



Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Chapter 28

Synthesis of the environmental
impact statement

28 Synthesis of the environmental impact statement

This chapter provides a synthesis of the findings of the environmental impact statement for the project, in response to the Secretary’s environmental assessment requirements issued for the project. The main body of the environmental impact statement and appendices should be referred to for further details.

The Secretary’s environmental assessment requirements as they relate to the synthesis of the environmental impact statement, and where in the environmental impact statement these have been addressed, are detailed in Table 28-1.

A summary of the proposed environmental management measures relevant to the project are included in Section 28.4.

Table 28-1 Secretary's environmental assessment requirements –synthesis of the environmental impact statement

Secretary’s requirement	Where addressed in EIS
1. The EIS must include, but not necessarily be limited to, the following: q. a chapter that synthesises the environmental impact assessment and provides:	This Chapter 28 (Synthesis of the environmental impact statement) provides the following:
- a succinct, but full, description of the project for which approval is sought;	A full description of the project in Section 28.1 .
- a description of any uncertainties that still exist around design, construction methodologies and/or operational methodologies and how these will be resolved in the next stages of the project;	A description of any uncertainties related to the design, construction methodologies and/or operational methodologies and their proposed resolution in Section 28.3 .
- a compilation of the impacts of the project that have not been avoided;	A compilation of the impacts of the project that have not been avoided in Section 28.4 .
- a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or offset these impacts;	A compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or offset these impacts in Section 28.4 .
- a compilation of the outcome(s) the proponent will achieve; and	A compilation of the outcome(s) the project would achieve in Section 28.6 .
- the reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts;	Project justification and conclusions in Section 28.1 and Section 28.7 . Section 27.2 of Chapter 27 (Cumulative impacts), presents the projects that have been assessed and may have potential cumulative impacts. Potential cumulative impacts are described in Section 27.3 and Section 27.4 of Chapter 27 (Cumulative impacts).

28.1 Overview and key features of the project

28.1.1 Overview of project need

Existing arterial road connections to Sydney's Northern Beaches, including Military Road/Spit Road, Mona Vale Road, Warringah Road and Eastern Valley Way, currently experience high levels of traffic congestion. This congestion adversely affects transport connectivity, travel times, economic prosperity and local amenity for both road users and local communities. These connections are integral to the economic growth of Sydney's Eastern Economic Corridor. As Sydney's population and economy continues to grow, so would the pressure on access to these connections. Consequently, improvements to transport networks would be essential for Sydney to continue to be competitive.

The Greater Sydney Region Plan – A Metropolis of Three Cities (Greater Sydney Commission, 2018a) identifies the importance of investing in and delivering efficient and effective transport systems including road infrastructure that would relieve congestion, improve travel times, improve road safety and enhance and expand capacity on key road corridors. The project would reduce congestion and improve road network performance and efficiency, enabling sustained growth and productivity across Sydney's Eastern Economic Corridor. By providing a new underground motorway bypass of existing surface arterial roads and a third Middle Harbour crossing, the project would also enhance the resilience of the road network across the Eastern Harbour City.

The public transport network connecting the Northern Beaches to destinations such as North Sydney, the Harbour CBD and Chatswood provides many people with direct access to employment hubs, as well as access to education facilities, health centres and hospitals, and sporting, cultural and entertainment facilities. The project would improve the capacity, journey times and reliability of bus services for the Northern Beaches region through reduced congestion on existing surface routes and would facilitate opportunities to expand the express bus service network through allowing express buses to travel within the new tunnels. This would improve access to key centres and result in more people having better access to jobs, goods and services.

The Beaches Link and Gore Hill Freeway Connection project is identified as a *priority initiative* by Infrastructure Australia's *Australian Infrastructure Plan: The Infrastructure Priority List* (Infrastructure Australia, 2018) in recognition of its importance in addressing urban congestion on Sydney's road network, enhancing critical cross-harbour capacity and Northern Beaches connectivity. This new connection would improve travel times to the international gateways of Sydney Airport and Port Botany, and strategic commercial and industrial centres including North Sydney, St Leonards and Macquarie Park. Increased network capacity and connectivity as a result of the project would also result in travel time savings for freight movements, further servicing the growth of Sydney's Eastern Economic Corridor.

