition and is illustrated in Figure 20-12.

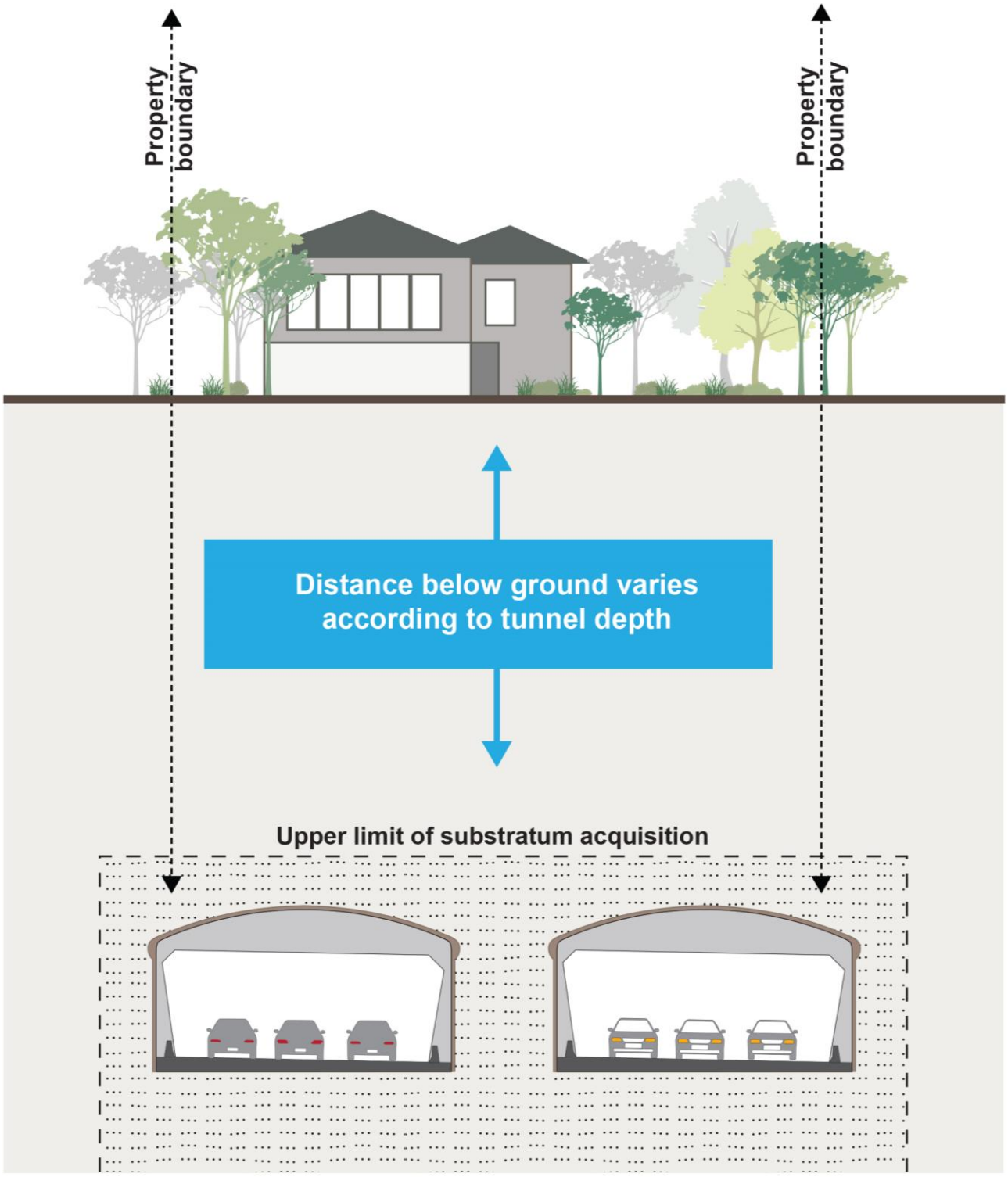

Figure 20-12 Example of substratum acquisition

Substratum acquisition would consist of a stratum acquisition envelope around the tunnels, including any associated ground support that may be required. In some circumstances, the introduction of the tunnels has the potential to limit development above the tunnels. For example, depending on the depth of the tunnels, the ability to construct basement levels in buildings above the tunnels may be restricted. However, this is generally only the case where the tunnel depth is shallow, near tunnel portals. Tunnel portal locations are described in Chapter 5 (Project description). Otherwise, substratum acquisition does not generally affect the future use of property at the surface. Subject to council regulations and approvals, landowners would generally be able to:

- Carry out improvements, such as installing a swimming pool
- Dig deeper foundations for a new building or second storey additions.

Where substratum acquisition is required, Transport for NSW would contact owners of affected properties. Transport for NSW has the authority to acquire the subsurface land, under the *Roads Act 1993*. The *Land Acquisition (Just Terms Compensation) Act 1991* provides that compensation is not payable for substratum acquisition of land or easements unless specific circumstances as detailed in that Act apply. Appendix C of the *Roads and Maritime Services land acquisition information guide* (Roads and Maritime Services, 2014b) sets out in detail the compensation provisions of the *Land Acquisition (Just Terms Compensation) Act 1991* relating to substratum acquisition.

Ground movement impacts

Excavation below ground has the potential to result in ground movement at the surface (settlement). Depending on the amount and nature of the ground movement, settlement may present a risk to nearby buildings and other structures during construction and operation of the project.

An assessment of potential ground movement impacts associated with the project is provided in Chapter 16 (Geology, soils and groundwater). The assessment identified the worst case risk of settlement impacts to buildings as ‘very slight’, where any damage can be easily treated during normal decoration. The areas where the most settlement is predicted to occur would be in the vicinity of the tunnel alignment, primarily above Flat Rock Reserve, the Wakehurst Parkway tunnel portal, and at the Burnt Bridge Creek Deviation tunnel portal, though no buildings are present at these locations. As such, the risk of building impacts due to settlement is therefore very low during both construction and operation of the project. Environmental management measures to manage the potential impacts from ground movement are included in Chapter 16 (Geology, soils and groundwater).

20.4.2 Land Use

Potential land use impacts during construction

The occupation of land for construction works and temporary construction support sites associated with the project has the potential to impact the use and development potential of affected land. While the occupation of land for construction might occur over four to five years, these impacts would be temporary in nature, except for sites that are subsequently used for operational infrastructure (refer to Table 20-6). Table 20-5 outlines the potential land use impacts at each construction site and temporary construction support site required for the project.

The occupation and use of land during construction could also result in impacts associated with traffic and transport, noise and vibration, air quality and social and economic values. Consideration of these impacts is provided in Chapter 8 (Construction traffic and transport), Chapter 10 (Construction noise and vibration), Chapter 11 (Operational noise and vibration), Chapter 12 (Air quality) and Chapter 21 (Socio-economics). Utility relocations, adjustments and protection are discussed in Chapter 5 (Project description) and Appendix D (Utilities management strategy).

Table 20-5 Potential land use impacts during construction

Construction location	Potential impacts on land use during construction
Cammeray to Northbridge	
Cammeray Golf Course construction support site (BL1)	The Cammeray Golf Course construction support site (BL1) would temporarily occupy a portion of the existing golf course adjacent to the Warringah Freeway, and residential properties to be acquired (as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project) along Morden Street in Cammeray. The site would be located on NSW Government owned land that is zoned for public recreational use associated with the Cammeray Golf Club. This site would be used for the construction and fitout of motorway facilities at the Warringah Freeway and would provide tunnel and construction support for the Beaches Link component of the project. However, the site would initially be established as a temporary construction support site for the Western Harbour Tunnel and Warringah Freeway Upgrade project. Transport for NSW proposes to address the potential impacts to the Cammeray Golf Course as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project in a manner that maintains the ability of the site to be used for golf-related activities during the construction and operational phases of that project. Transport for NSW is consulting with the golf club, and Department of Planning, Industry and Environment (Crown Lands) and North Sydney Council (the trustee) to achieve this. At the completion of construction, some land at the site would be used on an ongoing basis for the operation of permanent project infrastructure. This area would be smaller than the footprint during construction. The adjoining Cammeray Park sportsground, tennis club, croquet club and skate park would remain operational during construction and would not be directly impacted during construction.
Flat Rock Drive construction support site (BL2)	The Flat Rock Drive construction support site (BL2) would be located in Flat Rock Reserve in Northbridge. The site is on Council-owned land and is zoned for environmental conservation. During construction, the site would temporarily occupy a small portion (about 10 per cent) of the reserve and would preclude the use of the site for environmental conservation and public open space and recreation activities. At the end of construction, the impacted portion of the reserve would be rehabilitated in consultation with Willoughby City Council and the community, and returned to the landowner. The temporary use of this land would have a negligible impact on the continued use of the wider Flat Rock Reserve area and Flat Rock Gully area for public open space and recreational use, as access to these areas would be maintained at all times during the construction and rehabilitation works. Upon completion, the site and adjacent areas within Flat Rock Reserve could remain zoned for environmental conservation.

Construction location	Potential impacts on land use during construction
Gore Hill Freeway and surrounds	
Surface road works (Gore Hill Freeway Connection)	Surface road works for the Gore Hill Freeway Connection would be carried out on and adjacent to the Gore Hill Freeway at Artarmon. Construction activities carried out along the road corridor would generally be on land owned by Transport for NSW and zoned for infrastructure related uses. Land use impacts would be negligible for works carried out on land zoned SP2 Infrastructure. The Gore Hill Freeway Connection would also require surface works to be carried out on land zoned for public recreation, notably in the area adjacent to Punch Street and the Gore Hill Freeway in Artarmon. There is an existing shared path at this location that provides connectivity between Artarmon Reserve and the Artarmon industrial area, as well as car parking along Punch Street. Pedestrians and cyclists would be required to detour around work sites for the duration of construction. Surface works would also be carried out within Artarmon Park along the north side of the Gore Hill Freeway. Works are unlikely to impact the recreational use of Artarmon Park, as the impacted area is steeply sloped and vegetated with dense scrub. The adjoining Artarmon Reserve would not be impacted. At the completion of construction, part of the land zoned for public recreation would be converted to permanent project infrastructure.
Punch Street construction support site (BL3)	The Punch Street construction support site (BL3) would occupy land within the Artarmon industrial area, adjacent to the T1 North Shore and Western line and T9 Northern line rail corridors and south of the Gore Hill Freeway in Artarmon. The site would be a tunnel support and project management site and would be located on land that is zoned for both light industrial and infrastructure related uses. The site would temporarily change the existing land use at this location from light industrial to construction infrastructure. The temporary construction support site would require the permanent acquisition of several industrial properties located on Punch Street, Lambs Road and Cleg Street. The total number of property acquisitions at this location has been minimised where possible. While the temporary construction support site would result in the loss of some existing light industrial and commercial businesses, impacts to the continued viability of the Artarmon industrial area more broadly are anticipated to be minor. Further, the construction activities would not preclude the continued operation of light industrial and commercial uses on land that adjoins or is located in proximity to the temporary construction support site within the Artarmon industrial area. During construction, Lambs Road between Punch Street and Cleg Street would be closed to allow construction vehicles to access to the site. Existing access to this section of Lambs Road is via Cleg Street and Punch Street and access impacts due to this closure would be minor (refer to Chapter 8 (Construction traffic and transport)). At the completion of construction, remaining land at the site would be used on an ongoing basis for the operation of permanent project infrastructure.

Construction location	Potential impacts on land use during construction
Dickson Avenue construction support site (BL4)	The Dickson Avenue construction support site (BL4) would occupy land within the Artarmon industrial area adjacent to the Gore Hill Freeway, Dickson Avenue and Reserve Road in Artarmon. The site would mostly be located on land that is zoned for general industrial uses. The site would also occupy a small portion of land that is zoned for public recreation located at the eastern end of Dickson Avenue. The site would temporarily change the existing land use at this location from general industrial and public recreation to construction infrastructure. The temporary construction support site would require the permanent acquisition of several industrial and commercial properties located on Reserve Road, Waltham Street and Dickson Avenue. While the temporary construction support site would result in the loss of several general industrial and commercial businesses, the project would not impact upon the continued viability of the broader Artarmon industrial area. The permanent acquisition of a small portion of public recreation zoned land located at the eastern end of Dickson Avenue would have a negligible land use impact as the land is currently severed from any expansive open space area and is located adjacent the Gore Hill Freeway corridor. The site is unsuitable for public open space and recreation activities in its current state. At the completion of construction, remaining land at the site would be used on an ongoing basis for the operation of permanent project infrastructure including surface connections between the Gore Hill Freeway, Dickson Avenue and Reserve Road.
Barton Road construction support site (BL5)	The Barton Road construction support site (BL5) would occupy land bordered by the Gore Hill Freeway, Butchers Lane and medium density residential development in Artarmon. The site would mostly be located on land that is zoned medium density residential. The site would also occupy a small portion of land that is zoned for infrastructure related uses located adjacent to the Gore Hill Freeway corridor. Land that would comprise the site is part owned by Transport for NSW and is currently vacant land. The remainder of the site is owned by Willoughby City Council. This land would also be required for the duration of construction. The site would temporarily change the existing land use at this location to construction infrastructure. In the longer term, the land has been identified by Willoughby City Council as an appropriate location for affordable housing. The site would be rehabilitated and reinstated at the completion of construction in consultation with Willoughby City Council. The temporary use of this land for construction purposes would not impact on its future development potential. Any future development would be subject to separate assessment and approval in accordance with the *Environmental Planning and Assessment Act 1979* and is beyond the scope of this project.

Construction location	Potential impacts on land use during construction
Gore Hill Freeway median construction support site (BL6)	The Gore Hill Freeway median construction support site (BL6) would be located within the Gore Hill Freeway median and above the Lane Cove Tunnel portals in Artarmon. The site would comprise vacant land owned by Transport for NSW and zoned for infrastructure related uses. The site would temporarily be used for equipment storage to support the Gore Hill Freeway Connection. The temporary use of this land for construction activities would have a negligible impact as the land would be used in accordance with the current zoning.
Northbridge to Seaforth	
Middle Harbour south cofferdam (BL7)	The Middle Harbour south cofferdam construction support site (BL7) and Middle Harbour north cofferdam construction support site (BL8) would be temporarily located in Middle Harbour off Northbridge and Seaforth, respectively. Marine exclusion zones would be set up around these two sites, with controlled navigation channels provided through the main works area to facilitate the safe passage of all vessels and recreational users. Construction activities associated with these sites including works such as dredging and immersed tube tunnel unit placement would require the establishment of maritime speed restrictions around the construction equipment. This has the potential to result in minor increases to transit times for vessels that travel through Middle Harbour. Construction is not expected to have substantial impacts on vessel travel times as private vessels would be given right of way and speed restriction zones would be limited to areas in the immediate vicinity of construction vessels. The Northbridge Sailing Club makes use of Middle Harbour upstream of the Spit Bridge and would need to consider relocating sailing courses away from the marine works exclusion zones during construction. Exclusion zones and course routes would be clearly marked by buoys and project commercial craft associated with the project would be required to give way to recreational craft which is contrary to normal maritime protocols. Opportunities to minimise and manage potential impacts, including the relocation of sailing courses to upstream of the Middle Harbour crossing, would be investigated prior to construction in consultation with the club. Sites would be managed in accordance with the environmental management measures outlined in Chapter 8 (Construction traffic and transport). Private recreational users with vessels located upstream of the Spit Bridge may also be impacted by exclusions zones and closures of the navigation channel. Closures would occur midweek to minimise the impact on other waterway users including recreational boating traffic. During installation of the outer two immersed tube tunnel units, full closure of the channel would not be required and smaller vessels would be provided an escort to ensure safe passage around the construction works. Three jetties connected to separate properties at Seaforth would be inaccessible for the duration of construction due to exclusion zone established around Middle Harbour north cofferdam construction support site (BL8). The bed of the harbour occupied by the private foreshore structures is leased from Transport for NSW. Transport for
Middle Harbour north cofferdam (BL8)	

Construction location	Potential impacts on land use during construction
	NSW would consult with the owners of these properties to determine alternative arrangements. About 10 moorings located off Seaforth and leased from Transport for NSW would also need to be temporarily relocated due to the establishment of Middle Harbour north cofferdam construction support site (BL8). Potential temporary impacts on vessel movements and marine activities in Middle Harbour are further considered in Chapter 8 (Construction traffic and transport).
Spit West Reserve construction support site (BL9)	The Spit West Reserve construction support site (BL9) would be mainly located in the water west of Spit West Reserve in Mosman with a small land-based site located directly adjacent. The land-based component of Spit West Reserve construction support site (BL9) would be located on land zoned for public recreation. The water-based component of the site would require the temporary relocation of about 55 swing moorings leased from Transport for NSW in Middle Harbour, including in Pearl Bay and those located adjacent to Spit West Reserve. Relocations would be managed in accordance with the environmental management measures outlined in Chapter 8 (Construction traffic and transport). The land-based component of the site would require a portion of Spit West Reserve adjacent to the existing car park to be temporarily leased for the duration of construction, therefore temporarily changing the existing land use at this location from public recreation and open space to construction infrastructure. Recreational users of Spit West Reserve would be required to use alternative parts of the reserve, which could include areas to the north and south of the temporary construction support site. The existing shared user path located along the foreshore of Middle Harbour would be temporary diverted around the site with connectivity along the reserve maintained. The Mosman Rowing Club located to the south of the site may be required to make minor modifications to existing courses to ensure an adequate clearance is maintained around the water-based component of the temporary construction support site (including the floating immersed tube tunnel casting facility). A controlled right of way would be provided to rowers through the main works. The club would be consulted during construction planning to develop suitable environmental management measures, as described in Chapter 8 (Construction traffic and transport). The Spit West Reserve construction support site car park would provide. limited parking for construction supervisory staff. The Spit West Reserve public car park would not be utilised by construction workers. Instead, workers at this site would either use public transport or would be transported to the site by shuttle bus (where required) from the Balgowlah Golf Course construction support site (BL10). The impacted portion of Spit West Reserve would be rehabilitated in consultation with Mosman Council and returned to the landowner at the completion of construction. The temporary use of this land would not impact on the continued use of the site for open space and public recreational use at the completion of construction.

Construction location	Potential impacts on land use during construction
Seaforth to Balgowlah	
Surface road works at Balgowlah	Surface road works at Balgowlah would include the realignment and widening of Burnt Bridge Creek Deviation, and creation of new access road intersections at Burnt Bridge Creek Deviation and the existing intersection of Sydney Road and Maretimo Street. The surface road works would facilitate the widening of Burnt Bridge Creek Deviation, resulting in the establishment of permanent project infrastructure on public recreation zoned land at Balgowlah Golf Course. The surface road works would be carried out on land that is zoned SP2 infrastructure and RE1 Public Recreation. Works carried out within the road corridor and on land zoned SP2 Infrastructure would be consistent with the existing land use and zoning.
Balgowlah Golf Course construction support site (BL10)	The Balgowlah Golf Course construction support site (BL10) would encompass part of the Balgowlah Golf Course and parts of the properties acquired along Dudley Street. The site would be required for construction of the motorway tunnel connection to the Burnt Bridge Creek Deviation, new motorway facilities, the new access road and the new and improved open space and recreation facilities. Users of the golf course would need to use nearby alternative courses including Wakehurst Golf Course, Manly Golf Course and Warringah Golf Course, all located within two kilometres of the site and which provide equivalent recreation facilities. Residual land, primarily to the east and north of the new access road would progressively become available through the construction period, which would facilitate re-purposing it to the new and improved open space and recreation facilities. This would allow it to be handed over progressively for use by the community, consistent with the existing recreational land use and zoning. The new open space and recreation facilities to the west of the proposed access road, between the access road and the widened Burnt Bridge Creek Deviation, would be constructed and handed over to Northern Beaches Council after completion of the project. Construction of the new and improved public open space and recreation facilities is discussed further in Chapter 6 (Construction work). The existing clubhouse building is proposed to be removed for the new and improved open space and recreation facilities. However, consideration would be given to re-purposing the building for the wider community during the dedicated consultation process for the new and improved open space and recreation facilities jointly led by Transport for NSW and Northern Beaches Council. At the completion of construction, part of the existing Balgowlah Golf Course site would be occupied and used on an ongoing basis for the operation of permanent project infrastructure as shown in Figure 20-11.

Construction location	Potential impacts on land use during construction
Kitchener Street construction support site (BL11)	The Kitchener Street construction support site (BL11) would occupy land next to the Burnt Bridge Creek Deviation and directly north of the Kitchener Street bridge in Balgowlah. The site would support the surface road works at Balgowlah and would be located predominantly on vacant land zoned for public recreation. The site would also occupy land zoned for general residential land use. The land zoned for public recreation is currently vacant and is not used for public recreation purposes. Consequently, the temporary change of land use to construction infrastructure would be negligible. The site would be rehabilitated and reinstated at the completion of construction. The land zoned for general residential is owned by Transport for NSW and it may be used by the project as a site office and amenities. This would be confirmed during further design development and construction planning.
Seaforth to Frenchs Forest	
Surface road works at Killarney Heights and Frenchs Forest	Surface road works at Seaforth, Killarney Heights and Frenchs Forest would mostly involve the realignment and upgrade of the Wakehurst Parkway including integration of the project with road network upgrades completed as part of the Northern Beaches Hospital road upgrade project. Construction activities carried out along the Wakehurst Parkway would mostly be carried out on land owned by Transport for NSW and zoned for infrastructure related uses. Consequently, there would be no impact on land use and/or the development potential of land at Killarney Heights and Frenchs Forest. Construction works would not encroach within the adjoining environmental conservation zones or into the Garigal National Park.
Wakehurst Parkway south construction support site (BL12)	The Wakehurst Parkway south construction support site (BL12) would occupy land east of the Wakehurst Parkway between a point just south of Judith Street and the northern end of Kirkwood Street at Seaforth. The site would be located on land owned by Transport for NSW that is zoned and used for low density residential development. The temporary construction support site would temporarily change the existing land use from low density residential to construction infrastructure. At the completion of construction, all of the remaining land at the site would be rehabilitated and reinstated and made available for other uses. Reinstatement of the site may require the replacement of boundary fences for existing residential properties along Kirkwood Street located adjacent to the site. Any future development on the affected land would be subject to separate assessment and approval in accordance with the *Environmental Planning and Assessment Act 1979* and is beyond the scope of this project.

Construction location	Potential impacts on land use during construction
Wakehurst Parkway east construction support site (BL13)	The Wakehurst Parkway east construction support site (BL13) would occupy two portions of land east of the Wakehurst Parkway and north of Kirkwood Street currently owned by Sydney Water. The temporary construction support site would comprise both portions of land as one support site. One portion of land is surrounding the main Bantry Bay Reservoir site mostly north of the existing water tanks and would be leased by Transport for NSW from Sydney Water. The site would be temporarily used as a temporary construction support site for the duration of construction. The temporary occupation of this land would not affect the existing land use zoning that is applicable to the site. Sydney Water facility operations and the on-site Telstra tower would remain operational for the duration of construction activities at the site. All existing structures would be protected. The land to be leased would be rehabilitated in consultation with Sydney Water and returned to the landowner at the completion of construction. The other portion of the site would be located wholly on vacant non-operational Sydney Water owned land immediately north of the existing water tanks zoned for low density residential. Transport for NSW would acquire this non-operational part of the Bantry Bay Reservoir site from Sydney Water. This land would be rehabilitated and revegetated as soon as practicable after construction and would be handed over to Northern Beaches Council to manage for use by the community as part of the Manly Dam Reserve. This would add about 4000 square metres of new public space to the Manly Dam Reserve. A smaller portion of land required for the access road to and from the support site forms part of the Manly Dam Reserve, which is Crown land. This land would be leased, and rehabilitated and returned to Northern Beaches Council at the end of construction.
Wakehurst Parkway north construction support site (BL14)	The Wakehurst Parkway north construction support site (BL14) would occupy Transport for NSW owned land at the north east corner of the Wakehurst Parkway and Warringah Road in Frenchs Forest. The site would be located on land that is partly zoned for public recreation and partly zoned for infrastructure related uses. This site was previously used as a temporary construction support site for the Northern Beaches Hospital road upgrade project. As such, potential construction land use impacts would be considered negligible. Following construction, the site would be used for operation of the northern tunnel support facilities.

Potential land use impacts during operation

The project has the potential to permanently impact land use and the development potential of surrounding areas during operation. Permanent land use changes as a result of the project would occur largely in response to the physical introduction of permanent project infrastructure at Cammeray, Artarmon, Balgowlah, Killarney Heights and Frenchs Forest. The location of operational infrastructure has been developed with consideration of existing land use zones and future development to minimise permanent impacts, and is discussed further in Table 20-6.

Surrounding land would also be affected by the operation of the project. The operation of ventilation outlets at the Warringah Freeway, Gore Hill Freeway, Burnt Bridge Creek Deviation and Wakehurst Parkway has the potential to influence development patterns for existing and future elevated receptors (for example, those receptors within multi-storey residential buildings) and is discussed further in Table 20-7.

The permanent changes in land use due to the project would also have the potential to result in indirect impacts associated with traffic and transport, noise and vibration, air quality and social and economic values. Consideration of these potential impacts is provided in Chapter 9 (Operational traffic and transport), Chapter 11 (Operational noise and vibration), Chapter 12 (Air quality) and Chapter 21 (Socio-economics).