In addition to addressing the transport challenges created by the limited arterial roads servicing the Northern Beaches region, by relieving congestion, through traffic and 'rat running' on arterial roads, the project would also deliver benefits for urban amenity in local centres. Improved amenity in town centres along and next to key road corridors such as Mosman, Cremorne, Neutral Bay, Forestville and Seaforth would be expected as a result of reduced through traffic due to the project.

Transport for NSW is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* to construct and operate the Beaches Link and Gore Hill Freeway Connection, which would comprise two main components:

- Twin tolled motorway tunnels connecting the Warringah Freeway at Cammeray and the Gore Hill Freeway at Artarmon to the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Killarney Heights, and an upgrade of Wakehurst Parkway (the Beaches Link)
- Connection and integration works along the existing Gore Hill Freeway and surrounding roads at Artarmon (the Gore Hill Freeway Connection).

Key features of the project are described in Section 28.1.3.

28.1.2 Project objectives

The project objectives were developed to respond to the current and future network challenges and include:

- Providing greater capacity on the road network by reducing congestion and through traffic on arterial roads in northern Sydney
- Creating faster, more reliable journeys for freight services, public transport and other road users between the Northern Beaches region and other strategic centres across Greater Sydney
- Creating opportunities to expand and improve the public transport network connecting the Northern Beaches and key centres across Greater Sydney
- Improving productivity and access to services by facilitating faster and more reliable journeys for commuters and freight to reach their destinations
- Increasing the resilience of the Northern Beaches and North Shore road network to traffic incidents
- Improving urban amenity.

28.1.3 Key features of the project

Key features of the Beaches Link component of the project would include:

- Twin mainline tunnels about 5.6 kilometres long and each accommodating three lanes of traffic in each direction, together with entry and exit ramp tunnels to connections at the surface. The crossing of Middle Harbour between Northbridge and Seaforth would involve three lane, twin immersed tube tunnels
- Connection to the stub tunnels constructed at Cammeray as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project
- Twin two lane ramp tunnels:
 - Eastbound and westbound connections between the mainline tunnel under Seaforth and the surface at the Burnt Bridge Creek Deviation, Balgowlah (about 1.2 kilometres in length)
 - Northbound and southbound connections between the mainline tunnel between Seaforth and the surface at Wakehurst Parkway, Killarney Heights (about 2.8 kilometres in length)
 - Eastbound and westbound connections between Northbridge and the surface at the Gore Hill Freeway and Reserve Road, Artarmon (about 2.1 kilometres in length).
- New and improved public open space and recreation facilities at Balgowlah
- A new access road connection between the Burnt Bridge Creek Deviation and Sydney Road including the modification of the intersection at Maretimo Street and Sydney Road, Balgowlah
- Upgrade and integration works along the Wakehurst Parkway at Seaforth, Killarney Heights and Frenchs Forest, through to Frenchs Forest Road East
- New and upgraded active transport infrastructure (pedestrian and cyclist facilities)
- Ventilation outlets and motorway facilities at the Warringah Freeway in Cammeray, the Gore Hill Freeway in Artarmon, the Burnt Bridge Creek Deviation in Balgowlah and the Wakehurst Parkway in Killarney Heights
- Operational facilities, including a motorway control centre at the Gore Hill Freeway in Artarmon and tunnel support facilities at the Gore Hill Freeway in Artarmon and the Wakehurst Parkway in Frenchs Forest

- Other operational infrastructure including groundwater and tunnel drainage management and treatment systems, surface drainage, signage, tolling infrastructure, fire and life safety systems, roadside furniture, lighting, emergency evacuation and emergency smoke extraction infrastructure, Closed-Circuit Television (CCTV) and other traffic management systems.

Key features of the Gore Hill Freeway Connection component of the project would include:

- Upgrade and reconfiguration of the Gore Hill Freeway between the T1 North Shore and Western Line and T9 Northern Line overpass and the Pacific Highway overpass
- Modifications to the Reserve Road and Hampden Road bridges
- Widening of Reserve Road between the Gore Hill Freeway and Dickson Avenue
- Modification of the Dickson Avenue and Reserve Road intersection to allow for the Beaches Link off ramp
- Upgrades to existing roads around the Gore Hill Freeway to integrate the project with the surrounding road network
- Upgrade and inclusion of traffic lights of the Dickson Avenue and Pacific Highway intersection
- New and upgraded active transport infrastructure (pedestrian and cyclist facilities)
- Other operational infrastructure, including surface drainage and utility infrastructure, signage and lighting, CCTV and other traffic management systems.

The location of the project is shown in Figure 28-1 and key features are shown in Figure 28-2 and Figure 28-3.

The residual land created as a result of the project would largely continue to remain suitable for future development in accordance with the relevant land use zonings and applicable development standards. Where a part of any lot is identified as being usable post construction and surplus to operational requirements, or requiring boundary adjustment following the completion of construction, Deposited Plans of subdivision would be lodged at NSW Land Registry Services. Any future development of residual 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 the project.

A detailed description of the project is provided in Chapter 5 (Project description).



Indicative only – subject to design development

Legend

Operational features

- Beaches Link
- Gore Hill Freeway Connection
- Western Harbour Tunnel
- Warringah Freeway Upgrade
- M4-M5 Link tunnel fitout and commissioned as part of Western Harbour Tunnel

Connecting projects

- M4-M5 Link connections (indicative)
- Northern Beaches Hospital road upgrade project (Completed 2020)

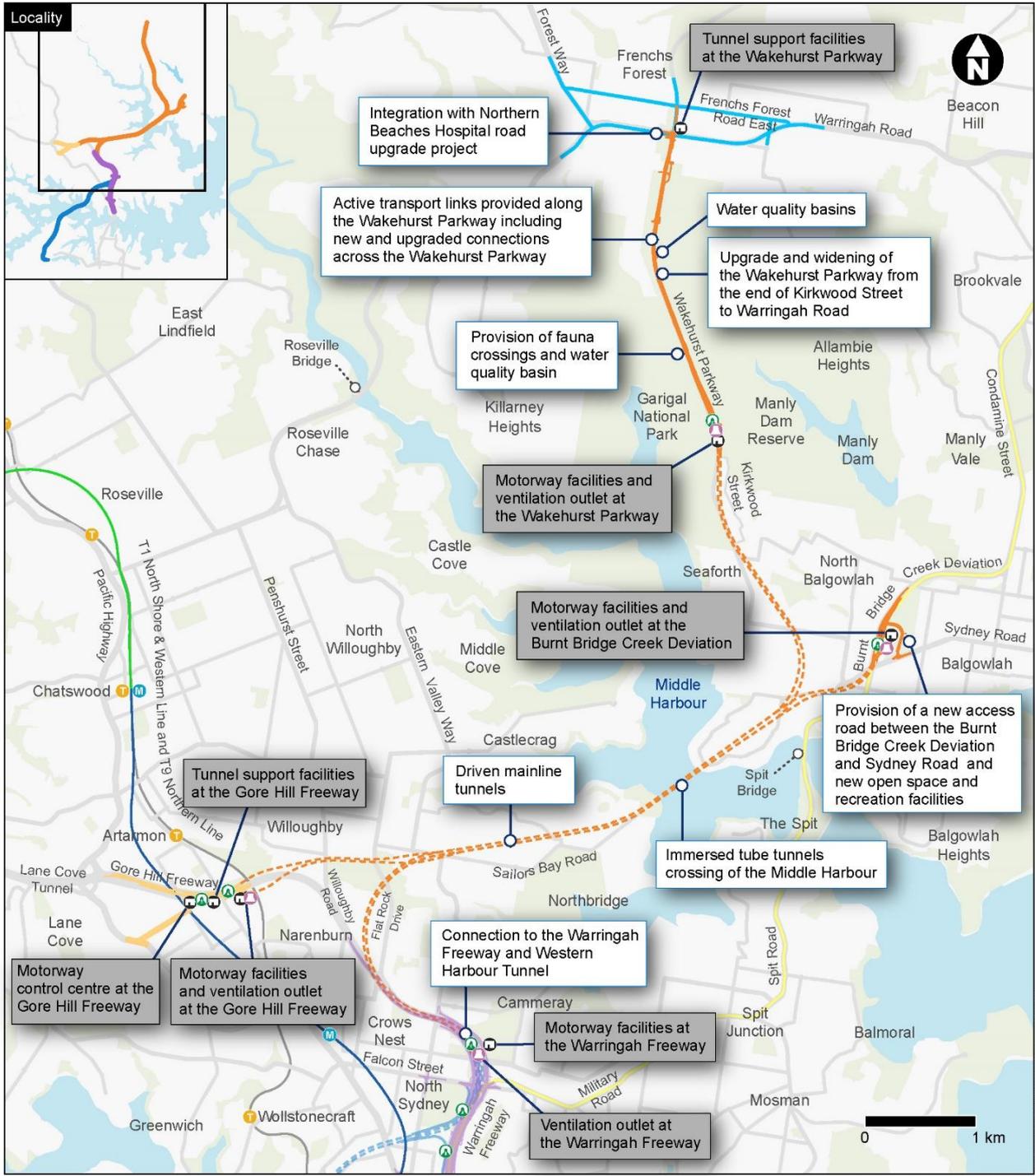
Other projects

- Sydney Metro City & Southwest (under construction)
- Sydney Metro Northwest

Existing rail network

- Suburban rail/Sydney Trains
- Light rail

Figure 28-1 The Western Harbour Tunnel and Beaches Link program of works



Legend

Operational features

- Beaches Link
- Gore Hill Freeway Connection
- Ⓐ Surface connection
- Ⓢ Permanent operational facility
- Ⓣ Ventilation outlet

Connecting projects

- Western Harbour Tunnel
- Warringah Freeway Upgrade
- Northern Beaches Hospital road upgrade project (Completed 2020)