Table 20-6 Potential land use impacts during operation

Operational infrastructure	Potential impacts on land use during operation
Cammeray to Northbridge	
• Surface connections at the Warringah Freeway • Underground connections to the Western Harbour Tunnel • Ventilation outlet and motorway facilities at the Warringah Freeway	Permanent project infrastructure would be established within the existing Cammeray Golf Course adjacent to the Warringah Freeway which would change a portion of the existing land use from public recreation to permanent transport infrastructure for the project. This would reduce the amount of land available for public recreational use. However, the layout would enable Cammeray Golf Course to be retained in a modified form that enables continuation of golf-related activities. Transport for NSW is consulting with Cammeray Golf Club, Department of Planning, Industry and Environment (Crown lands) and North Sydney Council (the trustee) to achieve this outcome. Operation of the ventilation outlet and motorway facilities at the Warringah Freeway might also place restrictions on future development because of the impact on potential elevated receivers. This issue is discussed further in the following section.
Gore Hill Freeway and surrounds	
• Connections to and from the motorway tunnel to the Gore Hill Freeway/Lane Cove Tunnel and Reserve Road • Realignment and upgrade of the Gore Hill Freeway • Modifications and upgrades to road bridges • Minor changes to local roads • Realignment and reconstruction of shared user infrastructure	The Gore Hill Freeway Connection component of the project would connect and integrate the Beaches Link tunnels with the Gore Hill Freeway/Lane Cove Tunnel and Reserve Road at Artarmon providing added connectivity. Surface road works would also include realignment and upgrade of the existing motorway and minor changes to the surrounding road network. Operational infrastructure including the ventilation outlet and motorway facilities at the Gore Hill Freeway, air supply facility and wastewater treatment plant would be located adjacent the eastern extent of the Gore Hill Freeway Connection on land currently bordered by Punch Street, Lambs Road and Cleg Street. The project infrastructure would be established within the Artarmon industrial area on land zoned for light industrial uses. While the project would reduce the amount of land that would otherwise be used for light industrial activities, the project is not expected to impact on the continued viability of the Artarmon industrial area more broadly. Further, the project would not preclude the continued operation of light industrial and/or commercial uses on land that adjoins or is located in proximity to the project infrastructure within the Artarmon industrial area. Changes to local roads within the Artarmon industrial area would include removal of the connection between Punch Street and Lambs Road, with the conversion of Punch Street to a cul-de-sac. The creation of a cul-de-sac at Punch Street would have a minor impact on connectivity throughout the north eastern portion of the Artarmon industrial area. Construction of the westbound off ramp connecting to Reserve Road would require the conversion of Dickson Avenue to a cul-de-sac, directly east of the intersection with Reserve Road in Artarmon. Access to the existing

Operational infrastructure	Potential impacts on land use during operation
• Wastewater treatment plant • Ventilation outlet and motorway facilities at the Gore Hill Freeway • Motorway control centre at the Gore Hill Freeway	properties on Dickson Avenue would be provided from Hesky Lane. While the cul-de-sac at Dickson Avenue would be a permanent change to the road network, access would be retained to all potentially affected properties and impacts to the existing general industrial and warehousing land uses would be minor. The creation of a cul-de-sac at Dickson Avenue would have a minor impact on connectivity throughout the eastern portion of the Artarmon industrial area. Permanent project infrastructure would also include new and upgraded connections to the existing road network along the Gore Hill Freeway corridor. This infrastructure would be established within the existing road corridor on land zoned for infrastructure related uses. The existing motorway creates a barrier between adjoining areas and restricts north-south connectivity for pedestrians and cyclists to the existing overpasses. While the project would not remove this barrier, the project would provide a positive contribution to the local area by providing new and upgraded active transport infrastructure that would improve connectivity across and around the Gore Hill Freeway. This would include the replacement of the shared user path along the southern side of the Gore Hill Freeway, replacement of the existing pedestrian footpath along the eastern side of the Reserve Road bridge, and a new pedestrian footpath adjacent to the cycle path behind the southern abutment of the Reserve Road bridge.
Northbridge to Seaforth	
• Immersed tube tunnels	Operational infrastructure in the area between Northbridge and Seaforth would include immersed tube tunnels for the crossing of Middle Harbour. The immersed tube tunnels would sit on both excavated rock within a trench and piles driven into the bed of the harbour maintaining between 16 metres and 22 metres of water depth over the tunnels, depending on the distance from the shore. The immersed tube tunnels would not introduce navigational impacts for water-based activities and operations carried out in Middle Harbour as marine vessels using Middle Harbour are already restricted by the relatively shallow harbour entrance at The Spit. Further, there would be no land use impacts during operation to foreshore land along Middle Harbour in Northbridge and Seaforth. No other permanent operational infrastructure would be established at surface level in the area between Northbridge and Seaforth. Works would otherwise comprise subsurface tunnelling that would not introduce any permanent impacts to existing land uses, current land use zones or the strategic land use direction of the area.

Operational infrastructure	Potential impacts on land use during operation
Seaforth to Balgowlah	
• New access road connecting Burnt Bridge Creek Deviation and Sydney Road • Road widening works and minor changes to local roads • New and upgraded active transport infrastructure • Ventilation outlet and motorway facilities at the Burnt Bridge Creek Deviation.	The project would introduce permanent land use impacts on the land at Balgowlah Golf Course as a result of: • The construction and alignment of tunnel portals within the Burnt Bridge Creek Deviation road corridor • The construction of a new access road through the existing golf course that would connect Burnt Bridge Creek Deviation and Sydney Road, and provide local access to the new and improved open space and recreation facilities • Establishment of a ventilation outlet and motorway facilities at the Burnt Bridge Creek Deviation • Realignment and reconstruction of the shared path on the south eastern side of Burnt Bridge Creek Deviation between the Kitchener Street bridge and Dudley Street • Construction of a new shared user path along the eastern side of the new access road between Burnt Bridge Creek Deviation and Sydney Road. Engagement with Northern Beaches Council as part of the project has identified potential for Balgowlah Golf Course and residual land from the Dudley Street properties to be developed as new and improved open space and recreation facilities, which would align with the *Northern Beaches Sportsground Strategy* (Northern Beaches Council, 2017a) and address the current under supply of sporting grounds available for public use in the local area. A dedicated consultation process jointly led by Transport for NSW and Northern Beaches Council would take place to give the community an opportunity to provide input on the final layout of the new and improved open space and recreation facilities at Balgowlah. This consultation would be separate to the consultation for the Beaches Link environmental impact statement. This process would start after the environmental impact statement public exhibition period and well in advance of construction starting. As part of this consultation process, a community reference group would be established, with representative stakeholder groups and the community, to support Transport for NSW and Northern Beaches Council with the development of this important public space. The design of permanent operational infrastructure established at the Balgowlah Golf Course has been optimised to increase the opportunities for the use of the remaining land as new open space and recreation facilities. Including residual land from properties acquired along Dudley Street, the project would return an area, equivalent to around 90 per cent of the current open space, to the community as new and improved public open space and recreation facilities. An indicative layout of the new and improved open space and recreation facilities at Balgowlah is provided in Figure 5-28 of Chapter 5 (Project description) and provides for a mix of active and passive recreation needs that address the current, and growing, shortfall in recreation facilities within the local area.

Operational infrastructure	Potential impacts on land use during operation
	Works at Balgowlah would also include new and upgraded active transport infrastructure to improve connectivity across and around the Burnt Bridge Creek Deviation, the new access road and new and improved open space and recreation facilities. This would include the realignment and reconstruction of the shared user path along the southern side of the Burnt Bridge Creek Deviation between a location south of the Kitchener Street bridge and the new intersection of the Burnt Bridge Creek Deviation with the new access road. The realigned and reconstructed shared user path would be connected with the existing shared user path at Dudley Street. Improvements would also include the extension of the existing shared user underpass beneath the Burnt Bridge Creek Deviation to the north of Dudley Street, and a new at-grade pedestrian crossing of the new access road at the intersection with Sydney Road. The final pedestrian and cycle facilities would be determined during further design development and consideration of the consultation process described above for the new and improved open space and recreation facilities at Balgowlah.
Seaforth to Frenchs Forest	
• Surface works to connect and integrate the project with the surrounding road network • Realignment and widening of the Wakehurst Parkway • New pedestrian underpasses beneath the Wakehurst Parkway • New fauna underpasses beneath the Wakehurst Parkway • Demolition and reconstruction of the pedestrian bridge near Aquatic Drive • Shared user path between Warringah Road and Kirkwood Street	The Wakehurst Parkway would be realigned and upgraded to allow connection to the ramp tunnels with the surface and widened between the ramp tunnels and Warringah Road in Frenchs Forest to improve capacity and safety. The works would be carried out entirely within the existing road reserve and Transport for NSW owned land zoned for infrastructure related uses. There would be no impact on existing land uses. The Wakehurst Parkway between Seaforth and Frenchs Forest currently creates a barrier between adjoining areas which largely severs east-west connectivity for fauna, pedestrians and cyclists where there is no dedicated crossing location. The project would provide a positive contribution to the local area by providing new and upgraded active transport infrastructure that would improve connectivity and user safety along and across the Wakehurst Parkway. This would include a new shared user path along the eastern side of the Wakehurst Parkway between Seaforth and Frenchs Forest, three new shared user underpasses of the Wakehurst Parkway, reconstruction and lengthening of the existing pedestrian overpass across the Wakehurst Parkway near Warringah Road, and a new shared user bridge over a drainage culvert and existing fauna underpass near Warringah Road. The project would also provide new and replaced fauna crossing infrastructure along the Wakehurst Parkway. Further detail on proposed fauna, pedestrian and cycle facilities is provided in Chapter 5 (Project description). The ventilation outlet and motorway facilities at the Wakehurst Parkway at Killarney Heights would be located above the ramp tunnel portals to the Wakehurst Parkway and on land within the existing road corridor that is zoned for infrastructure related uses. The ventilation outlet and motorway facilities are considered to be compatible with the existing land use zone. Land use zones surrounding the ventilation outlet and motorway facilities include national parks and nature reserves, public recreation and low density residential. These land use zones do not support multi-storey development and therefore any potential impacts from the ventilation

Operational infrastructure	Potential impacts on land use during operation
• Minor changes to local roads • Ventilation outlet and motorway facilities at the Wakehurst Parkway • Tunnel support facility at Frenchs Forest.	outlet and motorway facilities on future elevated receptors are not expected at this location. Further discussion on elevated receptors is provided below. Northern Beaches Council has adopted the *Northern Beaches Hospital Precinct Structure Plan* (2017b) which provides the overarching strategic land use planning framework for the area surrounding the Northern Beaches Hospital precinct. Part of the project would be located within the area covered by the structure plan, including the connection from the Wakehurst Parkway to Warringah Road in Frenchs Forest. The project would support the future land use planning framework that is envisioned under the structure plan and would improve connectivity to and from the Northern Beaches Hospital precinct.

The project would involve the operation of ventilation outlets and motorway facilities at the Warringah Freeway, Gore Hill Freeway, Burnt Bridge Creek Deviation and the Wakehurst Parkway (refer to Chapter 5 (Project description)).

Table 20-7 identifies land use zones and applicable height restrictions, if any, in an area of around 300 metres from each of the project ventilation outlets. It also outlines potential implications for existing and future land use planning.

The permanent changes in land use due to the project would also have the potential to result in indirect impacts associated with traffic and transport, noise and vibration, air quality and social and economic values. Consideration of these impacts is provided in Chapter 9 (Operational traffic and transport), Chapter 11 (Operational noise and vibration), Chapter 12 (Air quality) and Chapter 21 (Socio-economics). The air quality impact assessment (refer to Chapter 12) and the human health impact assessment (refer to Chapter 13) demonstrate that operation of the motorway facilities and ventilation outlets would not result in unacceptable air quality impacts or an unacceptable impact to human health for existing or future buildings (including elevated receptors) up to a height of 20 metres in the vicinity of the proposed ventilation outlets. However, there would be potential impacts for any future buildings above 20 metres in height and within 300 metres of the outlets that would need to be considered by the relevant local council as part of future development applications (refer to Chapter 12 (Air quality)).

Table 20-7 Existing building height restrictions around project ventilation outlets and motorway facilities

Ventilation outlet	Relevant land use zones within 300 metres of the ventilation outlet	Existing height restrictions within 300 metres of the ventilation outlet	Potential implications for existing and future planning controls
Ventilation outlet at the Warringah Freeway	Land use zones for the area around the ventilation outlet at the Warringah Freeway are shown in Figure 20-1 and include the following within 300 metres of the ventilation outlet: • Predominantly R4 High Density Residential and R3 Medium Density Residential, with some pockets of R2 Low Density Residential • A small area of B4 Mixed Use zone at the western end of Military Road • Several areas of SP2 Infrastructure, including education facilities, places of worship and road infrastructure • Areas of RE1 Public Recreation (including ANZAC Park, St Leonards Park and the Cammeray Golf Course).	Building height restrictions applicable to land around the ventilation outlet at the Warringah Freeway under the North Sydney LEP 2013 include: • A maximum of 12 metres for most land zoned R4 High Density Residential, with some pockets up to 16 metres around Military Road on the eastern side of the Warringah Freeway • A maximum of 8.5 metres for most land zoned R3 Medium Density Residential, with a single site on Lytton Street permitted up to 11 metres • A maximum of 8.5 metres for land zoned R2 Low Density Residential • A maximum of 16 metres for land zoned B4 Mixed Use • Maximum heights for land zoned SP2 Infrastructure (education establishments and places of worship) consistent with surrounding residential zones, being either 8.5 metres or 12 metres. There are no height limits imposed on SP2 Infrastructure (road infrastructure) zones.	All land use zones within 300 metres of the ventilation outlet, where habitable residential or commercial structures would be permissible, currently have height restrictions of less than 20 metres. Where height restrictions do not exist, particularly in RE1 Public Recreation and SP2 Infrastructure (road infrastructure) zones, development of elevated habitable structures would either be prohibited or inconsistent with the aims of the zone. No additional development controls would be required to manage the interaction between the operation of the ventilation outlet and currently permissible habitable structures in the area. However, if zoning and/or development controls were to be reviewed in the future, the potential for interactions between the project and future development for buildings above 20 metres and within 300 metres of the ventilation outlet would need to be considered.

Ventilation outlet	Relevant land use zones within 300 metres of the ventilation outlet	Existing height restrictions within 300 metres of the ventilation outlet	Potential implications for existing and future planning controls
Ventilation outlet and motorway facilities at the Gore Hill Freeway	Land use zones for the area around the ventilation outlet and motorway facilities at the Gore Hill Freeway are shown in Figure 20-2 and include the following within 300 metres of the ventilation outlet: • Predominantly R3 Medium Density Residential and R2 Low Density Residential to the north and east of the ventilation outlet • Predominantly IN1 General Industrial and IN2 Light Industrial to the south of the ventilation outlet • Pockets of RE1 Public Recreation (including Artarmon Park, Artarmon Reserve and Naremburn Park) • SP2 Infrastructure along the T1 North Shore and Western rail line and T9 Northern rail line and the Gore Hill Freeway corridor.	Building height restrictions applicable to land around the ventilation outlet and motorway facilities at the Gore Hill Freeway under the Willoughby LEP 2012 include: • Maximum heights of 8.5 metres, nine metres and 12 metres for land zoned R3 Medium Density Residential or R2 Low Density Residential, depending on location • No specified height restriction for land zoned IN1 General Industrial, IN2 Light Industrial, RE1 Public Recreation or SP2 Infrastructure.	All land use zones within 300 metres of the ventilation outlet, where habitable residential structures would be permissible, currently have height restrictions of less than 20 metres. Although it is possible that industrial development could be carried out at heights greater than 20 metres in the IN1 General Industrial or IN2 Light Industrial zones, it is anticipated that development at this height would either be undesirable or unlikely to include habitable spaces at or about 20 metres. For other land use zones, particularly in RE1 Public Recreation and SP2 Infrastructure (road infrastructure) zones, development of elevated habitable structures would either be prohibited or inconsistent with the aims of the zone. No additional development controls would be required to manage the interaction between the operation of the ventilation outlet and currently permissible habitable structures in the area. However, if zoning and/or development controls were to be reviewed in the future, the potential for interactions between the project and future development for buildings above 20 metres and within 300 metres of the ventilation outlet would need to be considered.

Ventilation outlet	Relevant land use zones within 300 metres of the ventilation outlet	Existing height restrictions within 300 metres of the ventilation outlet	Potential implications for existing and future planning controls
Ventilation outlet and motorway facilities at the Burnt Bridge Creek Deviation	Land use zones for the area around the ventilation outlet and motorway facilities at the Burnt Bridge Creek Deviation are shown in Figure 20-4 and include the following within300 metres of the ventilation outlet: • Predominantly R1 General Residential to the south and R2 Low Density Residential to the north • Areas of RE1 Public Recreation comprising the Balgowlah Golf Course site, several local parks and the riparian zone along Burnt Bridge Creek • SP2 Infrastructure along the Burnt Bridge Creek Deviation.	Building height restrictions under the Manly LEP 2013 and Warringah LEP 2011 include: • A maximum of 8.5 metres for land zoned R1 General Residential and R2 Low Density Residential in both local government areas • No specified height restriction for land zoned RE1 Public Recreation, or SP2 Infrastructure.	All land use zones within 300 metres of the ventilation outlet, where habitable residential structures would be permissible, currently have height restrictions of less than 20 metres. Where height restrictions do not exist, particularly in RE1 Public Recreation and SP2 Infrastructure (road infrastructure) zones, development of elevated habitable structures would either be prohibited or inconsistent with the aims of the zone. No additional development controls would be required to manage the interaction between the operation of the ventilation outlet and currently permissible habitable structures in the area. However, if zoning and/or development controls were to be reviewed in the future, the potential for interactions between the project and future development for buildings above 20 metres and within 300 metres of the ventilation outlet would need to be considered. The new and improved open space and recreation facilities at Balgowlah would not be restricted by the ventilation outlet.

Ventilation outlet	Relevant land use zones within 300 metres of the ventilation outlet	Existing height restrictions within 300 metres of the ventilation outlet	Potential implications for existing and future planning controls
Ventilation outlet and motorway facilities at the Wakehurst Parkway	Land use zones for the area around the ventilation outlet and motorway facilities at the Wakehurst Parkway are shown in Figure 20-5 and include the following within 300 metres of the ventilation outlet: • R2 Low Density Residential predominantly to the south, but with some small areas to the north of the ventilation outlet • Mainly E1 National Parks and Nature Reserves and E2 Environmental Conservation to the west of the ventilation outlet • Mainly RE1 Public Recreation (Manly Dam Reserve) to the east of the ventilation outlet, with a pocket (Seaforth Oval) to the south and an area of RE2 Private Recreation at the Seaforth Bowling Club • SP2 Infrastructure along the Wakehurst Parkway corridor.	Building height restrictions under the Manly LEP 2013 and Warringah LEP 2011 include: • A maximum of 8.5 metres for land zoned R2 Low Density Residential in both local government areas • No specified height restriction for land zoned RE1 Public Recreation, RE2 Private Recreation, E1 National Parks and Nature Reserves, E2 Environmental Conservation or SP2 Infrastructure.	All land use zones within 300 metres of the ventilation outlet which habitable residential structures would be permissible currently have height restrictions of less than 20 metres. Development of elevated habitable structures in other relevant land use zones is either prohibited, unlikely to be desirable, or inconsistent with the aims of the zone. No additional development controls would be required to manage the interaction between the operation of the ventilation outlet and currently permissible habitable structures in the area. However, if zoning and/or development controls were to be reviewed in the future, the potential for interactions between the project and future development for buildings above 20 metres and within 300 metres of the ventilation outlet would need to be considered.

Changes in public open space

The following public open space areas would be impacted during construction and operation:

- Cammeray Golf Course
- Flat Rock Reserve
- Artarmon Park
- Spit West Reserve
- Balgowlah Golf Course.

The temporary construction support sites at Flat Rock Reserve and Spit West Reserve would not be needed to operate the project and would be rehabilitated and returned to an equivalent state as soon as practicable at the completion of construction. The project would not impact the ability of these areas to be used in a manner consistent with their existing use as public open space.

Changes in public open space during operation of the project would be limited to the Cammeray and Balgowlah golf courses and Artarmon Park.

As discussed in Table 20-4 and Table 20-6, the changes at Cammeray Golf Course would be managed to ensure it is able to continue to be used for golf-related activities, albeit in a modified form.

The changes at Balgowlah Golf Course due to the project would preclude the continued operation of the golf course. As discussed in Table 20-4 and Table 20-6, engagement with Northern Beaches Council has identified potential for the residual land to be developed as open space and recreation facilities that better address the local government area's current and future needs. A dedicated consultation process jointly led by Transport for NSW and Northern Beaches Council would take place to give the community an opportunity to provide input on the final layout of the new and improved open space and recreation facilities at Balgowlah. As part of this consultation process, a community working group would be established, with representative stakeholder groups and the community, to support Transport for NSW and Northern Beaches Council with the development of this important public space.

Along with residual land from properties acquired along Dudley Street, the project would progressively return an area, equivalent to around 90 per cent of the current open space, to the community as new and improved public open space and recreation facilities (refer to Figure 20-11).

As discussed in Table 20-4, changes at Artarmon Park would be limited to the conversion of a portion of land adjacent to the Gore Hill Freeway zoned for public recreation for permanent project infrastructure. This change would not impact the long term viability of the remainder of Artarmon Park, as the impacted area is steeply sloped and vegetated with dense scrub. The adjacent and much larger Artarmon Reserve would not be impacted.

Land managed by the former Office of Environment and Heritage

The *Guidelines for developments adjoining land and water managed by the Office of Environment and Heritage* aim to provide advice to avoid and minimise any direct or indirect adverse impacts on land and water bodies managed by the former the Office of Environment and Heritage (now the Department of Planning, Industry and Environment (Environment, Energy and Science)).

These guidelines have been prepared for use by councils and other planning authorities when they assess development applications. While Clause 94 of the State Environmental Planning Policy (Infrastructure) 2007 provides for development for the purpose of road or road infrastructure facilities to be permissible without consent, as part of best practice, these guidelines have been considered in Table 20-.

Table 20-8 Issues to be considered for projects adjoining Office of Environment and Heritage land

Issues to be considered for projects adjoining Office of Environment and Heritage land	Where addressed in the EIS
Erosion and sediment control	An assessment of the project's impact on soil and land resources, with particular emphasis on soil erosion and sediment transport, is provided in Chapter 16 (Geology, soils and groundwater). Chapter 17 (Hydrodynamics and water quality) assesses the potential impacts on surface water with regard to erosion, siltation, and bank stability. Impacts from scour and erosion on geomorphology are also discussed.
Stormwater runoff	Minimising the effects of proposed stormwater and wastewater management on natural hydrological attributes and on the existing capacity of stormwater systems is described in Chapter 17 (Hydrodynamics and water quality).
Wastewater	The effects of proposed stormwater and wastewater management on surface water quality are assessed in Chapter 17 (Hydrodynamics and water quality). Information on wastewater discharge, including volumes and rates of discharge, are also discussed.
Management implications relating to pests, weeds, and edge effects	Impacts to terrestrial flora, including edge effects, spread of weeds and pathogens is discussed in Chapter 19 (Biodiversity).
Fire and the location of asset protection zones	An assessment of bushfire risks relating to construction and operation is presented in Chapter 23 (Hazards and risks).
Boundary encroachments and access through Office of Environment and Heritage land	The project would not encroach on or require access though Office of Environment and Heritage land.
Visual, odour, noise, vibration, air quality and amenity impacts	Consideration of these impacts is provided in Chapter 8 (Construction traffic and transport), Chapter 10 (Construction noise and vibration), Chapter 11 (Operational noise and vibration), Chapter 12 (Air quality), Chapter 21 (Socio-economics) and Chapter 22 (Urban design and visual amenity). Possible noise, vibration, dust and light spill impacts to native fauna species are discussed in Chapter 19 (Biodiversity).
Threats to ecological connectivity and groundwater-dependent ecosystems	Habitat connectivity is addressed in Chapter 19 (Biodiversity). Impacts to groundwater dependent ecosystems are considered in Chapter 16 (Geology, soils and groundwater) and Chapter 19 (Biodiversity).
Cultural heritage	Impacts to non-Aboriginal heritage are assessed in Chapter 14 (Non-Aboriginal heritage) and impacts to Aboriginal heritage are assessed in Chapter 15 (Aboriginal heritage).

20.5 Environmental management measures

The project has been designed to minimise the requirement for property acquisition as far as practical and optimise the use of land already owned by Transport for NSW. Measures to avoid, minimise or manage land use and property impacts as a result of the project are detailed in Table 20-9.

Additional environmental management measures relevant to the management of land use impacts are also outlined in other chapters of the environmental impact statement, including:

- Chapter 8 (Construction traffic and transport)
- Chapter 9 (Operational traffic and transport)
- Chapter 10 (Construction noise and vibration)
- Chapter 11 (Operational noise and vibration)
- Chapter 12 (Air quality)
- Chapter 13 (Human health)
- Chapter 21 (Socio-economics)
- Chapter 22 (Urban design and visual amenity).