Other projects

- Sydney Metro City & Southwest (under construction)
- Sydney Metro Northwest

Existing transport network

- Northern Beaches B-Line
- Suburban rail/Sydney Trains
- Ⓣ Train station

Design features

- Surface
- Tunnel

Figure 28-2 Key features of the Beaches Link component of the project

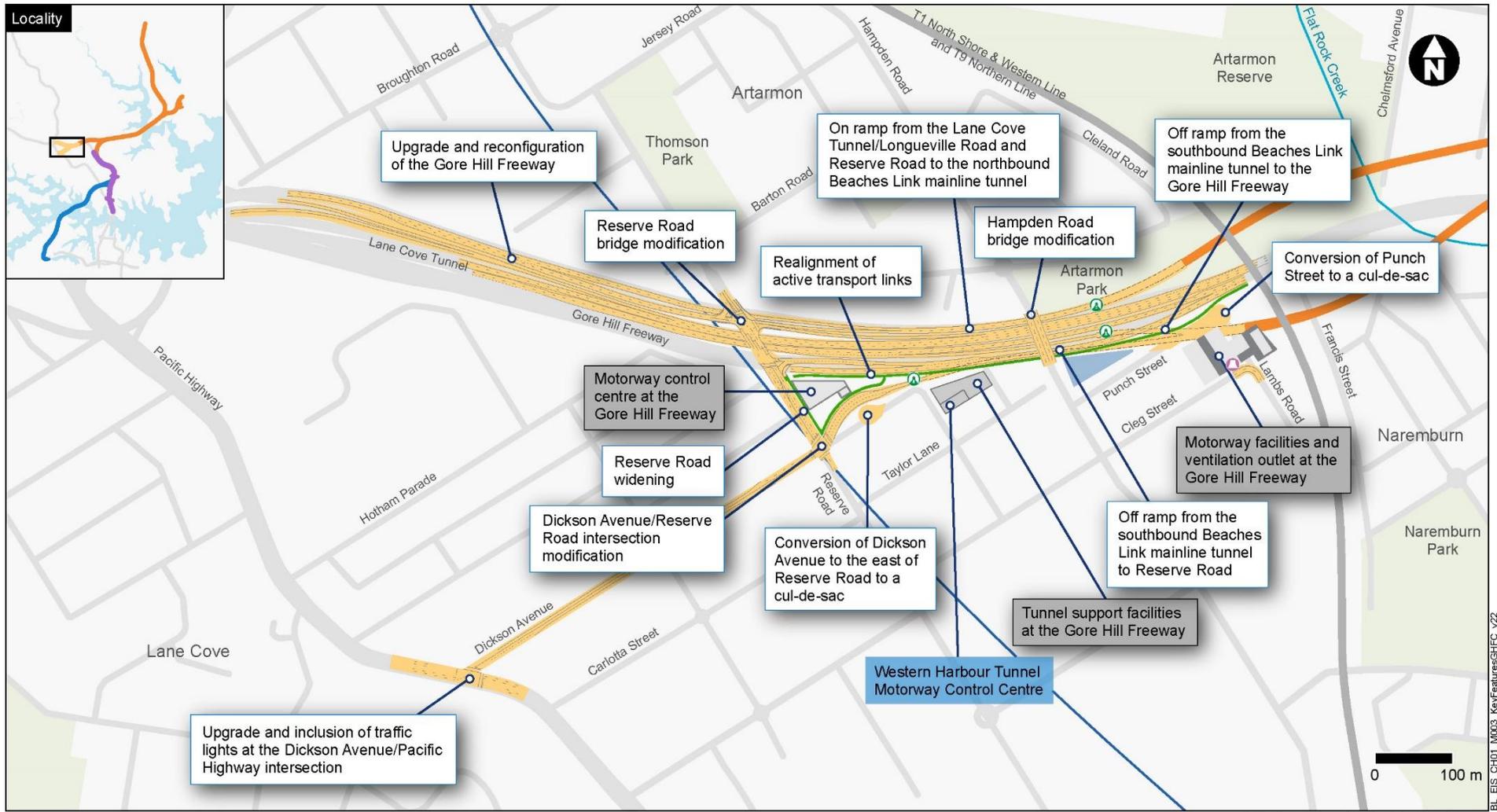


Figure 28-3 Key features of the Gore Hill Freeway component of the project

28.2 Construction of the project

A substantial amount of the work for the project would occur underground with the mainline and ramp tunnels being constructed using roadheaders. Where the tunnels cross Middle Harbour construction would involve excavation of the bed of the harbour and the placement of twin immersed tube tunnel units installed both on supporting piles and within a trench. The middle third of the tunnels would be installed on supporting piles and would sit generally just above the nominally dredged bed of the harbour. The northern and southern thirds of the tunnels would be installed within a trench of varying depth.

Large surface areas would be required to support underground construction activities and to support and construct the surface connections, tunnel portals, surface road works, active transport facilities (pedestrian and cyclist facilities) and operational facilities.

Construction activities for the Gore Hill Freeway Connection would generally include surface earthworks, bridgeworks, construction of retaining walls, installation of stormwater drainage and pavement construction.

Subject to planning approval and procurement, construction of the Beaches Link and Gore Hill Freeway Connection project (the project) is currently planned to commence in early 2023. On that basis, completion of the main construction works would be around around the end of 2027 with a likely opening to traffic in early 2028. Construction works for the new and improved open space and recreation facilities are planned to commence in 2023 and progressively staged to be fully completed in late 2028.

28.2.1 Key construction activities

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

Key construction activities would include:

- Early works and site establishment, with typical activities being property acquisition and condition surveys, utilities installation, protection, adjustments and relocations, installation of site fencing, environmental controls (including noise attenuation and erosion and sediment control), traffic management controls, vegetation clearing, earthworks, demolition of structures, building temporary construction support sites including acoustic sheds and associated access decline acoustic enclosures (where required), construction of minor access roads and the provision of property access, temporary relocation of pedestrian and cycle paths and bus stops, temporary relocation of swing moorings and/or provision of alternative facilities (mooring or marina berth) within Middle Harbour
- Construction of the Beaches Link, with typical activities being excavation of tunnel construction access declines, construction of driven tunnels, cut and cover and trough structures, construction of surface upgrade works, construction of cofferdams, dredging and immersed tube tunnel piled support activities in preparation for the installation of immersed tube tunnels, casting and installation of immersed tube tunnels and civil finishing and tunnel fitout
- Construction of operational facilities comprising:
 - A motorway control centre at the Gore Hill Freeway in Artarmon
 - Tunnel support facilities at the Gore Hill Freeway in Artarmon and at the Wakehurst Parkway in Frenchs Forest
 - Motorway facilities and ventilation outlets at the Warringah Freeway in Cammeray (fitout only of the Beaches Link ventilation outlet at Warringah Freeway (the outlet structure being constructed by Western Harbour Tunnel and Warringah Freeway Upgrade

project)), the Gore Hill Freeway in Artarmon, the Burnt Bridge Creek Deviation in Balgowlah and the Wakehurst Parkway in Killarney Heights

- A wastewater treatment plant at the Gore Hill Freeway in Artarmon
- Installation of motorway tolling infrastructure
- Staged construction of the Gore Hill Freeway Connection at Artarmon and upgrade and integration works at Balgowlah and along the Wakehurst Parkway with typical activities being vegetation clearing, earthworks, bridgeworks, construction of retaining walls, stormwater drainage, pavement works and linemarking and the installation of road furniture, lighting, signage and noise barriers
- Testing of plant and equipment and commissioning of the project, backfill of access declines, removal of temporary construction support sites, landscaping and rehabilitation of disturbed areas and removal of environmental and traffic controls.

Further details are provided in Chapter 6 (Construction work).