Table 20-9 Environmental management measures - land use and property

Ref	Phase	Impact	Environmental management measure	Location
LP1	All phases	Changes to lease arrangements	Transport for NSW will consult with existing lease holders of properties that will be directly affected by the project regarding any changes to lease arrangements.	BL/GHF
LP2	All phases	Residual land	Identification of residual land of the project will be confirmed during further design development and construction planning. Appropriate strategies for the ongoing management and/or divestment of the residual land will consider the location, land use characteristics, area and adjacent land uses.	BL/GHF
LP3	Pre-construction and construction	Property acquisition	Land acquisition for the project will be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, the *Roads and Maritime Services land acquisition information guide* (Roads and Maritime Services, 2014) and *Fact sheet: Property acquisition of subsurface lands* (Roads and Maritime Services, 2015) and in accordance with the land acquisition reforms announced by the NSW Government in 2016. Transport for NSW will appoint a Personal Manager – Acquisition to help landowners and residents who may be affected by acquisition for the project.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			The Personal Manager – Acquisition will be in regular contact with these individuals to provide updates on the project and respond to questions and queries. Should acquisition for the project be confirmed for a particular property, the Personal Manager – Acquisition will work with the affected landowners and residents to offer assistance and support throughout the acquisition and relocation process.	
LP4	Pre-construction and construction	Residual land at Balgowlah	A dedicated consultation process jointly led by Transport for NSW and Northern Beaches Council will take place to give the community an opportunity to provide input on the final layout of the new and improved open space and recreation facilities at Balgowlah. This process will start after the environmental impact statement public exhibition period and well in advance of construction commencing. As part of this consultation process, a community reference group will be established, with representative stakeholder groups and the community, to support Transport for NSW and Northern Beaches Council with the development of this important public space.	BL (Balgowlah)
LP5	Construction	Temporary use of land	Land subject to temporary use, including areas of public open space, will be rehabilitated as soon as practicable to an appropriate condition, taking into consideration the location, land use characteristics, area and adjacent land uses or in accordance with the urban design and landscape plan where applicable (environmental management measure V1). Rehabilitation will be carried out in consultation with the relevant landowner, the local council and community (where appropriate).	BL/GHF
LP6	Construction	Access impediments to private property	Where impacts to private property access is unavoidable during construction, landowners or lease holders/tenants where appropriate will be consulted in advance to develop appropriate alternative access arrangements.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
LP7	Operation	Air quality impacts for elevated receivers located around ventilation outlets and motorway facilities	Transport for NSW will assist Northern Beaches Council, North Sydney Council, Willoughby City Council, and the Department of Planning, Industry and Environment (as appropriate) in determining relevant land use considerations applicable to future development in the immediate vicinity of ventilation outlets for inclusion in local environmental plans or development control plans, where required, to manage interactions between the project and future development. This may include procedures for identifying the requirement for consultation with Transport for NSW.	BL/GHF

Beaches Link = BL, Gore Hill Freeway Connection = GHF

NSW GOVERNMENT

Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Chapter 21

Socio-economics

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21 Socio-economics

This chapter considers the potential impacts of the project on socio-economic issues from the construction and operation of the project and identifies management measures which address these impacts.

A detailed socio-economic assessment has been carried out for the project and is included in Appendix U (Technical working paper: Socio-economic assessment).

The Secretary's environmental assessment requirements as they relate to socio-economic issues and where in the environmental impact statement these have been addressed, are in Table 21-1.

Avoiding or minimising impacts has been a key consideration throughout the design and development process for the Beaches Link and Gore Hill Freeway Connection project. A conservative approach has generally been used in the assessments, with potential impacts presented before implementation of environmental management measures. The environmental management measures proposed to minimise the potential impacts in relation to socio-economics are included in Section 21.6.

Table 21-1 Secretary's environmental assessment requirements – Socio-economic

Secretary's requirement	Where addressed in EIS
Socio-economic, Land Use and Property	
1. The Proponent must assess social and economic impacts (of all phases of the project) in accordance with the current guidelines (including cumulative construction and operational impacts of the proposal and major projects in the vicinity of the project) and in consultation with relevant land owners (such as the Ports Authority of NSW and those land owners whose property is being acquired).	Socio economic impacts as a result of the project are presented in **Section 21.4** and **Section 21.5**. **Chapter 27** (Cumulative impacts) assesses the cumulative construction and operational impacts of the project and major projects in the vicinity of the project. A summary of consultation conducted for the project is provided in **Chapter 7** (Stakeholder and community engagement) and **Section 21.2.3**.
2. The Proponent must assess impacts from construction and operation on potentially affected properties, businesses, recreational users and land and water users, including amenity impacts (including from cumulative and extended construction time frames and construction fatigue), property acquisitions/adjustments, future land uses, access, relevant statutory rights, and community severance and barrier impacts resulting from the project.	Impacts to properties, including property acquisitions and future land uses during construction and operation, is discussed in **Chapter 20** (Land use and property). **Section 21.4** and **Section 21.5** present the socio-economic impacts as a result of the project. **Chapter 27** (Cumulative impacts) assesses the cumulative construction and operational impacts of the proposal and major projects in the vicinity of the project.
3. Where an immersed tube method (IMT) of construction is proposed for use in Middle Harbour, the Proponent must: a. provide details of how reductions to current Harbour depths will be avoided;	**Section 5.2.3** of **Chapter 5** (Project description) describes how, due to the profile of the harbour bed of Middle Harbour, the immersed tube tunnel units would sit both partially within a trench and above the bed of the Middle Harbour. **Section 9.4.4** of **Chapter 9** (Operational traffic and transport) indicates that shallow water depths at the entrance to Middle Harbour control

Secretary's requirement	Where addressed in EIS
	navigation in the vicinity of the proposed tunnel crossing. The tops of the immersed tube tunnels would not interfere with or restrict maritime activities.
b. provide details confirming the level of protection for the IMTs will be similar to or better than that of the existing Sydney Harbour Tunnel;	As discussed in **Chapter 6** (Construction work), an additional concrete layer would be provided to protect the top of the completed tunnel units from marine activities during operation, including falling or dragging anchors. **Section 23.3.4** of **Chapter 23** (Hazards and risks) details the risks associated with interactions between maritime traffic and the immersed tube tunnels. **Chapter 4** (Project development and alternatives) provides a justification for selection of the immersed tube tunnel method for the crossing of Middle Harbour.
c. identify impacts to ship scheduling in consultation with the Harbour Master; and	Due to depths constraints at the entrance to Middle Harbour, shipping does not occur in locations where construction works are proposed. **Chapter 8** (Construction traffic and transport) and **Chapter 9** (Operational traffic and transport) outline impacts related to the construction and operation of the immersed tube tunnel respectively. **Chapter 8** (Construction traffic and transport) specifies the consultation requirements with the Harbour Master to minimise impacts during construction. Impacts of closures in Middle Harbour on businesses are discussed in **Section 21.4**, **Section 21.5.6** and **Appendix U** (Technical working paper: Socio-economic assessment), including Annexure B.
d. provide details of full mission simulation which takes in account, movement of tunnel units past the Spit Bridge and within Middle Harbour.	Outcomes of the simulation report are outlined in **Section 8.4.3** of **Chapter 8** (Construction traffic and transport).
4. The Proponent must assess potential impacts on utilities (including communications, electricity, gas, fuel and water and sewerage) and the relocation of these utilities.	**Chapter 5** (Project description) outlines utilities and services management for the project and **Appendix D** (Utilities management strategy) provides a detailed description of utilities likely to be impacted and a framework for utility installations, relocations, adjustments and protection.
5. Where the project is predicted to impact on utilities the Proponent must undertake a utilities management strategy, identifying management options, including relocation or adjustment of the utilities.	**Appendix D** (Utilities management strategy) provides a detailed description of utilities likely to be impacted and a framework for utility installations, relocations, adjustments and protection.

Secretary's requirement	Where addressed in EIS
6. A draft Community Consultation Framework must be prepared identifying relevant stakeholders, procedures for distributing information and receiving/responding to feedback and procedures for resolving stakeholder and community complaints during construction and operation. Key issues that must be addressed in the draft Framework include, but are not limited to: a. traffic management (including property access, pedestrian access); b. landscaping/urban design matters; c. construction activities including out of hours work; and d. noise and vibration mitigation and management.	**Chapter 7** (Stakeholder and community engagement) summarises the content of the Community consultation framework. A Community consultation framework is provided in **Appendix E** (Community consultation framework).

21.1 Legislative and policy framework

The socio-economic assessment has been prepared to assess the impacts of the project in accordance with the *Environmental Impact Assessment Practice Note – Socio-economic assessment (EIA-N05)* (Practice Note) (Transport for NSW, 2020e). The Practice Note guides the assessment level and process for socio-economic impact assessments and outlines the requirements for establishing the socio-economic baseline.

Chapter 3 (Strategic context and project need) provides a description of national and state strategic planning and transport policies which are relevant to the project. Local council policies relevant to the socio-economic impacts of the project include:

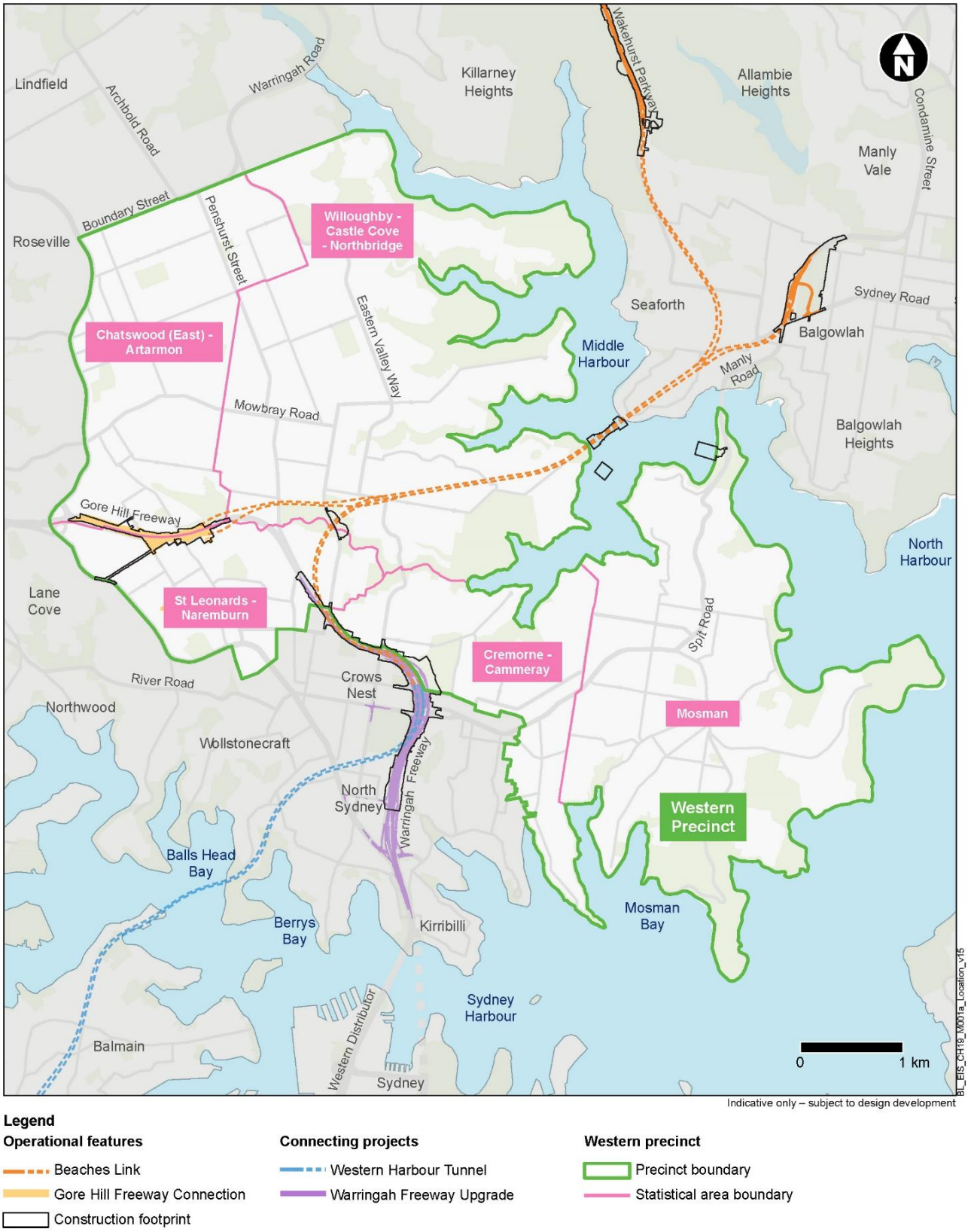
- *North Sydney Community Strategic Plan 2013-2023* (North Sydney Council, 2013)
- *Willoughby City Strategy* (Willoughby City Council, 2013)
- *Shape 2028 Northern Beaches Draft Community Strategic Plan 2017-2028* (Northern Beaches Council, 2018b)
- *Mosman Council Community Strategic Plan 2013-2023* (Mosman Council, 2013).

The project would generally support the actions of these plans by reducing congestion, improving travel times and enhancing the reliability of the road network across Sydney and improving access to and from the north, north-east and north-west of Sydney.

21.2 Assessment methodology

21.2.1 Precinct areas

The socio-economic assessment considers precincts including adjacent waterways, and comprises the Australian Bureau of Statistics (ABS) geographic boundaries (referred to as Statistical Area Level 2s) (SA2s). For the purposes of this assessment, two 'precincts' have been identified located to the north-east and south-west of Middle Harbour, referred to as the Western Precinct (Figure 21-1) and Eastern Precinct (Figure 21-2) Broader regional impacts were also considered, where relevant.



Legend

Operational features

- Beaches Link
- Gore Hill Freeway Connection
- Construction footprint

Connecting projects

- Western Harbour Tunnel
- Warringah Freeway Upgrade

Western precinct

- Precinct boundary
- Statistical area boundary

Figure 21-1 Western Precinct

Note: Apart from the motorway facilities, cut and cover structures and tunnelling works in Cammeray, the construction footprint shown on the Warringah Freeway would consist of low impact activities such as traffic control and management, line marking and staged surface roadworks tie-in works, and utility and cable works required to connect to the Western Harbour Tunnel and Warringah Freeway Upgrade project and other local roads.

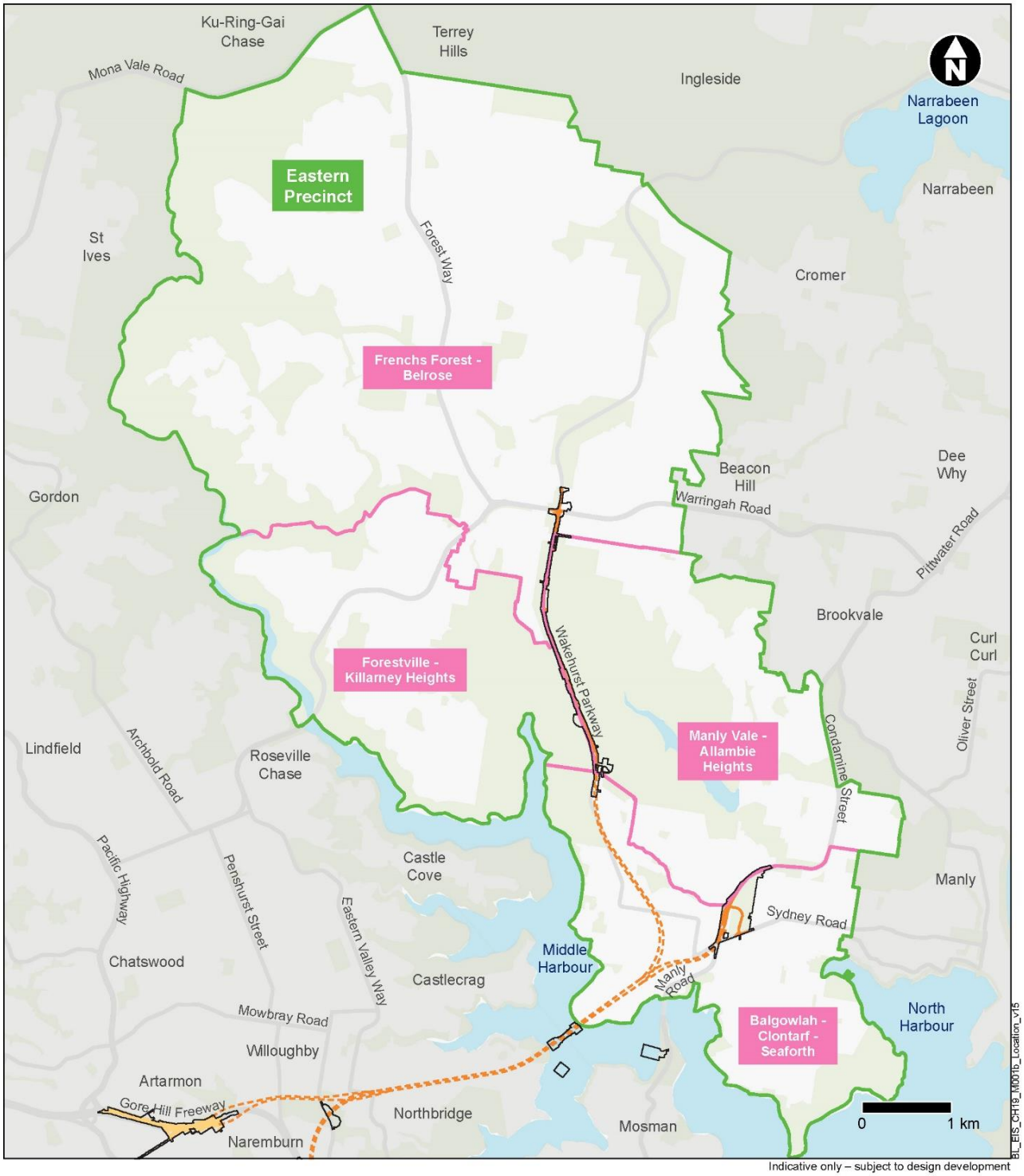


Figure 21-2 Eastern Precinct

21.2.2 Business surveys

A business impact survey was used to inform the business impact assessment to gain a better understanding of the main issues, perceptions and concerns of businesses regarding the project during both construction and operation. The business surveys were conducted in business centres that may be more susceptible to direct or indirect effects of construction and/or operation. All information gathered as part of the business surveys was collated into a database, analysed and summarised in a survey report. Further details are provided within the business impact assessment in Annexure A of Appendix U (Technical working paper: Socio-economic assessment). Further engagement with business stakeholders will be carried out during the environmental impact assessment exhibition period.

21.2.3 Stakeholder consultation

Community and stakeholder engagement, including consultation with relevant land owners (such as the Port Authority of NSW and land owners whose property is being acquired), local communities, businesses and government agencies, has informed the project's development. The socio-economic assessment has been informed by the outcomes of this engagement, including the identification of existing features and values important to the communities considered, and assessment of potential benefits and impacts of the project.

Further details regarding consultation carried out for the project (up to exhibition of the environmental impact statement) is provided in Chapter 7 (Stakeholder and community engagement).

21.2.4 Assessment approach

The socio-economic impact assessment involved identifying, assessing and evaluating changes to, or impacts on, communities, businesses and industry that are likely to occur as a result of the project. The assessment involved:

- Scoping the likely range of potential socio-economic impacts and identifying businesses and communities likely to be affected by the project
- Describing existing socio-economic and business characteristics, values and conditions in the study area. The description of existing socio-economic conditions principally draws on information from the ABS Census of Population and Housing 2016, supplemented with information and data from other publicly available sources and project specialist investigations
- Identifying and evaluating changes to existing socio-economic and business conditions and values in the study area due to the project's construction and operation. Positive and negative social and economic impacts are discussed; however, only negative impacts are assigned a level of significance, in accordance with the process outlined in the Practice Note. The level of significance of potential negative impacts was assessed by considering the sensitivity of the receptor and the magnitude of the proposed works. An evaluation matrix was used to identify the level of significance of the negative impact. Further information on the evaluation matrix is provided in Section 21.2.5. Positive impacts are qualitatively discussed but have not been assigned a level of significance using the evaluation matrix. The assessment considered potential project benefits and impacts relating to:
    - Property impacts, including impacts of property acquisition and temporary lease of property for construction
    - Equity, including the distribution of project benefits and impacts
    - Potential changes to population and demography
    - Employment, including direct and indirect employment impacts
    - Business and industry, including from direct property impacts and changes in the local business environment

- Social infrastructure, including from property acquisition, temporary lease of land, and changes in local access and connectivity and amenity
- Community values, including changes to local amenity, community cohesion, local character and identity, health and safety, and environmental and natural features
- Changes to access and connectivity, including for pedestrians, cyclists, public transport users, maritime transport users, and motorists

- Identifying measures to avoid, minimise or mitigate impacts on communities and community infrastructure and business and industry arising from the project.

21.2.5 Evaluation of significance

Potential negative impacts during project construction and operation have been considered using Table 21-2. The level of significance was determined with consideration of the sensitivity of the existing environment and magnitude of impact compared to the baseline condition. For the methodology adopted, a level of significance has only been assigned to potential negative impacts. Appendix U (Technical working paper: Socio-economic assessment) outlines what qualities contribute to the level of sensitivity for a receiver. The magnitude of an impact is dependent on its scale, intensity, duration and scope of works. When assessing the level of significance of negative impacts, consideration was given to:

- The range of potential direct and indirect impacts during construction and operation
- Cumulative impacts with other projects.

Table 21-2 Assessing the level of significance

		Magnitude			
		High	**Moderate**	**Low**	**Negligible**
Sensitivity	**High**	High impact	High-moderate impact	Moderate impact	Negligible impact
	Moderate	High-moderate impact	Moderate impact	Moderate-low impact	Negligible impact
	Low	Moderate impact	Moderate-low impact	Low impact	Negligible impact
	Negligible	Negligible impact	Negligible impact	Negligible impact	Negligible impact

21.3 Existing environment

This section provides an overview of the socio-economic characteristics of the two precinct areas assessed with regards to demographic profiles and housing, social infrastructure, community values, employment centres, and access and connectivity.

The existing environment with regard to traffic and transport, noise and vibration, air quality, human health, land use and property and urban design and visual amenity are outlined in Chapter 8 (Construction traffic and transport), Chapter 9 (Operational traffic and transport), Chapter 10 (Construction noise and vibration), Chapter 11 (Operational noise and vibration), Chapter 12 (Air quality), Chapter 13 (Human health), Chapter 20 (Land use and property) and Chapter 22 (Urban design and visual amenity).

21.3.1 Demographic profile

Table 21-3 provides a summary of the demographic profile of the precinct areas. This information has been sourced from the Australian Bureau of Statistics Census 2016.

Table 21-3 Demographic information for precincts

Characteristics	Western Precinct	Eastern Precinct
Population size and growth	• Population of about 122,694 in 2019 • Annual average growth of 1.5 per cent (2014-2019).	• Population of about 79,838 in 2019 • Annual average growth of 0.7 per cent (2014-2019).
Age profile	• Slightly higher proportion of residents 65 years and older (about 15 per cent) when compared to Greater Sydney (about 14 per cent) • An equal proportion of residents within the young working family of 15-64 years (about 67 per cent) when compared to Greater Sydney (about 67 per cent) • A slightly lower proportion of residents under the age of 14 years (about 18 per cent) when compared to Greater Sydney (about 19 per cent).	• Higher proportion of residents 65 years and older (about 17 per cent) when compared to Greater Sydney (about 14 per cent) • A lower proportion of residents within the young working family of 15-64 years (about 60 per cent) when compared to Greater Sydney (about 67 per cent) • A higher proportion of residents under the age of 14 years (about 23 per cent) when compared to Greater Sydney (about 19 per cent).
Cultural diversity	• About 40.6 per cent of residents were born overseas and 29.9 per cent of people spoke a language other than English • Greater Sydney recorded a lower proportion of people born overseas (about 36.8 per cent) and a higher proportion of people who spoke a language other than English (about 35.8 per cent).	• About 29.8 per cent of residents were born overseas and 16.4 per cent of people spoke a language other than English • Greater Sydney recorded a higher proportion of people born overseas (about 36.8 per cent) and a higher proportion of people who spoke a language other than English (about 35.8 per cent).
Vulnerability/ need for assistance	In 2016, about three per cent of residents needed assistance, compared to about five per cent for Greater Sydney.	In 2016, about 3.7 per cent of residents needed assistance, compared to about five per cent for Greater Sydney.
Dwellings	• In 2016, there were about 46,734 private dwellings, 48.4 per cent of which were apartment style dwellings, which was higher than the Greater Sydney average (25.9 per cent) • Apartment style dwellings were the primary form of housing.	• In 2016, there were about 26,061 private dwellings, 13.1 per cent of which were apartment style dwellings, which was lower than the Greater Sydney average (25.9 per cent) • Separate houses were the primary form of housing, contributing 71.4 per cent compared to Greater Sydney's 52.5 per cent.

Characteristics	Western Precinct	Eastern Precinct
Vehicle ownership	Of occupied private dwellings: • About 13.1 per cent did not own a vehicle • About 46.9 per cent owned one vehicle • About 37.7 per cent owned two or more vehicles.	Of occupied private dwellings: • About 4.5 per cent did not own a vehicle • About 31.6 per cent owned one vehicle • About 61.6 per cent owned two or more vehicles.
Income	Higher personal ($1172 per week) and household median ($2423 per week) incomes compared to Greater Sydney ($719 per week and $1750 per week respectively).	Higher personal ($895 per week) and household median ($2419 per week) incomes compared to Greater Sydney ($719 per week and $1750 per week respectively).
Employment	• Lower rate of unemployment (4.5 per cent) compared to Greater Sydney (6.0 per cent) • In 2016, the top four employment industries within the precinct areas included: • Health care and social assistance • Professional, scientific and technical services • Retail trade • Education and training.	• Lower rate of unemployment (3.8 per cent) compared to Greater Sydney (6.0 per cent) • In 2016, the top four employment industries, within the precinct areas included: • Health care and social assistance • Professional, scientific and technical services • Retail trade • Education and training.
Travel to work	For employed residents within the precinct: • About 39.8 per cent drove to work in a car as either driver or passenger • About 28.4 per cent used public transport to get to work (via rail or bus) • About 7.8 per cent used active transport (walked and/or cycled).	For employed residents within the precinct: • About 57 per cent drove to work in a car as either driver or passenger • About 14 per cent used public transport to get to work (via rail or bus) • About 3.6 per cent used active transport (walked and/or cycled).

21.3.2 Social infrastructure

Social infrastructure in the precinct areas

The precinct areas accommodate a wide range of community services and facilities of local and regional importance including education facilities; health, medical and emergency services; sport, recreation, cultural and leisure facilities; and community facilities. Consideration has also been given to social infrastructure within local government areas where required. These include, but are not limited to:

- Major hospitals such as the Mater Hospital at North Sydney, Royal North Shore and North Shore Private hospitals at St Leonards and the Northern Beaches Hospital at Frenchs Forest
- Tertiary education facilities, including TAFE NSW (at St Leonards and Brookvale) and the Australian Catholic University North Sydney Campus

- Regional and state sport and recreation facilities, such as Garigal National Park, which includes numerous bush walking tracks, Artarmon Reserve, Gore Hill Park, Naremburn Park, Flat Rock Reserve, Bicentennial Reserve and golf courses, including Cammeray Golf Course, Wakehurst Golf Course, Northbridge Golf Course and Balgowlah Golf Course
- Major retail, commercial uses, cultural and community support facilities located within the North Sydney, Mosman, Willoughby and Northern Beaches local government areas.

Social infrastructure near the project

Social infrastructure located near surface works and construction activities is shown in Figure 21-3 to Figure 21-10.

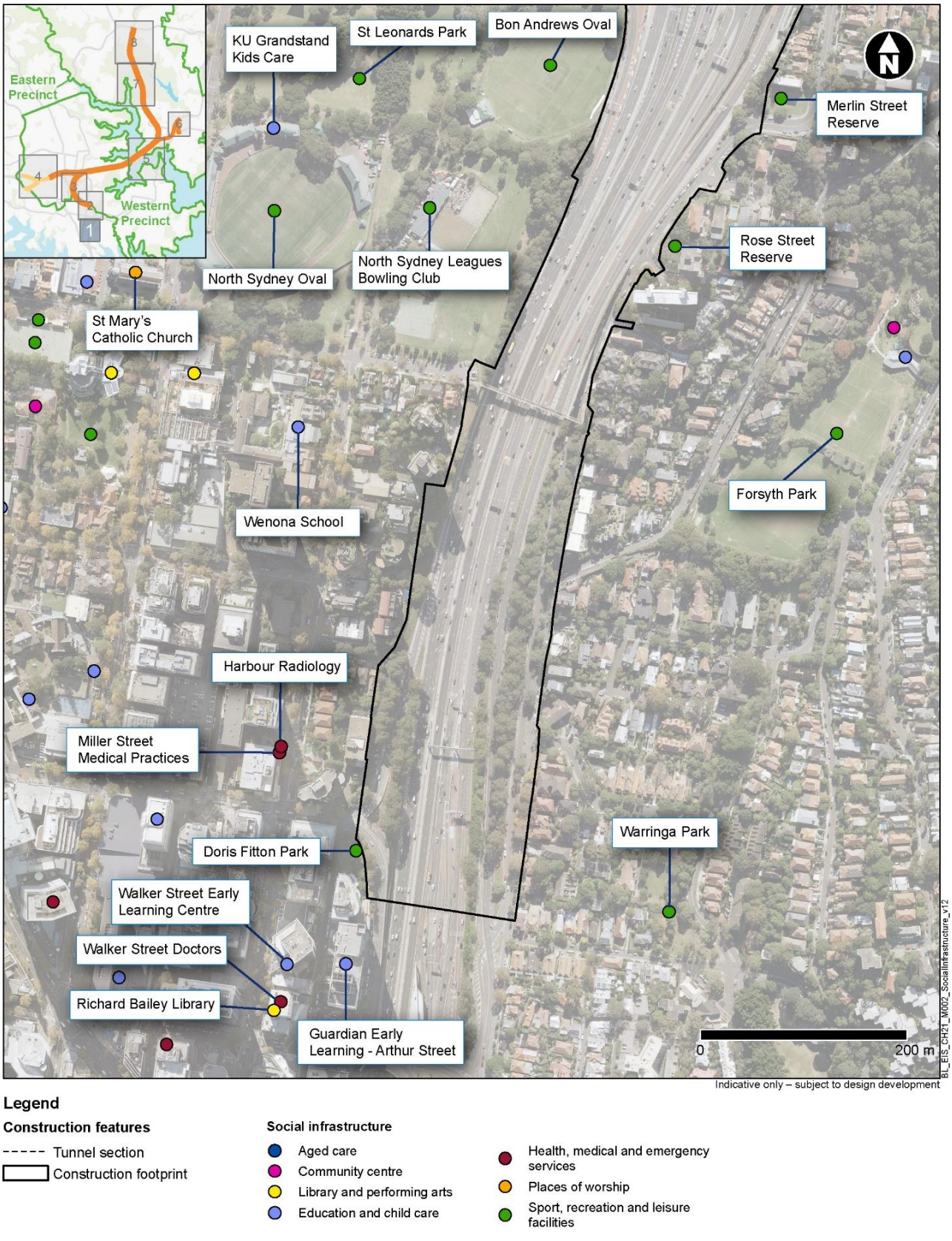


Figure 21-3 Social infrastructure near the project (map 1)

Note: The Beaches Link construction footprint within this area extends to include low impact construction activities that would be associated with traffic control and management, line marking, tie-in works, and utility and cable works.

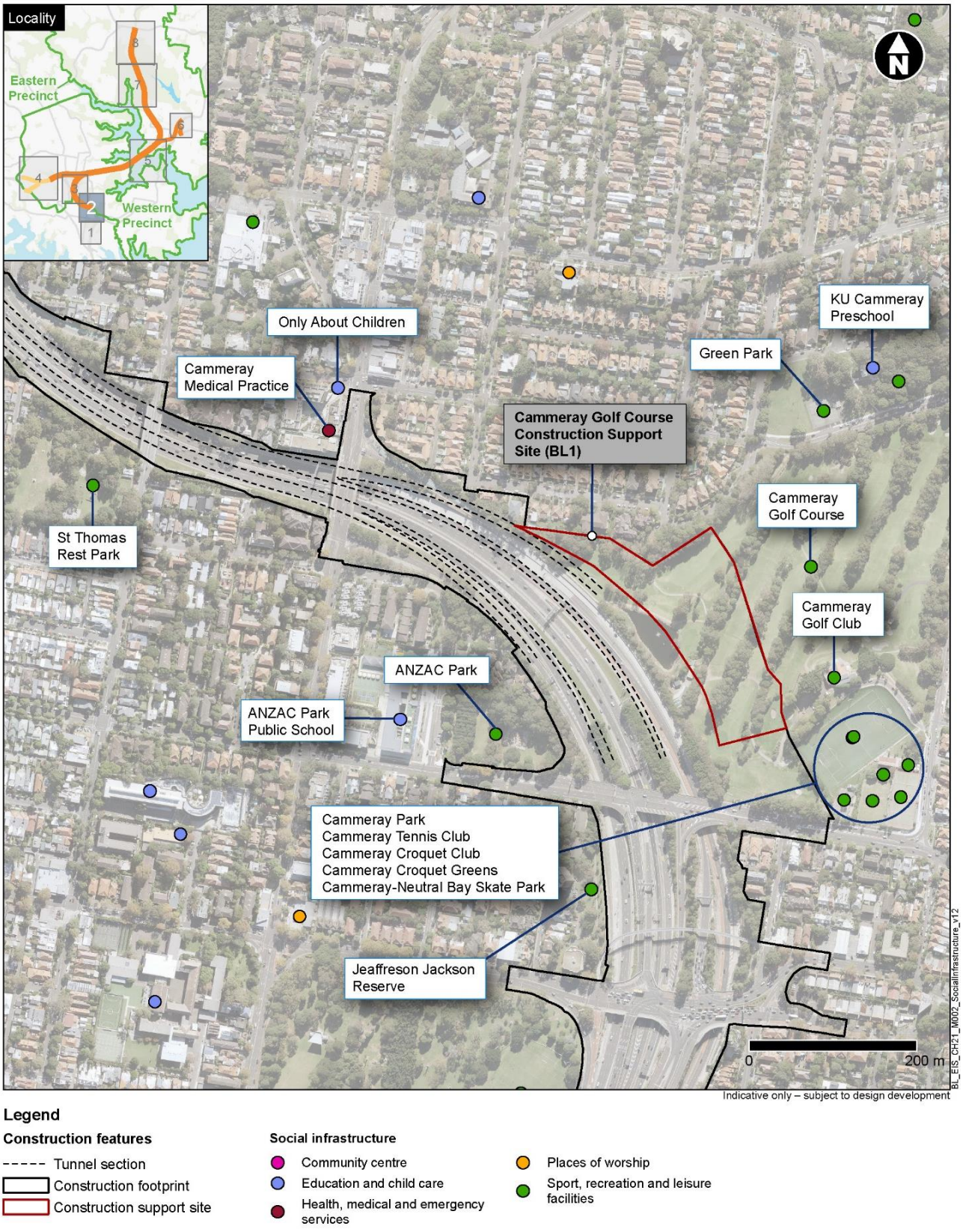


Figure 21-4 Social infrastructure near the project (map 2)

Legend

Construction features

- Tunnel section
- Construction footprint
- Construction support site

Social infrastructure

- Community centre
- Library and performing arts
- Education and child care
- Places of worship
- Sport, recreation and leisure facilities

Figure 21-5 Social infrastructure near the project (map 3)

Note: The Beaches Link construction footprint shown on Warringah Freeway within this area extends to include construction activities that would be associated with traffic control and management, line marking, tie-in works and utility and cable works.

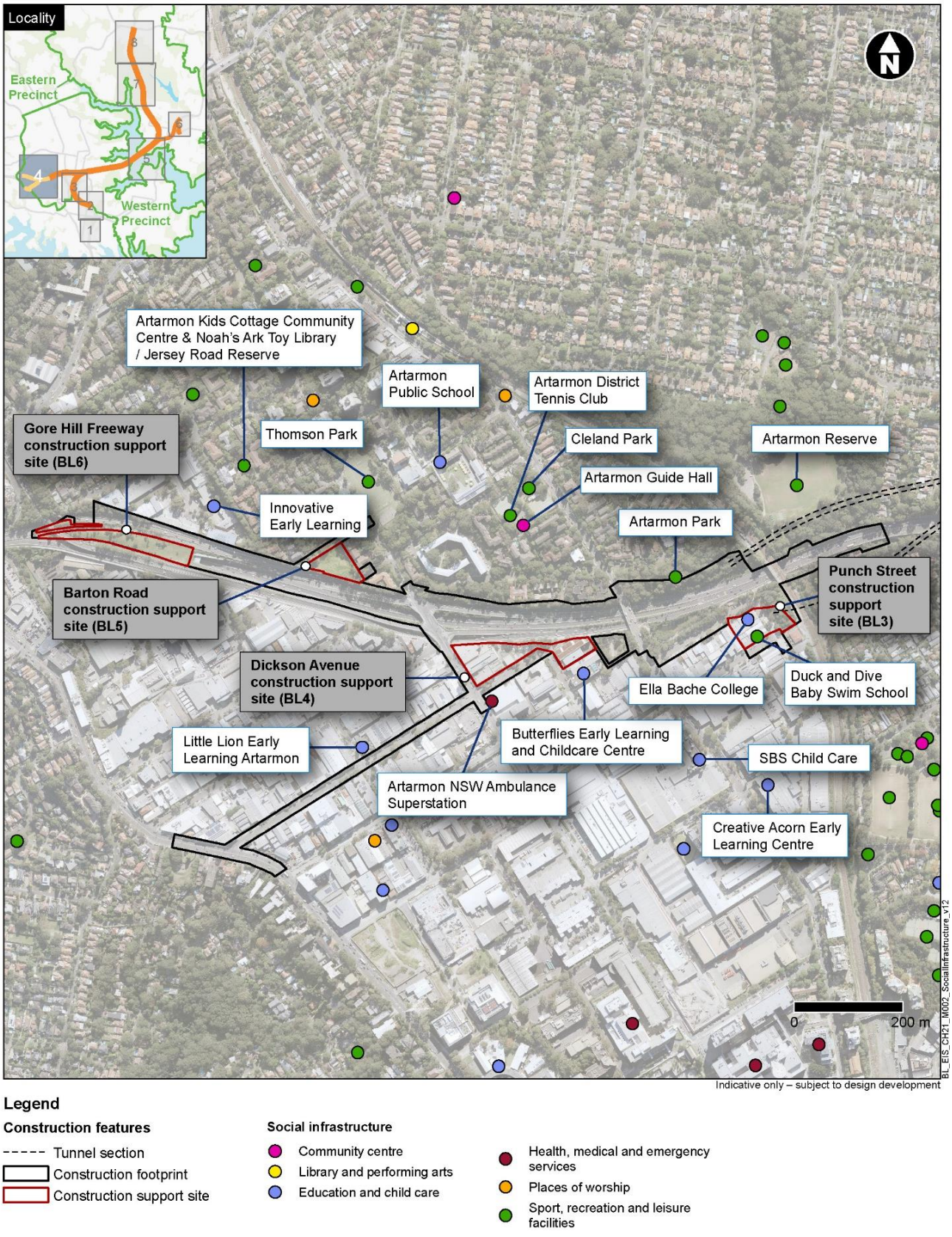


Figure 21-6 Social infrastructure near the project (map 4)

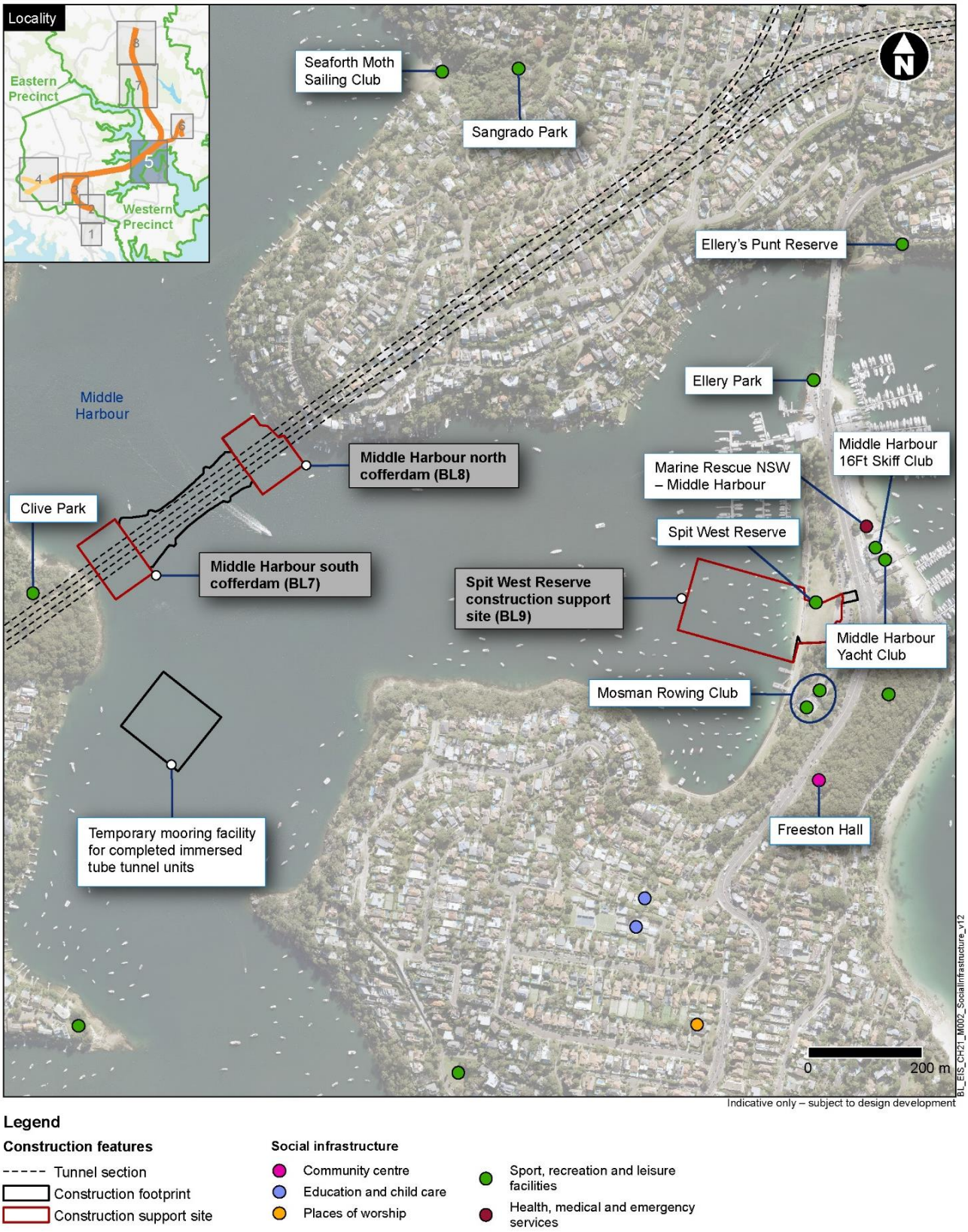


Figure 21-7 Social infrastructure near the project (map 5)

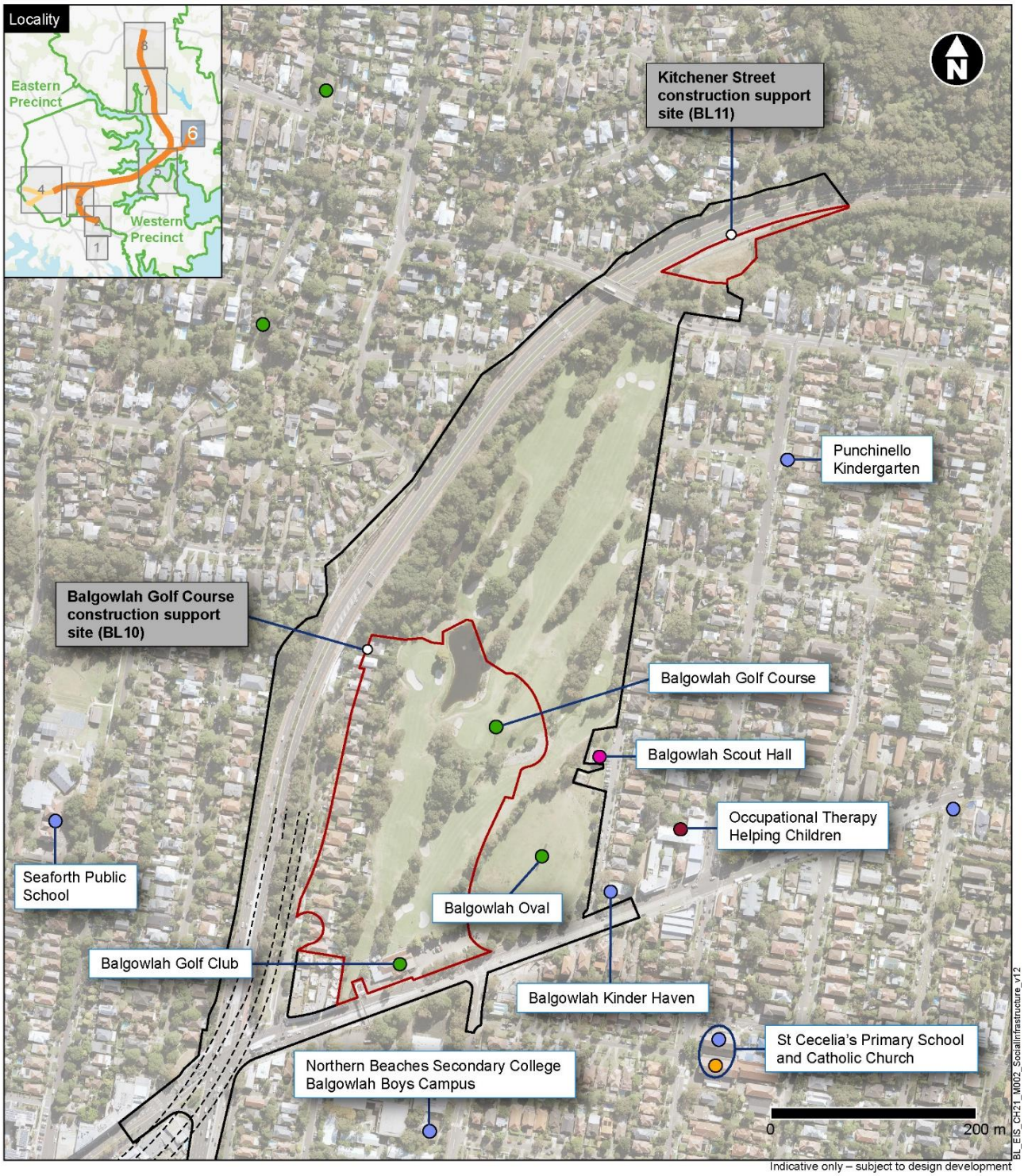
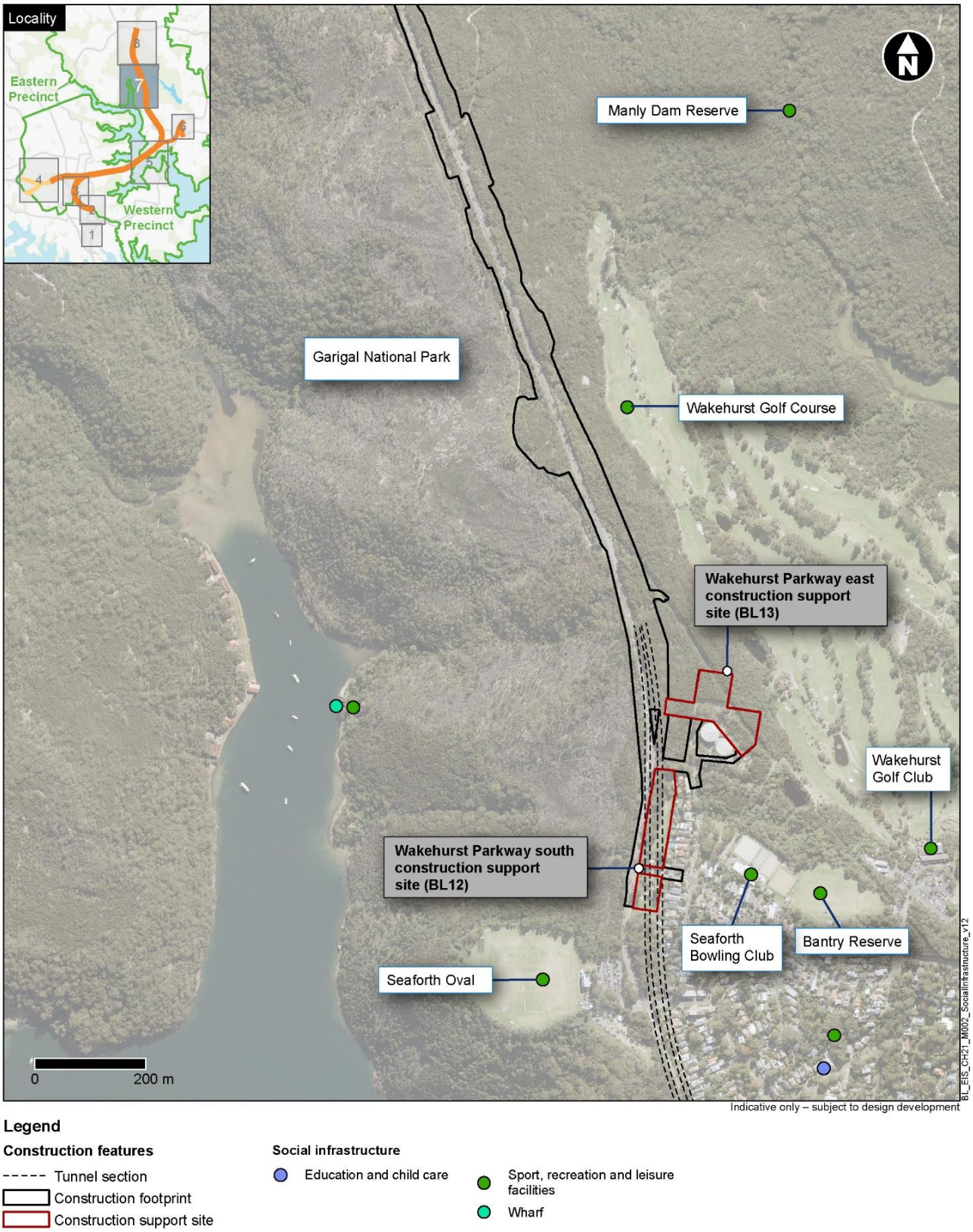


Figure 21-8 Social infrastructure near the project (map 6)



Legend

Construction features

- Tunnel section
- Construction footprint
- Construction support site

Social infrastructure

- Education and child care
- Sport, recreation and leisure facilities
- Wharf

Figure 21-9 Social infrastructure near the project (map 7)

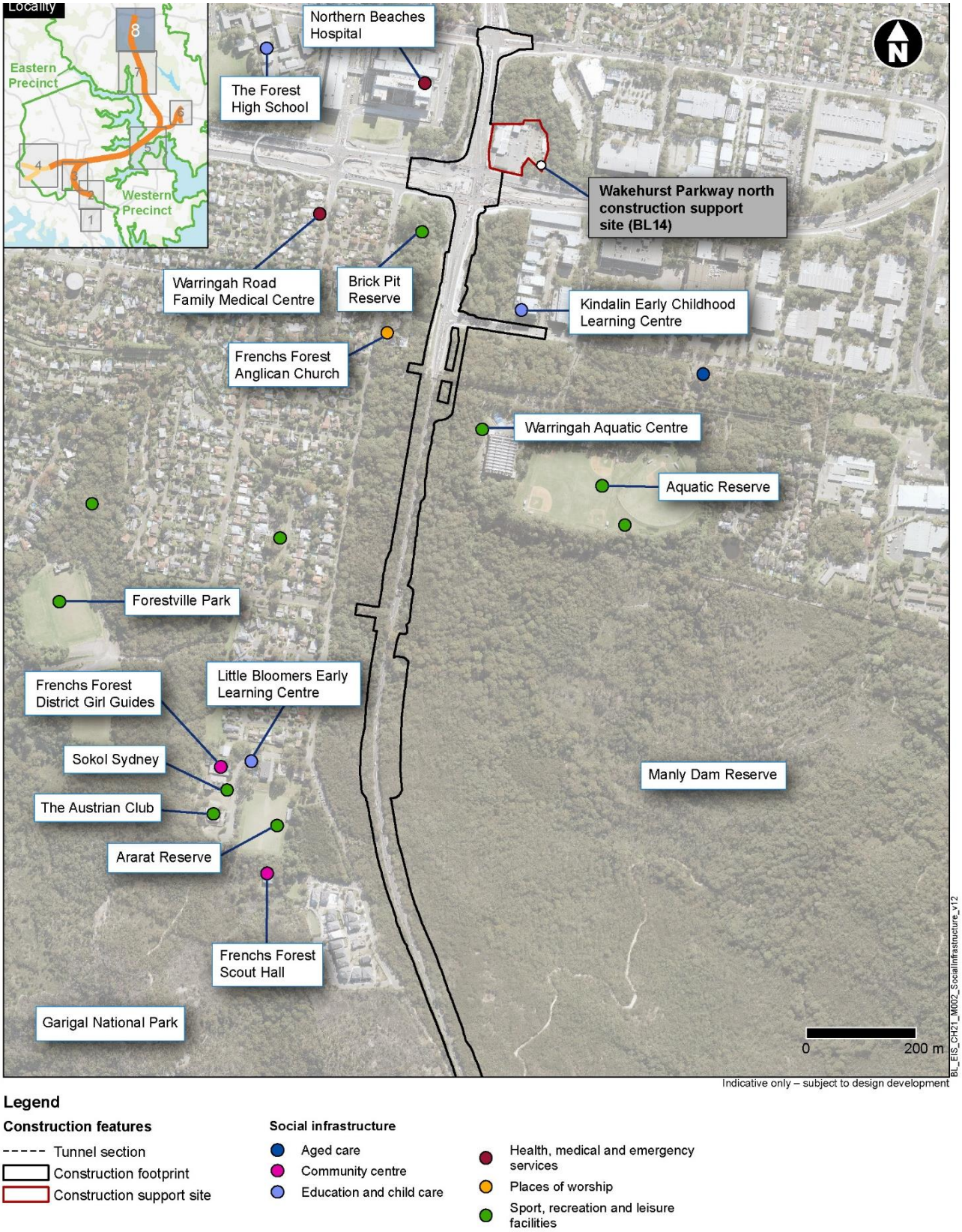


Figure 21-10 Social infrastructure near the project (map 8)

Middle Harbour community uses

The Middle Harbour accommodates a wide range of community users, community groups and clubs. These are described in Section 8.3.4 of Chapter 8 (Construction traffic and transport).

21.3.3 Community values

This section provides an overview of those values or features within the precinct areas that are likely to be important to local and regional communities within Greater Sydney. This has been informed by the review of existing literature (including council planning and strategy documents), assessment of places likely to be important to community members such as open space, heritage places and recreation facilities, review of community and stakeholder engagement outcomes and observations of the precinct areas.

Local amenity and character

Community values relating to local amenity and character refer to natural and physical qualities and characteristics that contribute to a person's appreciation of their surroundings. They relate to such things as built form and landscape, environmental conditions (such as existing noise levels and air quality), and heritage and cultural features.

Local amenity and character in the precinct areas are generally characterised by a diversity of land and water-based uses including:

- Pockets of high-density residential areas within the Western Precinct, such as at Chatswood and Artarmon, and pockets of medium-density residential at Cremorne and Cammeray
- Predominantly low-density residential areas within the Eastern Precinct, such as at Killarney Heights, Forestville, Allambie Heights, Balgowlah and Frenchs Forest
- Industrial uses at Artarmon adjacent to the Gore Hill Freeway and Pacific Highway
- Local centres and shopping precincts within both precincts, including major shopping centres at Chatswood
- Tourist attractions, such as Taronga Zoo in Mosman
- Parks and recreational facilities such as Cammeray Golf Course, Northbridge Oval, Bicentennial Reserve, Northbridge Golf Course, Balgowlah Golf Course, Wakehurst Golf Course, Waverton Park and Seaforth Oval
- Water based recreational activities and sporting clubs based on Middle Harbour
- Major social infrastructure such as hospitals (including the Royal North Shore Hospital, North Shore Private Hospital and Northern Beaches Hospital), educational uses and cultural facilities (such as places of worship, community centres and libraries)
- Open space areas, reserves and parks that are valued by local and regional communities for their landscape amenity, heritage and recreational values. These include Sydney Harbour National Park, Bradleys Head, Middle Head, Artarmon Park, Flat Rock Reserve, Clive Park, Spit West Reserve, Clontarf Beach and Reserve, Garigal National Park, Manly Dam Reserve and Dobroyd Head.

Community cohesion

Community cohesion refers to the connections and relationships between individuals, groups and neighbourhoods, and is encouraged by the existence of local social infrastructure, a sense of local identity, and opportunities for community participation. Levels of community cohesion and sense of belonging in the communities surrounding the project are expected to be good, with communities having access to a diverse range of local and regional level social infrastructure, strong support networks and a variety of meeting places such as sporting clubs, cafes and local centres that foster and support social interaction.

Community cohesion is also encouraged by connectivity or discouraged by barriers to movement as described in Chapter 20 (Land use and property). Many road corridors and arterial roads within the study area create existing barriers, both real and perceived, to local movement and connectivity within the study area and form boundaries to neighbourhoods, pedestrian and cycle movements and to some local centres. This may influence some people's ability or desire to move through the study area, impacting on their access to services, meeting places and participation in social networks.

Community and social networks are associated with social infrastructure such as schools, places of worship, sporting clubs, water-based clubs at Middle Harbour, and community, environmental, heritage and resident groups. Many of these community and social networks are long-standing and are supported by contributions from volunteers, which further strengthen community cohesion.

Communities in the precinct areas host a variety of local events, including festivals, exhibitions and markets. These provide opportunities to involve local communities and for residents to connect with and participate in community life, helping to foster a sense of community and local identity. These include:

- Local festivals, such as the North Sydney Children's Festival, Emerge Festival at Chatswood and the Festival of Mosman
- Cultural and sporting events, such as the Twilight Food Festival, Spring into Jazz at North Sydney, Sydney Harbour Regatta, Eurofest at Frenchs Forest and Mini-Mos Community Fun Run and Fair
- New Year's Eve, Chinese New Year and Australia Day celebrations
- Weekly and monthly farmer's markets and arts markets, including at North Sydney, Chatswood, Cammeray, Mosman and Frenchs Forest.

Community health and wellbeing

Maintaining a high level of community safety and ensuring people feel safe in public places is likely to be important to communities in the precinct areas. This is anticipated due to concerns raised during community and stakeholder engagement for the project regarding road safety and perceived safety impacts associated with locating construction works or operational infrastructure near local streets and social infrastructure. Concerns were also raised by the community regarding air quality during the operation of the project and potential impacts for local communities, schools and park users near tunnel portals and ventilation outlets. In particular, concerns in relation to the location of the tunnel portals and ventilation outlets and potential air quality impacts for school students and users of open space areas such as Artarmon Public School, Artarmon Park and Balgowlah Golf Course.

21.3.4 Business profile

Business centre profiles

A hierarchy of business centres has been applied to the precinct areas based largely on the hierarchy established in the *Greater Sydney Region Plan* by the Greater Sydney Commission, which identifies three types of centres: metropolitan city centres, strategic centres and local centres. There are no metropolitan city centres in the precinct areas. Chatswood, St Leonards and Frenchs Forest are strategic centres and there are several local centres. These are generally clustered on the main transport routes (such as rail corridors or bus routes) and provide either a specialist service to the broader area or a convenience service for the local community. Some business centres are also within the precinct areas for the Western Harbour Tunnel and Warringah Freeway Upgrade project. A summary of businesses within local centres within each precinct is provided in Table 21-4. Businesses that operate outside of business and industrial zones have not been overviewed in the existing environment description (Section 21.3); however, these have been considered in the assessment of impacts (refer to Section 21.4.7 and Section 21.5.6).

Table 21-4 Summary of business centres

Centre	General description
Western Precinct	
Miller Street, Cammeray	Commercial offices, food and beverage retailers, sports clubs and accommodation services, serving local residents as well as commuters and those visiting for work. Commercial businesses are not likely to rely on passing trade however retail businesses would have some reliance on passing trade.
Military Road Centre, Cremorne	Commercial offices, food and drink retailers, sports clubs and accommodation services, serving local residents as well as commuters and those visiting for work. It includes a car dealership, medical centre and mixed use building. The commercial businesses are not likely to rely on passing trade however retail businesses would have some reliance on passing trade. The car dealership is a destination business, while the medical centre services a neighbourhood catchment. The mixed use spaces service a local neighbourhood and further afield, depending on the businesses using the space.
Military Road Centre, Mosman	A wide variety of businesses including retail and commercial uses. Retail businesses include cafes and restaurants as well as boutique clothing stores. Commercial businesses include interior design and personal services businesses. There are also 'neighbourhood shops' such as convenience stores and pharmacies. The centre caters primarily to a neighbourhood catchment. Commercial businesses are not likely to rely on passing trade however retail businesses would have some reliance on passing trade.
Spit Junction Centre	A wide variety of businesses spanning retail and commercial uses as well as Mosman Council buildings. Retail businesses include cafes and restaurants and clothing stores. Commercial businesses include medical and gym/fitness businesses. Some businesses such as speciality retailers, service both a neighbourhood and wider catchment and are unlikely to be dependent on passing trade. These businesses are destination services as many customers would drive specifically to the businesses. Others, such as cafes, restaurants and medical businesses, cater primarily to a neighbourhood catchment and would have some reliance on passing trade. Large format retailers are also located at Spit Junction including a car dealership and furniture shops and smaller commercial premises (eg allied health services, professional suites, car wash and cafes).
The Spit Centre	A number of maritime related businesses and a small number of commercial businesses. Maritime businesses using The Spit includes three marinas, cafes and restaurants, boat rentals/sales, a commercial diving operation and Middle Harbour Yacht Club. These businesses are primarily destination services as many customers would drive specifically to the businesses. They also service local residents and visitors who visit to enjoy the amenity of the area.
Artarmon Industrial Centre	A large number of automotive businesses (vehicle sales, rental and repair) and film related businesses as well as construction related commercial businesses (such as equipment sale and hire). It includes a gym and fitness facilities, warehouse/storage facilities and commercial businesses. Businesses located in the centre are destination stores as many customers would drive specifically to the businesses and they are unlikely to be dependent on passing trade.

Centre	General description
Eastern Precinct	
Balgowlah Centre	A large shopping centre including retail and commercial businesses. The centre includes clothing, homeware and retail businesses as well as a large supermarket and other food retailers along with commercial businesses such as travel agents, a gym/fitness centre, personal services businesses, and a car wash located in the underground carpark. There are cafes and restaurants, as well as some commercial offices and retail stores, located along Sydney Road. The centre caters primarily to a neighbourhood catchment and would have some reliance on passing trade.
Seaforth Centre	Retail businesses include cafes and restaurants and commercial businesses including estate agents, a veterinary hospital and personal services businesses. A variety of 'neighbourhood shops' such as a post office, Bupa aged care facility and Balgowlah RSL Club are also in this area. The centre caters primarily to a neighbourhood catchment and would have some reliance on passing trade.
Manly Vale Business Centre	A variety of retail businesses (such as cafes, takeaways and restaurants, clothing stores, a pharmacy and homewares stores) and commercial businesses (such as interior designers, professional services businesses, personal services businesses, a doctor's surgery and a cluster of surfboard manufacturers). Some businesses, such as the pharmacy, doctor's surgery and cafes, serve a neighbourhood catchment while those such as interior designers and surfboard manufacturers are destination services as many customers would drive specifically to the businesses. The centre also includes commercial and retail businesses that are largely characterised by having large floorplates, for example supermarkets, furniture stores, wholesalers, hardware stores, construction businesses and specialist retailers. Most businesses in this centre are destination services as customers would drive specifically to the business. Businesses would have some reliance on passing trade.
Forestway Shopping Centre, Frenchs Forest	A large shopping centre comprising retail and commercial businesses such as clothing and homeware retail businesses, a large supermarket and food retailers, cafes and restaurants. The centre also includes commercial businesses such as banks, travel agents, a gym/fitness centre and personal services businesses. There is also a car wash located next to the main building. The centre caters primarily to a neighbourhood catchment and would have some reliance on passing trade.
Frenchs Forest Business Hub Centre	Commercial businesses including corporate offices, gym/fitness centres, sports facilities, storage facilities/warehouses, medical laboratories and distribution centres. It includes bulky goods retailers such as homeware and furniture stores. Many businesses in the centre, such as commercial offices and distribution centres, would not receive customers visiting their premises. Those that do, are destination services as many customers would drive specifically to the businesses. The gym/fitness centres cater mostly to employees working within the centre.

Centre	General description
Warringah Mall Shopping Centre, Brookvale	A large shopping centre consisting of retail (such as clothing, homewares, and food retailers) and commercial businesses (such as travel agents, banks, insurance companies and personal services businesses). There are cafes and restaurants located within a food court and throughout the shopping centre, and a car wash within the carpark. The centre caters primarily to a neighbourhood catchment with some customers travelling from further away, including from the wider Northern Beaches.
Austlink Business Park, Belrose	A diverse range of uses in the Austlink Business Park. Commercial businesses include corporate offices, gym/fitness centres, storage facilities/warehouses and distribution centres. It includes bulky goods retailers such as hardware, homeware and furniture stores. Many businesses in the industrial complex such as commercial offices and distribution centres would not receive customers. Those that do are destination services with customers driving specifically to the businesses. The gym/fitness centres cater mostly to employees working within the centre.

It is noted that, while in or close to the study area, the centres of Warringah Mall and Austlink Business Park were not considered to be directly influenced by the project and were not specifically profiled as part of the business impact assessment (refer to Annexure A of Appendix U (Technical working paper: Socio-economic assessment)).

Maritime businesses

Businesses that rely on the Middle Harbour for operation include:

- Maritime: boat moorings, boat ramps, boat licensing, marine rescue, boat maintenance and repairs, tow boats, marina facilities and fuel services
- Tourism: harbour cruises, outdoor recreation and sporting activity operators, and hire facilities and recreational boat hire
- Commercial: commercial fishing movements (commercial fishing is not allowed in the harbour, however, boats travel in the harbour to moor and distribute catch), charter boats, science and research, refueling and water taxis.

Middle Harbour does not accommodate any major commercial shipping operations, with most of maritime traffic associated with recreational and sporting activities.

A number of boat launching facilities are also available for commercial use throughout Middle Harbour.

Businesses assessed

Businesses within the precinct areas are generally clustered on the main transport routes and provide either a specialist service to the broader area or a convenience service for the local community. The location of the business centres in proximity to the project are shown in Figure 21-11. The locations of temporary construction support sites are also shown, as businesses within close proximity may experience impacts. The precinct areas also contain a wide variety of businesses located outside of a business centre. The top three industries of employment are health care and social assistance; professional, scientific and technical services; and retail trade.

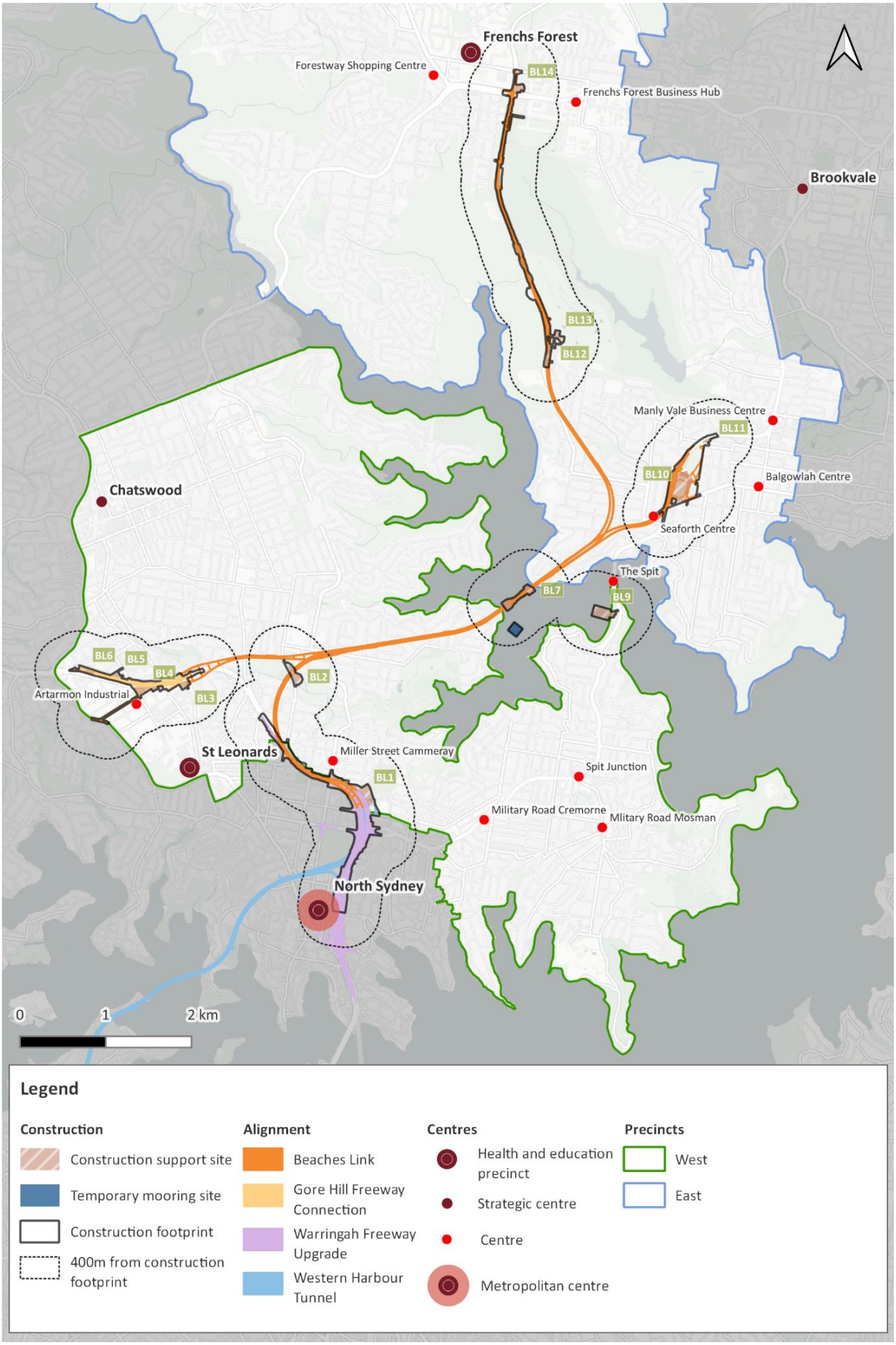


Figure 21-11 Business centres

Businesses survey results

Business survey results revealed that businesses in the area have varying degrees of sensitivity and dependency to project construction and operational aspects. Generally, there was a high perceived dependency (69 per cent) on vehicular passing trade, with 43 per cent of businesses surveyed as highly dependent. Sixty-six per cent of surveyed businesses perceived a dependency on pedestrian and cyclist passing trade. Changes in access to a centre, for example through congestion and changes in travel times (increases or decreases), may result in long-term changes to consumer and worker behaviour. The business survey found that 83 per cent of businesses perceived that they were sensitive to travel time delays, with 39 per cent of the respondents perceived to be majorly sensitive.

The majority of customers and employees surveyed use private vehicles as their primary transport mode. Fifty three per cent of businesses surveyed perceived that during the construction phase, the project would have no discernible positive or negative effects on travel time and access, with 46 per cent of respondents perceiving they would be affected negatively. However, upon operation, 63 per cent of business respondents perceived that the project would be positive for employee and customer access. The majority of businesses (65 per cent) perceived they were dependent on on-street parking, with 39 per cent of businesses recording major dependencies. The potential for the project to impact on deliveries and loading arrangements was also considered in the survey. The impact was considered by businesses to be neutral or positive with 60 per cent of businesses perceiving construction would have a neutral effect and approximately 54 per cent stating that the operation of the project would have a positive effect on servicing and delivery.

The potential for impacts from reduced exposure was perceived to be moderate, with 70 per cent of businesses dependent on business exposure and visibility and 47 per cent majorly dependent. Spit Junction and Frenchs Forest were the surveyed business centres that recorded the highest dependencies.

Changes to the local character and amenity of a place can affect the enjoyment and desirability of the environment, visitation numbers and trends, and consequently the economic activity of a commercial centre and the businesses located there. Overall, 82 per cent of businesses identified that they were dependent on the identity and character of the commercial centre they were located in, with 53 per cent majorly dependent. Fifty three per cent identified that they were dependent on a pleasant visual amenity, 11 per cent had a high sensitivity to noise, 16 per cent had a high sensitivity to air quality and 18 per cent had a high sensitivity to odour.

Overall, the business survey indicated that the majority of businesses perceived the project would have a neutral effect on demand for goods and services. The findings of the business survey assisted in determining the sensitivity of businesses and their ability to adapt and respond to project related changes to the socio-economic environment.

21.3.5 Access and connectivity

A detailed description of the existing traffic and transport environment surrounding the project is provided in Chapter 8 (Construction traffic and transport).

Road network

A number of major arterial roads are located near the project that provide access for communities to employment and infrastructure within the precinct areas, as well as for communities in the Greater Sydney region. Major arterial roads near the project include:

- Warringah Freeway, which passes through Naremburn, Cammeray, St Leonards and North Sydney and provides access to the Sydney CBD
- Pacific Highway, which passes through the precinct areas at Artarmon, St Leonards, Crows Nest and North Sydney
- Military Road, which provides access from North Sydney to Spit Road in Mosman

- Gore Hill Freeway, which passes through the Western Precinct at Artarmon, Naremburn and Willoughby and provides a connection to the Sydney CBD
- Lane Cove Tunnel, which passes through the Western Precinct at Artarmon and provides connectivity to the Sydney CBD and employment centres to the north-west such as Macquarie Park
- Eastern Valley Way/ Flat Rock Drive/ Brook Street, which passes through the Western Precinct at Naremburn and connects St Leonards, Willoughby and the Northern Beaches via Warringah Road
- Willoughby Road, which passes through the Western Precinct at Naremburn and Willoughby and connects St Leonards, Crows Nest and Chatswood (via Mowbray Road)
- Spit Road, which passes through Mosman and provides access to the Northern Beaches
- A8 Manly Road, which passes through Seaforth and provides connections to Mosman, Manly, the Northern Beaches (via Condamine Street/Pittwater Road) and the Forest District (via Frenchs Forest Road/ the Wakehurst Parkway)
- A8 Burnt Bridge Creek Deviation, which passes through Balgowlah and North Balgowlah and provides connections to Mosman, Manly, the Northern Beaches (via Condamine Street/Pittwater Road) and the Forest District (via Condamine Street/Allambie Road)
- Sydney Road, which passes through Balgowlah and Seaforth and provides connections to Seaforth and Manly
- The Wakehurst Parkway, which passes through Frenchs Forest and Killarney Heights and provides access to Seaforth, the Northern Beaches, the Northern Beaches Hospital precinct and the Forest District
- Warringah Road, which passes through Frenchs Forest and provides access to Chatswood, the Northern Beaches, the Northern Beaches Hospital precinct and the Forest District.

The Spit Bridge is also located within the study area. The bridge provides vehicle access between the Eastern and Western Precincts.

At the 2016 Census, car travel was the predominant mode of travel to work for residents in the precinct areas, with about 46.6 per cent of people aged 15 years or over using a car for all or part of their journey to work.

Public transport

Public transport modes across the precinct areas include rail, bus and ferry services. At the 2016 Census, bus transportation was the second preferred mode of transport across the precinct areas, carrying about 15.6 per cent of residents, followed by rail with about 7.2 per cent.

Further details for public transport services in the precinct areas are included in Chapter 8 (Construction traffic and transport).

Active transport

In 2016, walking and cycling were both common forms of active transport for commuters across the precinct areas, with about 6.1 per cent of residents walking or cycling to work. A number of shared user paths are located in the precinct areas, including separated off-road dedicated cycleways and dedicated on-road cycling lanes.

The pedestrian and cycle network is varied within the precinct areas. The Western Precinct offers off-road shared user paths at the following locations:

- Along the southern side of the Gore Hill Freeway
- Near Flat Rock Creek between Weedon Road and Flat Rock Drive
- Around Artarmon Reserve, Naremburn Park, Bicentennial Reserve and the Willoughby Leisure Centre

- Within Spit West Reserve and across Spit Bridge, connecting to the Spit Bridge to Manly Walk.

The Eastern Precinct offers off-road shared user paths at the following locations:

- Near Burnt Bridge Creek between Baringa Avenue and Condamine Street
- White Street, Lauderale Avenue, The Crescent, Commonwealth Parade and Fairlight Walk between Balgowlah and Manly
- Shared user bridge connecting Karingal Crescent Reserve and Forest Way
- Between Wakehurst Parkway north of Warringah Road and Frenchs Forest Road East, to the west of Inverness Avenue
- Shared user bridge across Warringah Road west of the intersection of Forest Way
- Shared user bridge across Warringah Road on the western side of the intersection with Hilmer Street
- Shared user bridge connecting Warringah Aquatic Centre and Bantry Bay Road
- Allambie Road between Aquatic Drive and Eaton Square
- Manly Dam Bike Track within Garigal National Park.

Maritime transport

Middle Harbour maritime transport, access, users and restrictions as well as marinas, boat ramps and mooring fields are discussed in Chapter 8 (Construction traffic and transport), Section 8.3.4.

21.4 Assessment of potential construction impacts

Construction of the project would have the potential to affect the social and economic environment of the precinct areas. These potential impacts are assessed in this section.

21.4.1 Property impacts and acquisition.

The project has been designed to minimise the need for surface property acquisition. This has been done by locating road infrastructure in tunnels and, where possible, using government owned land for construction and operation of the project. Nonetheless, some property acquisition would be required to facilitate construction of the project.

Property acquisition and temporary leases

The project would require the full and partial acquisition of 46 properties. This includes temporary leases of land required for temporary construction support sites and other construction works. The tunnel alignment would also pass under numerous residential and commercial properties and social infrastructure. The nature of direct property impacts, including details of property acquisitions, temporary occupation of land is discussed further in Chapter 20 (Land use and property).

Some residents and communities near the project may experience a level of stress and anxiety due to uncertainty about potential property impacts, property acquisition and proposed changes that may be associated with the project. These concerns were raised by community members during consultation for the project.

Twenty-eight residential properties would be fully acquired for the project, requiring affected households to relocate prior to construction. Some individuals impacted by acquisition of residential properties may also experience impacts on health and wellbeing associated with disruptions to social networks and personal relationships associated with their permanent or temporary relocation or relocation of neighbours. These impacts are likely to have the greatest effect on groups such as elderly, people with a disability, longer term residents and people on lower incomes, who are often more reliant on personal and community networks.

Properties required for the project would be acquired by Transport for NSW in accordance with the provisions of the (NSW) *Property Acquisition (Just Terms Compensation) Act 1991* and the Land Acquisition Reform 2016 process. The *Property Acquisition (Just Terms Compensation) Act 1991* provides the basis for assessing compensation. Transport for NSW has started consultation with affected property owners about the acquisition process and potential adjustments required to properties. Consultation will continue through the project development.

The sensitivity of affected individuals and households are considered to be high. However, the magnitude of the change is considered to be moderate given the number of affected residential properties relative to residential properties in the vicinity of the project. As a result, the overall significance of potential impacts from the acquisition of residential properties is considered high-moderate.

Other property impacts

The mainline and ramp tunnels would pass beneath numerous properties, including residential, commercial, industrial and social infrastructure properties. Potential impacts of relatively deep tunnels on the use of properties and future development potential was raised during community consultation for the project. Under the *Property Acquisition (Just Terms Compensation) Act 1991*, compensation is generally not payable for acquisition of land under the surface unless the surface of the overlying soil is disturbed or the support of that surface is destroyed or affected by construction of the tunnels.

Potential impacts on future development above tunnels generally only occurs in locations where the tunnel depth is shallow, for example close to portals. The location of the portals and tunnels beneath properties is not expected to impact on the future use of development of properties at the surface along the alignment. Subject to council regulations and approvals, landowners would generally be able to:

- Carry out improvements, such as installing a swimming pool
- Dig deeper foundations for a new building or second storey additions.

The overall significance of potential impacts on future development of properties directly above the tunnels is considered negligible, with the sensitivity of affected properties considered to be moderate, and the magnitude of the change considered to be negligible.

Concerns were raised during community and stakeholder consultation about potential for property damage, including to basement car parks, unit developments and pools, due to vibration from tunnelling activities. During construction, some properties located above or near the tunnel alignment may experience short term vibration and ground-borne noise impacts due to the use of equipment such as rock hammers and road headers. For most properties, vibration levels would generally be below levels that may cause potential risk to buildings or structures, including minor cracking. However, there is potential for cosmetic damage risks to a small number of properties, particularly more sensitive heritage buildings, closest to vibration intensive construction activities. Further discussion about potential vibration impacts on buildings and structures is provided in Chapter 10 (Construction noise and vibration).

The excavation of tunnels has potential to result in settlement at the ground surface, potentially impacting properties above or near the project. Some buildings near the project may experience very slight cosmetic damage due to settlement (for example, fine cracks that are easily treated during normal decoration), although this is not expected to impact on the serviceability or stability of buildings which is discussed in Chapter 16 (Geology, soils and groundwater). It is noted that the potential for settlement has been assessed without design measures such as tunnel linings, which would help to reduce settlement associated with groundwater drawdown. The overall significance of potential damage to properties above the tunnels (assessed conservatively without considering the installation of designed tunnel linings) during construction is considered moderate-low, with the sensitivity of affected properties being moderate and magnitude of change (that is, fine cracks that are easily treated during normal decoration) considered to be low.

The air quality impact assessment, provided in Appendix H (Technical working paper: Air quality), found that the operation of the ventilation outlets would have no adverse impacts predicted at any existing or future buildings up to a height of 30 metres in the vicinity of the ventilation outlet at the Gore Hill Freeway and 20 metres within the vicinity of the ventilation outlet at the Warringah Freeway. There are predicted impacts for potential future buildings above 30 metres in height within 300 metres of the Gore Hill Freeway ventilation outlet and for buildings above 20 metres within 300 metres of the Warringah Freeway ventilation outlet. This would not necessarily preclude such development, although consideration of the ventilation outlets would be required during the rezoning or development application stage for proposed future development.

Transport for NSW would assist North Sydney Council, Willoughby City Council, Northern Beaches Council and the Department of Planning, Industry and Environment (as appropriate) in determining relevant land use considerations, which may include requirements for consultation with Transport for NSW at the rezoning or development application stage.

The community raised concerns about potential impacts on property values for communities near the project. Changes to property values, both positive and negative, are driven by a range of economic, social and amenity factors, for example housing supply and demand, interest rates, economic growth, local amenity and accessibility to such things as employment and social infrastructure. The assessment concluded that it is likely that broader external factors would influence property values more than perceived or actual impacts resulting from a road upgrade, including the project.

21.4.2 Equity

Equity refers to a fair distribution of the resources that allow residents full participation in their community. Equity requires that the well-being of people with fewer resources is protected. Changes to conditions which may affect equity in the precinct areas include impacts to amenity, liveability, access and connectivity.

During construction, it is anticipated that impacts to equity would be more acutely experienced by those communities closest to surface works, temporary construction support sites, or occupants of properties above the tunnel alignment. Potential equity impacts would mainly relate to construction noise, dust and vibration affecting the amenity and liveability of the area, as well as changes in local access and connectivity. These impacts would be relatively short-term and localised to discrete locations as construction activities at each temporary construction support site would be comparatively less than the overall construction program. After construction, many of these communities would experience benefits relating to improved access and connectivity to destinations across the Greater Sydney region.

The overall significance of potential impacts on equity during construction is considered moderate, with the sensitivity of affected residents and the magnitude of change considered to be moderate.

21.4.3 Population and demography

The construction workforce would generally be sourced from across the Greater Sydney region and is not expected to result in an influx of workers at a scale that would impact population and demography in the precinct areas.

The relocation of residents associated with the acquisition of residential properties have potential to result in changes to population and demography at a local neighbourhood level, although potential changes in population and demography would represent a very small proportion of the study area's population and are not expected to impact on the population and demography of the study area as a whole. They are also likely to be very minor in the context of expected population and demography changes associated with planned development within the study area. The sensitivity of communities to changes in population is low and the magnitude of change is considered negligible given the existing population of the study area. As a result, the overall significance of potential impacts of the project's construction on population and demography is considered negligible.

Further information on property acquisition as a result of the project is provided in Chapter 20 (Land use and property) and discussed in Section 21.4.

21.4.4 Social infrastructure

During construction, potential impacts on social infrastructure in the precinct areas may result from:

- Loss of open space, parks and recreational facilities, due to use for temporary construction support sites and permanent project facilities
- Reduced visual amenity and increased air-borne construction noise, dust and visual environment, impacting on amenity for users of some social infrastructure
- Ground-borne noise and vibration from construction of the tunnels, impacting on amenity for users of social infrastructure above the tunnel alignment
- Changes in local access and traffic disruptions and delays due to construction activities and increased construction traffic
- Access restrictions to sections of Middle Harbour near proposed works.

Directly impacted social infrastructure

Social infrastructure would be directly impacted through the use of land for temporary construction support sites and project infrastructure. In particular, impacts would include:

- Temporary use of parks and open space areas for temporary construction support sites, resulting in the temporary loss of access to and use of land within the construction footprint
- Permanent loss of land at Cammeray Golf Course, Balgowlah Golf Course and Artarmon Park
- Direct impacts on land accommodating Ella Bache College and Duck and Dive Swim School at Artarmon, causing disruption to users of these facilities. It is likely that users of these facilities would be able to access similar services elsewhere
- Reduced amenity due to location of construction works and temporary construction support sites and changes in noise, dust and visual environment, potentially detracting from the use and enjoyment for people using the remaining parts of the social infrastructure.

Table 21-5 provides a summary of potential impacts on social infrastructure directly impacted by the construction of the project.

Table 21-5 Direct impacts on social infrastructure

Social infrastructure	Summary of potential impacts
Cammeray Golf Course	Impact on land within Cammeray Golf Course would initially result from the establishment of infrastructure required to support the Western Harbour Tunnel and Warringah Freeway Upgrade project construction and operation. Part of the site would be later adjusted to support the establishment of the Cammeray Golf Course construction support site (BL1) and infrastructure required for the project. Impact on land within Cammeray Golf Course has been assessed as of high-moderate significance. The sensitivity of the golf course to change is considered moderate and the magnitude of the impact considered high given the project's construction would result in a permanent change to the existing golf course. The impacted section of the golf course adjoins the Warringah Freeway corridor and Ernest Street. Construction and longer term operation of the ventilation outlet at the Warringah Freeway and other project support infrastructure would require reconfiguration of the golf course before

Social infrastructure	Summary of potential impacts
	construction, including changes to some holes on the golf course (for example, reducing the length of fairways). These works would be carried out as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project, which has been designed and developed to minimise impacts to the golf course. Transport for NSW will continue its collaborative engagement with Cammeray Golf Club to allow the golf course to continue operating as a nine hole golf course during construction. Changes to the golf course during construction may impact on the use and enjoyment of the golf course for some members, potentially resulting in some members and golfers accessing alternative golf courses. During construction, increased noise, dust and construction traffic may impact on the amenity of the golf course for some users and may deter some people from using the golf course during the construction phase. Partial acquisition of Cammeray Golf Course for the Western Harbour Tunnel and Warringah Freeway Upgrade and the Beaches Link and Gore Hill Freeway Connection projects may also increase demand for golf membership of other clubs in the Northern Sydney region. After construction, areas of the golf course not required for permanent project infrastructure would be reinstated and rehabilitated, including replacement trees and landscaping.
Flat Rock Reserve	A small portion (about 10 per cent) of Flat Rock Reserve would be temporarily leased for use as the Flat Rock Drive construction support site (BL2). The construction support site would result in the temporary loss of access to and use of land within the construction footprint, temporarily disrupting the use of this land for informal recreation. Public access to areas of the reserve outside of the Flat Rock Drive construction support site (BL2) would be maintained during construction. The existing shared user path would be temporarily realigned along the western perimeter of the construction support site. Pedestrian pathways on the eastern perimeter of the site would be maintained with two minor temporary diversions required (refer to Chapter 8 (Construction traffic and transport) for further details). Clearing of trees would be required for the temporary construction support site establishment. However, Flat Rock Drive construction support site (BL2) is located in an area previously used as a landfill site comprising re-generated growth, and clearing of older, more established trees would be avoided where possible. The loss of trees would temporarily impact on the landscape and visual amenity of the reserve until new trees or landscaping or other recreation facilities becomes established. The clearing of trees in the reserve is also likely to be a concern for the local community. The amenity of other areas outside of the Flat Rock Drive construction support site (BL2) would be diminished during construction and may detract from the enjoyment of people visiting accessible parts of the parks or nearby facilities. Following construction, areas affected by construction and not required for the ongoing operation of the project would be rehabilitated and/or re-purposed, including with replacement trees and landscaping, with potential landscape and visual amenity impacts diminishing as the new trees or landscaping becomes established. Land affected by construction is therefore not expected to impact on the long-term use of Flat Rock Reserve. The rehabilitation of Flat Rock Reserve would be carried out through further consultation with Willoughby City Council and the community.

Social infrastructure	Summary of potential impacts
	Overall, the significance of potential impacts on Flat Rock Reserve during construction are assessed as moderate, with the sensitivity of the park and magnitude of the impact considered moderate.
Artarmon Park	Construction of the project would require the temporary lease of a portion (about 12 per cent) of land within Artarmon Park to allow for construction activities for the eastbound on-ramp from Lane Cove Tunnel/Longueville Road. Clearing of mature trees would be required for construction and operation of the on-ramp. The loss of these trees would temporarily impact on the landscape and visual amenity of the park until new trees or landscaping becomes established. Clearing of these trees is also likely to be a concern for the local community. Public access to the park from Parkes Road and Hampden Road would be maintained during construction. Works are unlikely to impact the recreational use of Artarmon Park, as the impacted area is steeply sloped and vegetated with dense scrub. The adjoining Artarmon Reserve (containing a playground, sports facilities and oval) would not be impacted. At the completion of construction, part of the land zoned for public recreation would be converted to permanent project infrastructure. The remainder of the land affected by construction would be reinstated after construction and is not expected to impact on the long-term use of Artarmon Park. Overall, the significance of potential impacts to Artarmon Park during construction of the project are assessed as moderate-low, given the sensitivity of the park to impacts is expected to be moderate and the magnitude of the impact is considered low.
Spit West Reserve	During construction, a portion of waterfront open space at Spit West Reserve would be temporarily leased for use as the Spit West Reserve construction support site (BL9). The sensitivity of the area affected by the project's construction and the magnitude of the impact are considered moderate. During construction, part of the reserve would be unavailable for public use for a period of about 48 months. The existing shared user path along the foreshore of Middle Harbour and Spit West Reserve would be temporarily diverted around the construction support site. The amenity of Spit West Reserve would also be diminished during construction and may detract from the enjoyment of people visiting accessible parts of the reserve or nearby facilities. These impacts would be temporary, with the affected areas of the reserve rehabilitated and landscaped following construction.

Social infrastructure	Summary of potential impacts
Balgowlah Golf Course and Balgowlah Golf Club	Land currently owned by the State of NSW and occupied by the Balgowlah Golf Course would be utilised for: • The operation of the Balgowlah construction support site (BL10), which would be re-purposed at the end of the project as new and improved open space and recreation facilities. This portion of land would be leased by Transport for NSW for the construction support site • Construction of a new access road, motorway facility and ventilation outlet. This portion of land would be acquired by Transport for NSW for the permanent facilities • Construction of new and improved open space and recreation facilities which would be constructed on residual land immediately after the dedicated consultation process is completed. The project would return an area, equivalent to around 90 per cent of the current open space, to the community as new and improved public open space and recreation facilities. Residual land not used for construction, primarily to the east and north of the new access road, would be progressively made available as new and improved open space and recreation facilities, subject to the completion of a dedicated consultation process led by Transport for NSW and Northern Beaches Council. As part of this consultation process, a community reference group would be established, with representative stakeholder groups and the community, to support Transport for NSW and Northern Beaches Council with the development of this important public space. Residual land not required for operation of the project is discussed in Section 21.5.3 and in Chapter 20 (Land use and property). The temporary construction support site would occupy part of the land (about 28 per cent) for a period of up to five years and the golf course would be permanently closed at the start of construction, which has been assessed as of high significance. Members of the golf club would be required to use alternative facilities, including Wakehurst Golf Course, Manly Golf Course and Warringah Golf Course, all of which are located within two kilometres of Balgowlah Golf Course. Construction of the project, including the new and improved open space and recreation facilities, would also require the select clearing of established trees within the golf course, including a small area of previously modified Burnt Bridge Creek riparian corridor. The loss of these trees may be a concern for some community members and impact on visual and landscape amenity of the surrounding area. The sensitivity of the golf course to change is considered high and the magnitude of the impact considered high, given the project's construction would result in the golf course not being available for public use.

Indirectly impacted social infrastructure

During construction, impacts on amenity may be experienced by some users of social infrastructure near the project due to the presence of construction infrastructure, increased traffic (including increased heavy vehicle movements) and construction noise and dust. Changes in amenity can affect how users interact with or enjoy an environment or their ability to participate and concentrate. A reduction in the enjoyment or convenience of social infrastructure access may also deter users and potentially impact on community participation levels, which would have an impact on community values.

A number of schools and childcare facilities are located near the project (refer to Figure 21-3 to Figure 21-10). Students, teachers and visitors at the schools would potentially experience temporary amenity impacts due to increased noise and on occasion dust from construction activities at temporary construction support sites and surface road upgrades. Education and childcare facilities may also experience increased construction traffic and occasional dust impacts due to the use of Sydney Road by construction vehicles.

The Wakehurst Parkway north construction support site (BL14) is located near the Northern Beaches Hospital. Increased noise, occasional dust and construction traffic, has the potential to impact on the amenity for patients and workers of the hospital, although any potential impacts from the associated adjacent minor surface roadworks would be for a very short period only and are generally expected to be negligible.

Construction at Artarmon associated with the Gore Hill Freeway Connection component of the project, including the Dickson Avenue construction support site (BL4), would be near the Artarmon NSW Ambulance Superstation on Reserve Road. Access for emergency services would be maintained during construction. Consultation would be carried out with emergency services prior to and during construction of the project regarding potential impacts.

During construction of the project, Spit Road would be used for heavy vehicle access to the Spit West Reserve construction support site (BL9). Spit Road provides access to a number of recreation and leisure facilities and is the starting point for the Spit to Manly Walk. Increased construction traffic along Spit Road may impact on the perceptions of safety for people accessing social infrastructure at this location.

Middle Harbour also provides for informal and formal recreational opportunities, such as boating, fishing, sailing, rowing and kayaking. During construction of the project, there would be a requirement for four partial and two full planned closures of up to 48 hours each of Middle Harbour between Northbridge and Seaforth Bluff, to facilitate immersion of the immersed tube tunnel units. These closures would occur on weekdays to limit the disturbance to harbour recreational users, community groups and clubs. During full closure of Middle Harbour, no boating traffic would be able to pass the location of the Middle Harbour crossing. During partial closure of Middle Harbour, navigational restrictions would prohibit larger vessels from crossing the harbour between Northbridge and Seaforth Bluff. Smaller vessels passing through may require escort vessels to be provided. This would result in periods of traffic disruptions, potentially affecting recreational movements and access and connectivity for sporting clubs associated with Middle Harbour.

During all other days of the construction phase, partial restrictions of Middle Harbour with maritime speed restrictions and controlled access through the site would be required. Recreational users, such as boating, sailing, rowing and kayaking would be allowed to travel through the site in a controlled manner ensuring the safety of both the waterway user and the project team. Ongoing consultation and communication with users of Middle Harbour, such as with the local community, Mosman Rowing Club, Northbridge Sailing Club (located in Clive Park), Seaforth Moth Sailing Club (part of the Northbridge Sailing Club), Middle Harbour Yacht Club and users of D'Albora Marinas The Spit, would assist in managing potential impacts.

Users of other social infrastructure near construction activities, such as recreational facilities (including Balgowlah Scout Hall, Balgowlah Oval, and basketball and netball courts at Willoughby) and places of worship, may also experience potential impacts on amenity due to the presence of nearby construction infrastructure and associated construction noise.

The sensitivity of social infrastructure to amenity impacts is considered moderate with some ability of social infrastructure to adapt to change. The magnitude of the impact is also considered moderate given the duration of potential construction impacts, resulting in the overall significance of amenity impacts at social infrastructure being assessed as moderate.

Short-term low impacts on amenity may also be experienced for users of some social infrastructure located above or near the tunnel alignment due to vibration and ground-borne noise impacts from tunnelling. Those facilities that may be more sensitive to the effects of ground-borne noise and vibration include:

- Places of worship, such as Armenian Evangelical Brethren Church at Sailors Bay Road, Northbridge and St Mark's Anglican Church at Tunks Street, Northbridge
- Childcare facilities such as Sue's Childcare Castlevale at Artarmon Road, Willoughby; Naremburn Early Learning Centre at Donnelly Road, Naremburn; Northside Baptist Preschool at Sailors Bay Road, Northbridge; St Mark's Northbridge Preschool at Malacoota Road, Northbridge; and Jacaranda Creative Play Centre at Fromelles Avenue, Seaforth
- Educational uses such as Seaforth Public School at Kempbridge Avenue, Seaforth.

Some users may notice ground-borne noise and vibration for a short period as works occur beneath or near the property. Potential impacts would be managed through ongoing consultation with managers and users of these facilities. Further information about potential noise and vibration impacts are discussed in Chapter 10 (Construction noise and vibration). Overall, the sensitivity of social infrastructure located along the tunnels and magnitude of potential amenity impacts from tunnelling are considered low, resulting in the significance of potential impacts from tunnelling on the amenity of social infrastructure being assessed as low.

Temporary changes to local access and connectivity for motorists, pedestrians, cyclists and public transport users, may impact on access to social infrastructure near the project. A number of schools are located near surface works and temporary construction support sites at Cammeray and Balgowlah. Increased construction traffic may impact on perceptions of safety for children and students (refer to Section 21.4.5). The implementation of safeguards and management measures would assist in managing potential impacts.

Although controlled navigation routes would be provided through the site, increased marine construction traffic and activities could impact upon the perceptions of safety for water craft and other recreational users of the Middle Harbour. Measures would be implemented to manage potential safety risks associated with road and maritime construction traffic. Further details are provided in Appendix F (Technical working paper: Traffic and transport).

21.4.5 Community values

Potential impacts on community values during construction may be experienced by communities within the precinct areas due to:

- Temporary adverse changes in local amenity for residents, businesses, facilities and public open space areas near temporary construction support sites and surface works due to noise and dust generated from construction activities
- Temporary adverse changes in local amenity for occupants of properties located above the tunnel alignment due to ground-borne noise and vibration from construction activities
- Light spill from night time construction activities at temporary construction support sites and construction works in road reserve areas at the Warringah Freeway, the Gore Hill Freeway and Burnt Bridge Creek Deviation/Sydney Road
- Temporary changes in local access and connectivity, including for motorists, public transport users, pedestrians and cyclists, resulting in delays and disruptions
- Adverse changes in visual amenity and local character due to the presence of temporary construction support sites and surface works, infrastructure, and clearing of vegetation within the construction footprint.

Local amenity and character

Noise, dust, vibration, traffic, and visual impacts from construction activities may temporarily impact on the amenity for some residents and social infrastructure closest to surface works. Impacts on night time amenity due to construction noise and vibration and light spill may also be experienced should works need to be carried out outside of standard daytime hours. This may impact on night time amenity or sleeping patterns for some residents. These impacts would be short-term and may

potentially impact on the use and enjoyment of some homes, businesses, facilities and natural areas, particularly of outdoor areas.

As discussed in Section 21.3.3, Middle Harbour influences the local amenity and character of the precinct areas and is important to the local community. Middle Harbour provides a range of formal and informal recreational opportunities to both local and regional communities (including tourists). As described in Chapter 6 (Construction work), during construction, cofferdams would be located in Middle Harbour and used as temporary construction support sites. Visual and noise impacts during construction may have a negative impact on the use and enjoyment of Middle Harbour for some people, including formal and informal recreational users of land and water based facilities.

The project would require the clearing of vegetation in road reserve areas along the Wakehurst Parkway. Loss of vegetation may impact on community values relating to landscape and visual amenity of this area and the natural environment.

The project would also require the clearing of vegetation within Artarmon Park, Balgowlah Golf Course and areas of re-generated growth within Flat Rock Reserve. Loss of vegetation may also impact on community values relating to landscape and visual amenity of these areas and the natural environment. The extent of clearing on residual Balgowlah Golf Course land will be confirmed after a dedicated consultation process to determine the final form of the new and improved open space and recreation facilities to be constructed in the area.

Following construction, areas affected by construction and not required for the ongoing operation of the project would be rehabilitated and/or repurposed in accordance with the urban design and landscape plan. This would include replacement trees and landscaping, with potential landscape and visual amenity impacts diminishing as the new trees or landscaping become established.

Overall, the sensitivity of communities near the project to changes in amenity and magnitude of potential amenity impacts is considered moderate, resulting in the significance of potential impacts on local amenity assessed as moderate. The implementation of safeguards and management measures, in conjunction with ongoing consultation and communication with local communities, would assist in managing potential impacts on local character and amenity.

Community cohesion

The project construction phase has the potential to result in impacts on community cohesion by restricting access to some existing social infrastructure and meeting places, such as Cammeray Golf Course, and the removal of golfing facilities at Balgowlah Golf Course. This may reduce opportunities for social and community interaction, temporarily impacting on community cohesion.

Potential increased construction noise, dust and traffic may impact on the amenity of the Cammeray Golf Course for some users and may deter some people from using the golf course during the construction phase. This has potential to disrupt some social networks associated with the club. The amenity of other community facilities and meeting places near the project may also be disturbed, such as Balgowlah Scout Hall, Mosman Rowing Club and public facilities at Spit West Reserve. This may impact on people’s use and enjoyment of these facilities.

Overall, potential impacts to community cohesion as a result of construction of the project have been assessed to have a moderate significance, with the sensitivity of meeting places to changes and the magnitude of impacts considered moderate.

Community health and wellbeing

Some areas near temporary construction support sites and along the Warringah Freeway and surface connections such as to the Gore Hill Freeway have potential to experience impacts from construction activities that create extended periods of noise potentially above the relevant assessment thresholds including for sleep disturbance. This has the potential to result in sleep disturbance for some residents and occupants of buildings nearest to these works, potentially impacting health and wellbeing for some individuals. Underwater noise and vibration from some construction activities within Middle Harbour (for example, installation of piles and dredging) has potential to cause sound pressure levels that may affect people diving or swimming (refer to Chapter 13 (Human health)). Mitigation measures proposed include communication to ensure the

community are aware of the timing of impact piling in Middle Harbour for cofferdam works. Impact piling works would be similar to works carried out recently for Sydney Harbour wharf upgrades by Transport for NSW.

The potential for construction dust to impact on health and wellbeing of groups in the community who may be more sensitive to changes in air quality (such as children, elderly people or people who suffer from asthma or similar conditions), is likely to be of concern for some community members near construction activities.

Increased construction traffic could impact upon the perceptions of road safety. This would be particularly relevant in areas that attract higher numbers of pedestrians, such as near local centres or social infrastructure.

The presence of a large construction workforce has potential to disrupt amenity and impact on perceptions of safety for surrounding neighbours and users of nearby social infrastructure. Workers on the project would be subject to the *Transport for NSW Code of Conduct* which outlines expectations for staff in and outside the workplace. The expectations within the *Code of Conduct* would be reinforced through construction worker inductions prior to commencement of construction and toolbox talks which focus on appropriate behaviours when working within the community.

The sensitivity of the general community to perceived health and safety impacts is moderate and the magnitude of possible impacts is considered low, resulting in the overall significance of potential impacts to community health and safety as a result of the project's construction being assessed as moderate-low.

21.4.6 Economics

Employment

During construction, the project would benefit employment through direct employment opportunities on the project and indirect employment opportunities in businesses and industries that support this construction.

A project of this scale is expected to support up to 7500 full time equivalent job years (direct employment) during the five years of construction, including construction workers and professional and administration staff. About 2350 full time equivalent jobs (2000 for Beaches Link and 350 for the Gore Hill Freeway Connection) would be expected to be supported during peak construction. Indirect employment opportunities would be generated across local, regional and national businesses in industries that support construction such as manufacturing and services.

The project's construction phase is likely to provide benefits for groups such as Aboriginal people, women, young people and the unemployed. This would support the NSW Government's *Infrastructure Skills Legacy Program* (Training Services NSW, 2020), which seeks to increase the representation of young people, Aboriginal people and women in the construction industry.

In particular, construction would provide opportunities to boost the number of skilled women construction workers and the number of women in trade-related work as outlined in the *NSW Women's Strategy 2018-2022, Advancing economic and social equality in NSW* (NSW Government, 2020) and *Infrastructure Skills Legacy Program*. To meet the targets within the *Infrastructure Skills Legacy Program*, the contractor would be required to employ women in two percent or more of trade-related roles, doubling the number of women in trade related work. The implementation of the NSW Government's Aboriginal Participation in Construction policy would also provide employment and training opportunities for Aboriginal people.

Training opportunities and apprenticeships provided by construction would support skills development and enhance opportunities for future employment for individuals. Income from employment on the project would also support improved social and economic outcomes for individuals. A workforce strategy for the project, that includes strategies to increase employment and training opportunities for the groups discussed above, would be developed and implemented and would help to maximise employment benefits of the project.

The construction workforce would generally be sourced from across the Greater Sydney region. It is expected that there would be capacity within the regional labour force for the project.

21.4.7 Business and industry

Businesses across the precinct areas may be affected during the construction phase by temporary changes in passing trade, access and travel time (for employees, customers, deliveries and/or servicing), parking, serving and deliveries and amenity. Depending on the nature of the business, the actual impact on business revenue may vary (positively or negatively). These impacts may be an inconvenience for businesses affected although they would be temporary in nature as construction activities at each temporary construction support site would be comparatively less than the overall construction program. There may also be benefits for businesses due to increased passing trade and business exposure.

Potential impacts have been assessed for those business centres identified as being most likely to experience direct and indirect construction impacts. Potential impacts at these locations are discussed below. Further information is provided in the business impact assessment in Annexure A of Appendix U (Technical working paper: Socio-economic assessment).

Passing trade

Passing trade refers to customers who choose to visit a business because they see it when walking, cycling or driving past, not because they planned to go there.

Construction of the project would result in changes to vehicle, pedestrian and cyclist flows that could influence the level of passing trade. Some businesses could benefit due to passing trade being re-directed to them or due to increases in construction workers in the area. Conversely some businesses might be disadvantaged as traffic is diverted away, or as they become less attractive to passing trade due to construction impacts (such as reduced visibility, amenity, ease of access or parking availability).

Increased passing trade from construction workers and construction vehicles is predicted for a number of business clusters located near the temporary construction support sites. Vehicle diversions are also expected to increase traffic along Sydney Road, leading to an increase in passing trade. Increased pedestrian and cyclist passing trade is expected at Francis Road, Lambs Road, Cleg Street and Reserve Road in Artarmon as a result of the diversion of the Gore Hill Freeway shared footpath. Overall, benefits to businesses as a result of passing trade are expected during construction.

Employee and customer access

The construction phase of the project would result in changes to road, public transport and active transport networks, which may affect employee and customer access. Increased journey times can affect staff recruitment and retention, which may in turn impact on business productivity and function. Similarly, customers may respond to access difficulties and delays by visiting alternative centres that offer similar goods or services, resulting in a loss of trade for affected businesses.

Businesses often rely on parking facilities for deliveries and/or services and parking convenience for workers and customers. Increased demand and competition for car parking could influence customers to drive to an alternative business providing similar goods or services in a more accessible location. A reduction in parking spaces may also impact on visitor numbers to the broader area and therefore reduce opportunities for passing trade. Limitations on business parking could also reduce productivity, employee attraction and retention. For example, competition for parking may increase in the Artarmon Industrial Centre precinct due to the additional construction workers in the area. Construction workers will be actively encouraged to use public transport rather than travelling to work by car. Where public transport availability to temporary construction support sites is limited, shuttle bus transfers may also be provided from public transport centres where required. This would be of moderate significance for the Artarmon industrial area, as the sensitivity and magnitude would be moderate.

The traffic and transport assessment (refer to Chapter 8 (Construction traffic and transport)) identified that road network performance would be affected during construction, with a number of temporary road closures and increased construction traffic resulting in increased travel times in some areas. The T2 transit lanes currently in operation along the Gore Hill Freeway would be permanently converted to general traffic lanes to allow for construction of the Gore Hill Freeway Connection and to improve lane utilisation. This is not expected to materially impact employee and customer travel times by bus (refer to Chapter 8 (Construction traffic and transport) for more information). Changes to road network performance would likely affect employee and customer travel time and the efficiency of services and deliveries. Impacts of moderate significance on employee and customer access would be experienced by businesses within Artarmon Industrial Centre, and impacts of moderate-low significance would be experienced at The Spit. Impacts on employee and customer access would be experienced by businesses within the Frenchs Forest Business Hub Centre, Manly Vale Business Centre, Balgowlah Centre, Seaforth Centre, and Miller Street Cammeray and would be of low to negligible significance as both sensitivity and magnitude would be low to negligible.

Construction vessels travelling from the Outer Harbour to Middle Harbour would complete their movement when the Spit Bridge is open. Given the length, limited speed and limited manoeuvrability of the immersed tube tunnel units, the construction contractor may be required to arrange several special bridge opening times outside of peak traffic periods to transport the units to their intended destination. If required by the construction contractor, the additional bridge opening times would have a limited impact on maritime businesses.

Servicing and deliveries

Businesses rely on deliveries and dispatch of goods to support the sale of products and/or services. Businesses also require services from other businesses such as refuse collection. These activities are often required to occur daily or multiple times per day. The construction phase of the project would result in changes to loading zones, road performance and road network configuration, which can affect the reliability and capacity of servicing and delivery. This may temporarily impact travel times and vehicle-related costs as well as revenue for businesses.

Reduced road performance is expected to lead to some delays in service and delivery times to businesses, however it is expected that impacts to business viability would be minor. The business surveys indicated that 60 per cent of businesses believed construction of the project would have a neutral effect on servicing and delivery, whereas 39 per cent of businesses believed it would have a negative effect.

The closure of Lambs Road between Punch Road and Cleg Street, and periodic closures of Reserve Road, Hampden Road, Dickson Avenue and Punch Street during construction are expected to have impacts of moderate significance on businesses in the Artarmon Industrial Centre because of disruption to servicing and deliveries, as the level of sensitivity and magnitude is moderate.

A key factor in receiving servicing and deliveries is access at the business location itself, as this access is often reliant on dedicated loading zones. The construction of the project is, however, not anticipated to remove loading zones or parking that would affect the business clusters.

The significance of impacts on services and deliveries would be low at the Frenchs Forest Business Hub Centre, the Manly Vale Business Centre, the Balgowlah Centre and the Seaforth Centre.

Amenity

The construction phase of the project would affect the amenity of an environment, including for people visiting or working at local businesses in the precinct areas. This would be as a result of increased noise, vibration and dust, or reduced visual outlook and business visibility. Changes to amenity can affect business ambience, productivity, functionality, exposure and client patronage. Business clusters that have higher dependency on amenity to attract and retain customers would be more susceptible to changes in amenity as a result of construction activity.

During construction, visual amenity would be affected by the removal of vegetation and the introduction of temporary construction support sites, equipment and other visible elements such as hoardings and fencing. This is most likely to impact on those retail, personal service providers, cafes and restaurants that rely on the pleasantness and quality of an environment to attract customers. Important aspects of visual amenity which may be affected include access to natural daylight, clear sightlines and permeability to the surrounding landscapes. Businesses that rely on storefront exposure to attract customers may be affected by reduced visibility or safety concerns of customers as a result of the presence of construction machinery and materials. The significance of impacts on amenity at the Balgowlah Centre would be low, and moderate-low at the Artarmon Industrial Centre, the Seaforth Centre and The Spit.

Increased noise and vibration levels from construction activities and traffic could also impact on customer amenity, and on the amenity and productivity levels of employees. Potential exposure to dust and air pollutants could impact on cleanliness and attraction in particular for sensitive business receive such as education, accommodation and food services that rely on outdoor dining.

The establishment of construction infrastructure and increased construction traffic at Spit West Reserve would have an impact on the views, character and identity of maritime businesses at The Spit. Although cafes, restaurants and the function rooms/event spaces at The Spit have a high dependency on visual amenity, the orientation of view corridors from these businesses would be in a direction away from the construction footprint, and the significance of amenity impacts are expected to be moderate-low.

Employee productivity and communication

During construction, there would be a temporary increase in noise levels due to the use of construction plant, equipment and vehicles that may affect employee productivity and communication. The significance of impacts on employee productivity and communication for businesses at the Artarmon Industrial Centre, along Punch Street, Cleg Street, Waltham Street and the Gore Hill Freeway, would be low as the sensitivity and the magnitude of change for this business centre would be low. Impacts on employee productivity and communication would be negligible at the Balgowlah Centre and are not anticipated at businesses at the Frenchs Forest Business Hub, Miller Street (Cammeray), The Spit and Seaforth Centre.

Business visibility

The construction phase of the project would result in changes to vehicle, pedestrian and cyclist flows that could influence the level of business exposure and visibility. Some businesses could benefit as they might be exposed to more potential customers (ie through pedestrian or traffic diversions) while others might not, as traffic is diverted away or construction hoardings reduce the ease of access to/visibility of their business, which could result in a loss of trade. During construction, site hoardings may impact business visibility along Punch Street and Dickson Avenue, resulting in a low significance of impact on business visibility at the Artarmon Industrial Centre. However, overall, benefits are anticipated for the business centres assessed.

Demand for services

The construction phase of large infrastructure projects can affect demand for local and regional goods and services. This can result in both negative and positive impacts with some businesses experiencing a loss of customers avoiding particular areas due to construction activities while other businesses experiencing increased trade from construction workers in the area. Demand for services, such as construction recruitment agencies, construction companies and resource suppliers, can also be generated from infrastructure projects, creating employment opportunities both within and outside local business centres.

Construction of the project would benefit short-term local employment opportunities through the creation of direct construction related employment on the project and indirect employment opportunities in businesses and industries that support the construction works. An increase in construction workers in an area often provides an economic injection into the local economy due to increased demand for local services. As a consequence of the increase in workers associated with

construction of the project, the largest benefits from increased trade are anticipated for convenience retail and the food and beverage industry.

Demand for services at business centres along the project are generally assessed as being benefited during construction of the project.

Displacement of businesses

The acquisition of properties, including cessation of leases, and subsequent relocation or closure of businesses has the potential to result in:

- Disruptions to business operation
- Loss of revenue
- Relocation and re-establishment costs
- Training expenses for new employees and cost of productivity loss until new workers are at the same skill productivity level as the old workers
- Trade catchment alterations
- Business closure.

Businesses required to close or relocate due to the project are predominantly commercial, light industrial or speciality services, including a media and production company, swim school and beauty college, and are located in the Artarmon Industrial Centre. These businesses would service a wider area and would likely employ a small number of workers. Due to the nature of these businesses and the supply of alternative industrial zoned land in the surrounding area, it is likely that these businesses would relocate to another trade catchment. This would result in relocation and establishment costs with potential loss in trade and revenue during this time.

The project would also result in permanent land use impacts at the Balgowlah Golf Course. Land currently occupied by the Balgowlah Golf Course would be utilised by the Balgowlah construction support site (BL10) and the construction of a new access road, motorway facility and ventilation outlet. The temporary construction support site would occupy part of the land for a period of up to five years and the golf course would be permanently closed at the start of construction. The closure of the golf course would result in a loss of employment. Residual land would be progressively become available through the construction period which would facilitate re-purposing it as part of the new and improved open space and recreation facilities, subject to completion of a dedicated consultation process led by Transport for NSW and Northern Beaches Council as described in Chapter 6 (Construction work). As part of this consultation process, a community reference group would be established, with representative stakeholder groups and the community, to support Transport for NSW and Northern Beaches Council with the development of this important public space.

Of the businesses affected by property acquisitions, there are limited co-dependencies or synergies between those that would be acquired and those that would remain operational in the surrounding catchment. Therefore, the operation of remaining businesses is not expected to be substantially affected by these changes. The significance of property acquisitions on individual businesses is expected to be high-moderate, with level of sensitivity considered to be high and magnitude of change considered to be moderate.

Overall, the number of acquisitions and businesses required to cease operation to facilitate the project is relatively low for an infrastructure project of this scale. Although the impact on individual businesses may be significant, the compensation process is generally designed to reduce this impact. Refer to the business impact assessment in Annexure A of Appendix U (Technical working paper: Socio-economic assessment) for further details.

Maritime businesses

Construction activities have the potential to impact maritime businesses as follows:

- Middle Harbour access:
  - Generally, access through Middle Harbour between Northbridge and Seaforth Bluff would be restricted via a controlled navigation route for all business related water craft. Recreational users, such as boating, sailing, rowing and kayaking would be allowed to travel through the site in a controlled manner ensuring the safety of both waterway users and the project team. These controlled restrictions would occur during the whole of the construction period. This would result in the slowing of maritime traffic potentially affecting recreational movements and resulting in potential access and connectivity impacts for Mosman Rowing Club, Northbridge Sailing Club, Seaforth Moth Sailing Club (part of the Northbridge Sailing Club), Middle Harbour Yacht Club and maritime businesses located at The Spit local centre (low significance)
  - Construction of the project would require up to six closures, including two full and four partial closures, of Middle Harbour between Northbridge and Seaforth Bluff for periods of up to 48 hours each to install the immersed tube tunnel units. These closures would normally occur on weekdays to limit the disturbance to maritime and tourism businesses. During full closure of Middle Harbour, no boating traffic would be able to pass the location of the Middle Harbour crossing. During partial closure of Middle Harbour, navigational restrictions would prohibit larger vessels from crossing the harbour between Northbridge and Seaforth Bluff, while smaller vessels passing through may require escort vessels to be provided. This would result in periods of maritime traffic disruptions potentially affecting recreational movements and resulting in potential access and connectivity impacts for Mosman Rowing Club, Northbridge Sailing Club, Seaforth Moth Sailing Club, Middle Harbour Yacht Club and maritime businesses located at The Spit local centre (low significance)
- Employee and customer access: Construction works may require several additional bridge opening times of the Spit Bridge outside of peak traffic periods to transport immersed tube tunnel segments, which may have a limited impact on maritime businesses. The project would also require some commercial moorings to be temporarily relocated during the construction phase (negligible significance)
- Amenity: Construction activities are expected to impact on local amenity and alter the views, character and identity of Mosman Rowing Club, Northbridge Sailing Club, Seaforth Moth Sailing Club (part of the Northbridge Sailing Club), Middle Harbour Yacht Club and businesses within The Spit local centre (low significance)
- Travel time delays: Business harbour users such as boat hire businesses and commercial boats would experience a minor increase in travel time resulting from imposed speed restrictions during construction (negligible significance)
- Business operation impacts: Interference with training routes used by members of the Mosman Rowing Club, course layouts for Northbridge Sailing Club, Seaforth Moth Sailing Club or kayak routes have the potential to result in existing members joining an alternative club. Any impacts on these clubs may also have indirect impacts on cafes in The Spit which are often visited by club members after training. Increased wash from barge and work vessel movements may also disrupt boating and kayak users, although the duration of peak works would be relatively short (low significance).

During construction, maritime businesses and waterway users would also experience temporary changes to access and temporary impacts on amenity during construction. Impacts to waterway users have been reduced by minimising movement of moorings, limiting closure, ensuring right of way for recreational craft over construction maritime vessels and maintaining access to the foreshore where feasible (as discussed in Section 21.4.8). Businesses and users would be able to adapt to the change with minimal disruptions to the way they operate or use the waterway.

While there may be temporary impacts on some maritime businesses during construction, there is not expected to be a lasting impact on these businesses. Any effects would be experienced at an individual business level, with no discernible changes to overall performance of the broader maritime industry. Measures would be defined that outline how marine works would be carried out and mitigate potential business impacts as far as practical.

Refer to Chapter 8 (Construction traffic and transport) for safeguards to manage impacts from maritime construction activities.

21.4.8 Access and connectivity

Potential short-term impacts on access and connectivity are identified below.

Roads and private access

The following potential access impacts are anticipated:

- Temporary changes to road conditions near construction activities, including several partial and full road closures, temporary diversions and access changes, removal of some on-street parking, and reductions in speed limits, resulting in possible delays and disruptions for motorists and other road users
- Increased construction traffic on roads within the precinct areas, including heavy vehicles used to deliver materials and equipment and construction worker vehicles, potentially impacting on road safety for motorists, pedestrians and cyclists. However, most construction traffic would access temporary construction support sites from the arterial road network or water
- The permanent removal of 10 parking spaces along Ernest Street and the temporary removal of parking spaces on other local roads such as Punch Street, Dickson Avenue, Barton Road, Cleg Street and Hampden Road, resulting in a reduction of available parking. Some car parking for the construction workforce would be provided at the temporary construction support sites. Where on-site parking is not provided or where provision of on-site parking cannot accommodate the full construction workforce, feasible and reasonable management measures that minimise parking impacts on the surrounding road network will be implemented, such as encouraging the use of public transport and provision of workforce shuttle buses
- Access to private properties near proposed works is generally expected to be maintained during construction. Where temporary changes are required, suitable access arrangements would be implemented in consultation with affected property owners.

The sensitivity of road users to changes in construction traffic and the magnitude of impacts are considered moderate. As such, the overall significance of impacts on road users are assessed as moderate. The significance of potential impacts to parking as a result of the project's construction have been assessed as moderate-low, with the sensitivity being moderate and magnitude of impacts considered low. The sensitivity of individuals to changes in private property access would be low and magnitude of impact are considered negligible, resulting in an overall significance of impacts on property access being assessed as negligible.

Public and active transport

The following potential public transport impacts are anticipated:

- Potential disruptions to bus services, including from changes to road conditions and the temporary relocation of some bus stops near construction works for safety, resulting in possible delays and disruptions for bus users and changes in bus access for some people
- Delays or short-term changes in local routes and bus priority infrastructure may be required due to temporary road adjustments and could result in minor travel time increases.

Changes to local bus routes and bus stops would be determined prior to the start of works in consultation with relevant stakeholders, including other divisions of Transport for NSW and bus operators. Advanced notification would be provided to affected bus customers and bus stops would

be relocated within walking distance of their existing position, to minimise disruption where reasonable and feasible. The sensitivity of commuters to changes in public transport services are considered moderate, with the magnitude of impacts considered low. As such, potential impacts to public transport as a result of construction of the project have been assessed to have a moderate-low significance.

Active transport impacts would be anticipated due to temporary closures or changes to pedestrian and cycle paths would be required near construction works for safety of pedestrians and cyclists. Existing connectivity for users of these facilities would be maintained and temporary access arrangements would result in a small increase in travel distances. Temporary closures and adjustment of pedestrian and cycle paths would include:

- Temporary detour of the Warringah Freeway shared user path and provision of signalised pedestrian and cyclist crossing at the access for the Cammeray Golf Course construction support site (BL1)
- Temporary detour of the shared user path within Flat Rock Reserve (parallel to Flat Rock Drive, on the western side of the Flat Rock Drive construction support site (BL2)), and provision of signalised pedestrian crossing at the access to the Flat Rock Drive construction support site (BL2) (the existing walking tracks along the eastern perimeter of the site would be largely maintained with two minor temporary diversions required)
- Temporary adjustments to Reserve Road, Dickson Avenue and Punch Road footpaths at Artarmon and to Hampden Road footpaths and cycle path near to works at Artarmon Park
- Temporary detour to the Gore Hill Freeway shared user path near to the Dickson Avenue construction support site (BL4)
- Closure of Lambs Road due to Punch Street construction support site (BL3)
- Temporary detour of the Figtree Lane shared user path around the Spit West Reserve construction support site (BL9)
- Provision of signalised pedestrian crossing at the Sydney Road and Burnt Bridge Creek Deviation site accesses for the Balgowlah Golf Course construction support site (BL10)
- Temporary adjustment to Manly Dam mountain bike track at Wakehurst Parkway
- Demolition and replacement of the Wakehurst Parkway pedestrian bridge. The existing bridge will remain operational while the replacement works are carried out
- Temporary adjustments to Wakehurst Parkway shared user path near the Wakehurst Parkway north construction support site (BL14).

Overall, the significance of potential impacts to active transport as a result of construction of the project have been assessed as low, with the sensitivity and magnitude of impacts considered low.

Maritime transport

The following potential maritime transport impacts are anticipated:

- Generally, access through the site between Northbridge and Seaforth Bluff would be restricted via a controlled navigation route for all business related water craft. These controlled restrictions would occur during the whole of the construction period. This would result in the slowing of maritime traffic potentially affecting recreational movements and resulting in potential access and connectivity impacts for Mosman Rowing Club, Northbridge Sailing Club, Seaforth Moth Sailing Club, Middle Harbour Yacht Club and maritime businesses located at The Spit local centre
- Temporary closures of Middle Harbour between Northbridge and Seaforth Bluff, which would occur on weekdays to limit the disturbance to harbour recreational users, community groups and clubs. During the two proposed 24 to 48 hour full closures of Middle Harbour, all marine traffic would be restricted from moving through the site for the period. During the four proposed 24 to 48 hour partial closures of Middle Harbour, navigational restrictions would prohibit larger

vessels from crossing the harbour between Northbridge and Seaforth Bluff. Smaller vessels passing through may require escort vessels to be provided. This would result in periods of traffic disruptions, potentially affecting recreational movements and access and connectivity for sporting clubs associated with Middle Harbour

- The six steel shell immersed tube tunnel units and heavy marine construction plant would need to access the Spit West Reserve construction support site (BL9) via the Outer Harbour and then via Middle Harbour between Grotto Point and the Spit Bridge. Navigation impacts in these areas are not expected to be substantial due to the lower frequency of construction vessel movements and the increased space the Outer Harbour provides for maneuverability
- Business harbour users such as boat hire businesses and commercial boats would experience a minor increase in travel time resulting from imposed speed restrictions during construction, however the significance of impacts is considered to be negligible
- The establishment and operation of the Spit West Reserve construction support site (BL9) would require temporary relocation of around 45 swing moorings. The establishment of the Middle Harbour north cofferdam (BL8) would require the temporary relocation of about 10 swing moorings below Seaforth Bluff and would prevent access to three private marina berths in Seaforth Bluff. Temporary alternative marina berths would be provided at D'Albora Marinas at The Spit or other marinas nearby. Relocated moorings would be relocated elsewhere in Middle Harbour in consultation with the lease holder(s) during construction and would be restored to their original position on completion of the project. A number of moorings would also require very short term temporary relocation on the eastern side of the channel, west of Bradys Point to allow safe passage of the immersed tube tunnel units.

Ongoing engagement and communication with users of Middle Harbour, such as with the local community, Mosman Rowing Club, Northbridge Sailing Club, Seaforth Moth Sailing Club, Middle Harbour Yacht Club and users of D'Albora Marinas The Spit, would assist in managing potential impacts. Rowers and sailing craft would have right of way over maritime construction vessels in the vicinity of the project. Overall, the significance of potential impacts on maritime transport during construction have been assessed as low, with the sensitivity of maritime users considered moderate and the magnitude of potential impacts low.

21.5 Assessment of potential operational impacts

The operation of the project has the potential to positively and negatively affect residents, businesses, road users, users of social infrastructure and the wider community. This section provides an assessment of potential social and economic impacts within the precinct areas during operation of the project.

21.5.1 Equity

The operation of the project would provide improved access and connectivity which would benefit the wider community and people living and working in or near the precinct areas. In particular, reduced congestion and improved journey times provided by the project would help to reduce travel time for individuals, families and the wider community, increase time available to individuals and families for leisure, and increase access to employment opportunities within convenient commuting times. Reduced traffic congestion, upgrades to bus infrastructure and opportunities for new express bus services delivered by the project would also have benefits that would be shared by local and regional communities.

In conjunction with the Western Harbour Tunnel and Warringah Freeway Upgrade project, the project would help to reduce traffic on major roads in the precinct areas, including Military Road/Spit Road/Manly Road, Warringah Road, Eastern Valley Way, Pacific Highway and Western Distributor, Frenchs Forest Road, the Ourimbah Road corridor and local roads such as Brook Street (Naremburn). It would also support local environment and amenity improvements in the precinct areas and surrounding region and improve access and connectivity for residents, business

and industry in the precinct areas, northern suburbs, north western suburbs, south western suburbs and the Greater Sydney region.

21.5.2 Population and demography

Travel time savings and improved accessibility provided by the project are likely to make some areas within or near to the precinct areas more attractive for people looking to relocate. While this change has been occurring and is expected to continue, the project is likely to contribute to the acceleration of development locally and regionally, particularly when considered in conjunction with the Western Harbour Tunnel and Warringah Freeway Upgrade project.

21.5.3 Social infrastructure

As discussed in Section 21.4.4, a number of open spaces would be used during construction of the project. At completion, land not required for operation of the project would be rehabilitated and reinstated. However, some land would be retained for operational purposes as follows:

- A portion of land at Cammeray Golf Course would be acquired and/or leased as part of the Warringah Freeway Upgrade component of the Western Harbour Tunnel and Warringah Freeway Upgrade project. Part of the site would be later adjusted to support the establishment of the Cammeray Golf Course construction support site (BL1) and operational facilities and other utilities for the project. This would require the reconfiguration of the golf course to allow its ongoing use. As discussed above, Transport for NSW will continue its collaborative engagement with Cammeray Golf Club to allow the golf course to continue operating as a nine hole golf course during construction. The establishment of the motorway facilities would change the visual setting of this location. Landscaping would be provided to reduce the visual impacts of these facilities. Further discussion about the project's impacts on visual and landscape impacts are provided in Chapter 22 (Urban design and visual amenity). The sensitivity of the golf course to change is considered moderate and the magnitude of the impact considered high given that the project would result in a permanent change to the existing golf course. As a result, the overall significance of potential impacts to Cammeray Golf Course during operation of the project are assessed as high-moderate
- A portion of land currently occupied by the Balgowlah Golf Course would be acquired by Transport for NSW for the construction of permanent facilities, including a new access road, motorway facility and ventilation outlet, leading to the closure of the golf course. This would require members and visitors of the golf club to access golf courses elsewhere, impacting on social networks associated with the club. The sensitivity of the golf course to change is considered high and the magnitude of the impact considered high given the permanent closure of the golf club. As a result, the overall significance of potential impacts to Balgowlah Golf Course during operation have been assessed as high.

  The project would progressively return an area, equivalent to around 90 per cent of the current open space at Balgowlah Golf Course, to the community as new and improved public open space and recreation facilities. A dedicated consultation process jointly led by Transport for NSW and Northern Beaches Council will take place to give the community an opportunity to provide comment on the final layout of the new and improved open space and recreation facilities at Balgowlah. This consultation would be separate to the consultation for the Beaches Link and Gore Hill Freeway Connection environmental impact statement. This process would start after the environmental impact statement public exhibition period and well in advance of construction starting.

  As part of this consultation process, a community reference group would be established, with representative stakeholder groups and the community, to support Transport for NSW and Northern Beaches Council with the development of this important public space. Residual land, primarily to the east and north of the new access road, would progressively become available through the construction period, which would facilitate re-purposing it to the new and improved open space and recreation facilities. This would allow it to be handed over progressively for

use by the community. The new and improved open space and recreation facilities to the west of the proposed access road, between the access road and the widened Burnt Bridge Creek Deviation, would be constructed and handed over to Northern Beaches Council after completion of the project. Further information regarding the new and improved open space and recreation facilities at Balgowlah is provided in Chapter 20 (Land use and property)

- The project would require the permanent acquisition of a portion of land at Artarmon Park to accommodate road infrastructure associated with the Gore Hill Freeway Connection. This is not expected to impact on the ongoing use or functioning of the park and its facilities, which mainly include seating and dog off lease area within a vegetated open space. Overall, the significance of potential impacts on the permanent strip acquisition of Artarmon Park during operation of the project have been assessed as moderate-low, with the sensitivity of the park to impacts considered moderate and the magnitude of the impact low.

During operation, the project would contribute to improved access and connectivity through improved travel time and improved travel time reliability, including to local and regional infrastructure within and near the precinct areas including major hospitals, tertiary education facilities, regional and state sport and recreation facilities, and major retail, commercial uses, cultural and community support facilities (refer to Section 21.3.2). However, operation of the project may also result in impacts to some social infrastructure due to changes in local road access.

Overall, the significance of impacts on social infrastructure from the project's operation is considered low, with the sensitivity of social infrastructure to changes and the magnitude of potential impacts considered low.

21.5.4 Community values

Local amenity and character

Operation of the project may result in changes to traffic noise levels for communities near the tunnel connections and the Warringah Freeway. In particular, increased traffic noise may be experienced by some receivers near the surface connections at the Gore Hill Freeway, Balgowlah and the Wakehurst Parkway due to forecast increases in traffic volumes and realignment or widening of roads closer to receivers. Conversely, decreased traffic noise impacts may be experienced by some communities near the surface connections at Balgowlah, the Gore Hill Freeway and the Warringah Freeway due to the forecast reduction in traffic volumes along existing surface roads with traffic being moved into tunnels. This may have beneficial impacts on local amenity at some properties.

The early development of the new and improved open space and recreational facilities in Balgowlah would improve access to sport and recreational facilities for surrounding communities. Increased availability of public open space and passive and active recreation facilities would impact positively on local amenity in this area. Use of the residual land for such facilities would address the current under supply of sporting grounds available for public use in the local area.

The sensitivity of communities near the entry and exit ramp tunnels to connections at the surface to adverse changes in local amenity and character and the magnitude of potential changes are considered low. As such, the overall significance of potential impacts on local character and amenity from the project's operation are assessed as low.

Community cohesion

Community cohesion is encouraged by connectivity or discouraged by barriers to movement. During operation, the project would support improved travel and access to work, business and leisure activities in the precinct areas and the Greater Sydney region. Regionally, improved accessibility and connectivity is likely to provide long-term benefits for community cohesion. In particular, travel facilitates social interactions and where access on major routes is constrained, some people may avoid making trips. Reduced travel times and improved travel time reliability may encourage some people to make trips they otherwise wouldn't, helping to facilitate community cohesion.

Locally, residential property acquisition has the potential to impact on community cohesion through the disruption to social networks and community relationships. As discussed in Chapter 20 (Land use and property), 28 residential lots would be wholly impacted by the project's construction and operation, requiring affected households to relocate before construction. This has potential to disrupt personal networks and local social connections associated with residents of these properties, particularly if the households are not able to find suitable alternative accommodation in the local area. Residents of Dudley Street at Balgowlah are likely to experience the greatest disruption to local social connections. Elsewhere, while any impact is likely to be important to affected individuals and their local networks, the impact in the context of the project as a whole is expected to be minor given the relatively small number of properties acquired.

Increased traffic volumes on roads such as the Wakehurst Parkway leading to and from connections may reinforce existing perceived barriers to local movements for pedestrians and cyclists, potentially influencing some people's ability to access services and meeting places. Conversely, improvements to pedestrian and cycle facilities with upgraded infrastructure (for example, along and under the Wakehurst Parkway) would support increased connectivity and enhanced safety, helping to encourage greater pedestrian and cycle movements.

Changes to Cammeray Golf Course and the closure of Balgowlah Golf Course and associated golf club may also impact on community cohesion. The permanent impact on the continued operation of Balgowlah Golf Course would require members and visitors to access golf courses elsewhere, impacting on social networks associated with the club. Potential impacts on individual members is likely to depend on individual circumstances such as the length of membership and the ability to access membership at an appropriate alternative club. The closure of the club may result in some members no longer participating in the sport. This is most likely to be long-term members or older golfers, potentially impacting individuals' general levels of physical activity, and overall wellbeing associated with the possible loss of social networks and personal relationships. The progressive establishment of new and improved public open space and recreation facilities in Balgowlah would provide opportunities for community members to meet and connect, helping to support community interaction and cohesion within the broader local community.

Changes to the Cammeray Golf Course may impact on the use of the golf course for some members. While works carried out as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project would allow the Cammeray Golf Course to continue operating as a nine hole golf course, this may potentially result in some members and golfers accessing alternative golf courses, particularly following possible disruptions associated with changes to amenity during construction. These changes may impact on some social networks associated with the clubs.

The sensitivity of affected individuals and the magnitude of impact on community cohesion is considered moderate. As such, the overall significance of potential impacts on community cohesion due to the closure of Balgowlah Golf Club and permanent changes to Cammeray Golf Course are assessed as moderate.

Community health and wellbeing

Some residents and communities near the project may experience a level of stress and anxiety (refer to Chapter 13 (Human health)) due to uncertainty about potential property impacts and proposed changes. This may impact on the health and wellbeing of some individuals. Some residents impacted by acquisition of residential properties may also experience impacts on health and wellbeing associated with disruptions to social networks and personal relationships associated with the relocation of residents.

The operation of motorway facilities and ventilation outlets at the Warringah Freeway, the Gore Hill Freeway, Burnt Bridge Creek Deviation and the Wakehurst Parkway may influence people's perceptions of air quality in surrounding areas. This is likely to be of particular concern for surrounding residents and users of social infrastructure near ventilation outlets (for example, ANZAC Park Public School, Balgowlah Boys High, Seaforth Public School, ANZAC Park, Cammeray Park, Cammeray-Neutral Bay Skate Park, Cammeray Tennis Club and Seaforth Oval). Concerns about potential impacts on the health of students of schools near ventilation outlets were raised during consultation for the project.

The project tunnel ventilation outlets contribution to air pollutant concentrations would be negligible and any predicted changes in air quality mainly due to changes in traffic volumes on surface roads. At a regional level, potential impacts on air quality would be negligible and generally undetectable. Refer to Chapter 12 (Air quality) for an assessment of air quality impacts from the project. The overall significance of this impact is assessed as negligible, with the sensitivity of affected communities considered moderate and the magnitude of the impact considered negligible.

The project would support improvements in road safety, with reduced traffic demands along key surface road transport corridors including heavy vehicles transferring into the tunnels resulting in a forecast reduction in crashes across the network and consequent delays and disruptions during major incidents. Specifically, the project would result in substantial reductions in traffic volumes on the existing crossings into and out of the Northern Beaches peninsula, with the largest reductions in traffic volumes being on the Spit Road and Military Road corridor (refer to Chapter 9 (Operational traffic)).

The establishment of new and improved public open space and recreation facilities at Balgowlah Golf Course site would provide greater access to active and passive recreation facilities for surrounding communities, helping to encourage increased participation in recreation activities and overall levels of physical activity. The project would also include new and upgraded active transport infrastructure along the Burnt Bridge Creek Deviation and new access road at Balgowlah, and a new shared user path along Wakehurst Parkway from Seaforth to Frenchs Forest. This would support safer and easier access for pedestrians and cyclists, further helping to encourage increased walking and cycling and overall levels of physical activity.

21.5.5 Economic

Employment

The project would support improved access and connectivity to employment areas in the study area and the wider Sydney region. Changes to the business environment or the acquisition of properties accommodating businesses as part of the project may cause some loss of local employment, which may result in loss of income for affected employees and business owners. Potential impacts on employment due to the relocation of businesses to alternate sites are likely to be dependent on the businesses' new location (that is whether alternate premises are found locally) and individual circumstances of employees, for example increased commuting distances and times and ability of individual employees to travel to the new business location. While this would be a concern for employees and owners of affected businesses, given the small number of commercial properties affected, this is not expected to impact on the overall levels of employment in the precinct areas.

Freight and efficiency costs

Operation of the project would deliver significant long-term improvements to freight and efficiency costs for a large number of businesses and business centres within the region. Operation of the project would have benefits for businesses and business centres across the Northern Beaches by reducing travel times for light commercial and freight trips, which would in turn reduce transportation costs and increase efficiency. It is noted that Spit Road and Military Road have access restrictions for large articulated trucks (ie B-doubles and other higher mass limit vehicles). As such, access to the Northern Beaches for B-doubles is currently limited to Mona Vale Road and Warringah Road. Notwithstanding, the project would result in the majority of heavy vehicle trips on existing roads travelling through the Northern Beaches peninsula transferring to the tunnels. Peak period heavy vehicle volumes on Spit Road, Warringah Road and Mona Vale Road would decrease as a result of the project.

The movement of freight and commercial trips from surface arterial corridors to motorways would also increase the amenity of businesses and business centres located along the main arterial corridors into and out of the Northern Beaches peninsula. Amenity improvements are most likely to be experienced at The Spit, Spit Junction, Forestville, Seaforth, Neutral Bay and Cremorne.

Employment and customer access

The project would increase the accessibility of the Northern Beaches and reduce travel time from Manly to Chatswood, Chatswood to Dee Why-Brookvale and St Leonards, North Sydney to Chatswood, St Leonards, Artarmon and Macquarie Park.

The introduction of an additional transport connection, which increases the efficiency of a network and connectivity across a broader geographic area, can lead to expanded trade catchment and employment opportunities due to improved accessibility. The project has the capacity to increase the secondary trade catchment (the area from which the business attracts or services 20 to 30 per cent of customers). With the project, travel time from Artarmon to Manly, Frenchs Forest to North Sydney and North Sydney to Balgowlah would be between 10-15 minutes faster in both directions, compared to an alternative 'Do minimum' (without the project) scenario in 2027 and 2037. These travel time savings expand the catchment areas benefiting businesses in the suburb and further afield.

There would be a reduction in traffic demand on the Spit Road and Military Road corridor with improved travel times due to reduced congestion. Customers and employees accessing the centres of Military Road Mosman, Military Road Cremorne, Spit Junction and Neutral Bay would benefit from improved travel times.

Existing local and B-Line bus services would also benefit from reduced congestion on surface routes resulting in efficiency improvements in journey-to-work time. Additional significant improvements would result from the addition of further express bus routes using the tunnels to access employment centres and connecting to transport hubs like North Sydney and new transport services like the new Sydney Metro stations at Crows Nest and North Sydney.

Overall, any negative impacts associated with road alterations are localised and are offset by network wide improvements in travel time and accessibility. The significance of impacts on employee and customer access would be negligible.

Tolling

Tolling infrastructure has been included as part of this environmental assessment to provide the NSW Government with the option to apply tolls to traffic using the Beaches Link tunnels. While no decision on final toll costs has been made, if tolls were introduced, the additional tolling expense may deter some customers from driving to a business centre (that induces a toll charge) if there is another centre offering similar services in a location without the toll charge. This would cause a redistribution of customer expenditure, potentially benefiting some locations while others are disadvantaged. Although customer behaviour may alter, the trade catchments of businesses would generally remain consistent as customer expenditure is redistributed equally on either end of the connection. Alternate untolled routes would be available for motorists using existing surface roads.

The assessed significance of impacts associated with tolling are expected to be low, with the sensitivity of affected businesses to tolling changes and magnitude of impacts considered to be low. Overall, although the potential introduction of tolling would be a direct cost to businesses and persons, this would be offset by the reductions in congestion, vehicle running costs and travel time savings.

21.5.6 Business and industry

During operation, potential impacts on businesses located near the project may result from:

- Increased passing trade due to increased traffic volumes
- Improved travel times for employees and customers accessing the centres due to increased travel speeds
- Changes to access for employees and customers
- Potential increase to the trade catchment for some businesses, due to improved accessibility.

Potential impacts on business and industry have been assessed for those business centres identified as being most likely to experience direct and indirect operational impacts as discussed below. Business centres which are not anticipated to experience operational impacts include the Warringah Mall, Austlink Business Park, Manly Vale Business Centre, Seaforth Centre, Miller Street Cammeray and The Spit. These centres have not been included in the discussion below.

Passing trade

Operation of the project may result in changes to vehicle, pedestrian and cyclist flows that could influence the level of passing trade.

The operation of the project would result in additional passing trade for businesses within the Balgowlah Centre and the Frenchs Forest Business Hub due to increased traffic demand. In addition, pedestrian and bicycle facilities to be provided as part of the project would improve the active transport network and benefit passing trade. Overall, benefits to businesses within the Balgowlah Centre are expected due to increased passing trade as a result of the project.

The conversion of Dickson Avenue east of Reserve Road to a cul-de-sac and the removal of property access to Reserve Road (replaced with access via Hesky Lane) would potentially reduce passing traffic on Reserve Road, and increase on Hesky Lane and the surrounding road network (such as Taylor Lane, Cleg Street, Herbert Street and Waltham Street). Overall, the Artarmon Industrial Centre has a negligible sensitivity to passing trade and low magnitude of change, making the significance of any negative impacts as a result of the project considered to be negligible.

Employee and customer access

Operation of the project would result in changes to road, public transport and active transport networks, which would affect employee and customer access.

Customers and employees at the Artarmon Industrial Centre may experience minor inconvenience due to disruptions in the local road network and the conversion of Dickson Avenue and Punch Street to cul-de-sacs. However, impacts are considered minimal to businesses as there would be minimal impact on travel times. The centre has a low sensitivity to customer and employee access and negligible magnitude of change, resulting in a negligible significance of impacts.

The project would result in isolated, minor localised increases in travel times and minor reduced travel speeds in the southbound direction on Wakehurst Parkway, north of Warringah Road, and reduced local access from Wakehurst Parkway northbound into Frenchs Forest Road East. This may affect employee and customer access to the Frenchs Forest Business Hub. However, impacts are considered to be negligible to businesses as there would be a negligible magnitude of change. The substantial increase in connectivity would counter negative impacts and enhance accessibility for the broader catchment.

Existing local and B-Line bus services would benefit from reduced congestion on surface routes resulting in efficiency improvements in journey-to-work time. Substantial improvements would also result from the addition of new express bus routes using the tunnels to access employment centres and connecting to transport hubs like North Sydney and new transport services like the new Sydney Metro stations at Crows Nest and North Sydney.

Overall, the project would have long term positive effects on the business environment through improved connectivity and road network efficiency, expanded trade catchments, reduced passenger travel time and improved safety and active transport network infrastructure.

Servicing and deliveries

Changes in the road network performance may lead to some minor localised impacts to delivery times in Frenchs Forest north of Warringah Road, which may result in impacts of low significance on servicing and deliveries for businesses within the Frenchs Forest Business Hub Centre. The level of sensitivity of the centre is moderate and the magnitude of change is low.

Generally, the project is expected to result in benefits to servicing and deliveries due to increased transport efficiencies and road capacity. The additional, faster and more direct road connections

would improve connectivity to the broader network and enhance the efficiency of supply chain movements, allowing deliveries to reach their destinations more quickly.

Amenity

Businesses within the Balgowlah Centre may experience a very minor increase in noise due to an increase of vehicles along Sydney Road. This is unlikely to noticeably alter local amenity as the existing acoustic environment is already subject to higher vehicle noise, and therefore the impact would be negligible.

Businesses within the Artarmon Industrial Centre may experience impacts on amenity and character due to views of the motorway facilities and ventilation outlet, motorway control centre and portals, and due to the removal of vegetation. However, industrial land use generally has a lower dependency on character and amenity than commercial or mixed use centres. The level of sensitivity of the centre is negligible and the magnitude of change is considered to be low. As a result, the significance of potential impacts is considered to be negligible.

Employee productivity and communication

Businesses within the Artarmon Industrial Centre along Punch Street, Cleg Street, Waltham Street and the Gore Hill Freeway may experience slightly higher noise levels due to additional vehicles on the road. The significance of these impacts is considered negligible, with a negligible sensitivity and low magnitude of change.

Business visibility

The operation of the project may result in benefits for businesses within the Balgowlah Centre and Artarmon Industrial Centre due to improved business visibility as a result of increased traffic at these locations.

Demand for services

During operation of the project, businesses are generally expected to experience benefits to demand for services due to improved access and connectivity, and increased trade catchments. No negative impacts on demand for services are anticipated due to the project.

Maritime businesses

The top of the immersed tube tunnels would be up to 9.2 metres above the existing elevation of the harbour bed at the centre of the crossing. The water depth above the immersed tube tunnels would vary between 16 metres and 22 metres, depending on the distance from the shore (due to the profile of the bed of the harbour). Such reduction in water depth is considered inconsequential as the draught of vessels in this part of the Harbour is constrained by shallow water depths downstream. Refer to the navigational impact assessment in Annexure A of Appendix F (Technical working paper: Traffic and transport).

Commercial moorings relocated during construction would be restored at or near their original position upon operation of the project.

Once in operation, the project would have no impacts on business reliant on the Middle Harbour for operation.

21.5.7 Access and connectivity

Road and private access

The project would improve regional access and connectivity for motorists and other road users by providing an alternative crossing of Middle Harbour. The project would relieve congestion on the Military Road/Spit Road and Warringah Road/Eastern Valley Way corridors, and enable faster, more reliable journeys for bus customers, freight and private vehicles on all road corridors crossing Middle Harbour. The project would improve access to key commercial and employment centres including the Sydney CBD, North Sydney, Artarmon, St Leonards, Macquarie Park and other strategic centres. This would have positive long-term impacts for motorists.

Locally, the project would provide an alternative to existing arterial connections including Warringah Road, Military Road/Spit Road and the Spit Bridge, which currently experience high levels of traffic congestion and constrained freight access. The project would also enhance the resilience of the road network by providing additional road network capacity and alternate north-south and east-west linkages to reduce congestion and potential gridlock in the event of incidents on the road network.

The project has potential to change traffic movements on local roads near to the tunnel connections. Reduced traffic congestion on arterial roads would reduce 'rat running' through local neighbourhoods, impacting positively on local access and connectivity for motorists, pedestrians and cyclists. Surface connections at Balgowlah have potential to increase the incidence of 'rat running' on some local roads. Traffic calming measures would be implemented where required and agreed in consultation with Northern Beaches Council, which would help to minimise potential for 'rat running' on local roads.

Public and active transport

The project would provide opportunity for improved access to public transport for local and regional communities. The new tunnels would allow the opportunity for new public transport routes including express buses within the tunnel to be developed in response to diverse travel demands and support new social and economic development such as the Northern Beaches Hospital precinct in Frenchs Forest. The new tunnels would reduce congestion on key arterial routes like Warringah Road, Eastern Valley Way and Military Road thereby improving travel times and reliability of buses in peak periods between the Northern Beaches, North Sydney, north western Sydney and the Sydney CBD. The new tunnels would also make buses a more attractive surface route transport option by relieving existing congestion and removing stop start conflict to improve existing travel times thereby supporting further mode shift to public transport. In particular, the project would allow new express bus connections between major centres on the Northern Beaches and Frenchs Forest and those in the lower North Shore, Sydney CBD, the north-west and beyond and opportunity for efficient access and interchange with the Sydney Trains and Sydney Metro stations at North Sydney.

The majority of cycling and pedestrian infrastructure along the project corridor provides links to recreational areas such as parks and open space. Cycle routes on the road network within and surrounding the project corridor are predominantly located within the road corridor. The project would improve cyclist and pedestrian connectivity along the project corridor through increased provision of dedicated cyclist and pedestrian links. This includes the provision of a new and upgraded pedestrian and cyclist infrastructure around surface connections and along the upgraded Wakehurst Parkway. It is anticipated that these improvements in connectivity would encourage greater use of existing infrastructure by pedestrians and cyclists.

The project would contribute to improved access and connectivity to social infrastructure within Middle Harbour and the Northern Beaches, which would increase access to recreational opportunities such as kayaking, boating and swimming.

Reinstatement of moorings impacted during construction near the Middle Harbour immersed tube tunnels would be as close as possible to their current locations.

A detailed assessment of potential operational traffic impacts of the project is included in Chapter 9 (Operational traffic and transport).

21.6 Environmental management measures

Measures to avoid, minimise or manage social and economic impacts as a result of the project are detailed in Table 21-6. Additional measures relevant to the management of socio-economic impacts are also outlined in other chapters of the environmental impact statement, including:

- Chapter 8 (Construction traffic and transport)
- Chapter 9 (Operational traffic and transport)
- Chapter 10 (Construction noise and vibration)
- Chapter 11 (Operational noise and vibration)
- Chapter 12 (Air quality)
- Chapter 13 (Human health)
- Chapter 20 (Land use and property)
- Chapter 22 (Urban design and visual amenity).

Table 21-6 Environmental management measures – socio-economics

Ref	Phase	Impact	Environmental management measure	Location
SE1	Design	Social infrastructure	Where feasible and reasonable, the extent of permanent impact on public open space areas (for example, Artarmon Park) will be minimised in further design development.	BL/GHF
SE2	Construction	Social infrastructure	Ongoing engagement will be carried out with representatives of user groups and managers of social infrastructure located near surface construction works/construction support sites and sensitive social infrastructure above the tunnel alignment (for example, schools, places of worship, aged care, child care, health and medical facilities) about the timing and duration of construction works and management of potential impacts.	BL/GHF
SE3	Pre-construction and construction	Stakeholders, community and business	Consultation for the project will be carried out in accordance with the Community Consultation Framework provided as Appendix E of the environmental impact statement.	BL/GHF
SE4	Pre-construction and construction	Employment benefits	A workforce strategy for the project that includes strategies to increase employment and training opportunities for groups such as Aboriginal people, women, young people and the unemployed will be developed and implemented to help maximise employment benefits of the project.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
BU1	Pre-construction and construction	Businesses	Where businesses are affected by property acquisition, or lease cessation, the acquisition and compensation process will be implemented in line with the *Determination of compensation following the acquisition of a business guideline*. Compensation for a business conducted on land that is acquired should be determined in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* as relevant.	BL/GHF
BU2	Construction	Businesses	Specific consultation will be carried out with businesses potentially impacted during construction. Consultation will aim to identify specific potential construction impacts for individual businesses.	BL/GHF
BU3	Construction	Businesses	Based on consultation with businesses, specific feasible and reasonable measures to maintain business access, visibility, parking and address other potential impacts as they arise through the construction phase will be identified and implemented. A phone hotline that enables businesses to find out about the project or register any issues will be maintained.	BL/GHF

Beaches Link = BL, Gore Hill Freeway = GHF