28.2.2 Temporary construction support sites

Temporary construction support sites would be required as part of the project and would include tunnelling and tunnel support sites, civil surface sites, cofferdams, mooring sites, wharf and berthing facilities, laydown areas, parking and workforce amenities. Temporary construction support sites would include:

- Cammeray Golf Course (BL1)
- Flat Rock Drive (BL2)
- Punch Street (BL3)
- Dickson Avenue (BL4)
- Barton Road (BL5)
- Gore Hill Freeway median (BL6)
- Middle Harbour south cofferdam (BL7)
- Middle Harbour north cofferdam (BL8)
- Spit West Reserve (BL9)
- Balgowlah Golf Course (BL10)
- Kitchener Street (BL11)
- Wakehurst Parkway south (BL12)
- Wakehurst Parkway east (BL13)
- Wakehurst Parkway north (BL14).

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

28.3 Project uncertainties

As with any project of the nature and scale of this project, the project design presented in this environmental impact statement would continue to be refined during further design development. This design development would be guided by the key principles adopted during the planning and assessment phase of the project. Some flexibility has been provided in the design to:

- Allow for refinement during further design and construction planning phase to consider alternative construction techniques

- Allow for refinement in response to submissions received following the exhibition of this environmental impact statement
- Respond to improved technologies or materials
- Improve value for money.

The final design may vary from that described in Chapter 5 (Project description). If approval is granted, any changes to the project would be reviewed for consistency with the assessment contained in the environmental impact statement including relevant environmental management measures, environmental performance outcomes and any future conditions of approval. If design refinements are not consistent with the approval issued by the Minister for Planning and Public Spaces, approval would be sought from the Minister for any such modifications in accordance with the requirements of Division 5.2 of the *Environmental Planning and Assessment Act 1979*.

Areas where further work would be carried out to optimise the design outcomes and construction planning include refinements to:

- Avoid utilities that present substantial construction difficulties in terms of logistics, time and/or cost
- Reduce the duration of construction
- Avoid areas of environmental sensitivity
- Reduce impacts on the community during construction and/or operation
- Improve operation of the project without increasing the potential environmental impacts.

For any future design refinements, a screening assessment would be carried out to consider whether the refinement would result in:

- Any inconsistency with the conditions of approval
- Any inconsistency with the objectives and operation of the project as described in the environmental impact statement
- A change to the approved project that may require a modification of the approval
- Any potential environmental or social impacts of a greater scale or impact on previously unaffected receivers than that considered by the environmental impact statement or the submissions and preferred infrastructure report.

Table 28-2 outlines key project components that have been identified as requiring resolution during further design development, construction and/or operation of the project and references where these uncertainties are discussed in this environmental impact statement.

Table 28-2 Resolution of project uncertainties

Project uncertainties	Proposed resolution	Timing	Where discussed
Tunnel design and operational facilities	<ul style="list-style-type: none"> Confirmation of the final tunnel alignment would be carried out by the construction contractor, once appointed Future consultation to engage with communities and affected stakeholders about the final alignment of the mainline and ramp tunnels would be carried out to explain any differences between the design presented and assessed in this environmental impact statement and the design refined during further development, as required The final configuration and design requirements for the tunnel electricity supply and substations and mains water connection (if required) would be determined during further design development in consultation with relevant utility providers. 	Design	Chapter 5 (Project description)
New and improved open space and recreation facilities	<ul style="list-style-type: none"> 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 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 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. 	Design	Chapter 5 (Project description)
Local road changes	The need for, design and location of traffic calming measures as part of the surface connections and road works to be provided at the Burnt Bridge Deviation at Balgowlah would be confirmed during further design development in consultation with Northern Beaches Council.	Design	Chapter 5 (Project description)

Project uncertainties	Proposed resolution	Timing	Where discussed
Utilities	Confirmation of the extent of installation, relocation, adjustment and/or protection of utilities would be carried out during further design development and in consultation with the relevant utility providers. To confirm the extent of utility works, additional utility tracing and/or potholing investigations may be required and may result in the need to carry out works outside of the construction footprint, particularly within and around surface connections and road works. As described in Chapter 5 (Project description), Appendix D (Utilities management strategy) provides the framework for how these utility relocations and adjustments would be identified, assessed and managed.	Design	Chapter 5 (Project description) Appendix D (Utilities management strategy)
Temporary construction support sites – location, layout and facilities	The final location and layout of temporary construction support sites would be confirmed during construction planning, with consideration of the final construction methodologies for the project and in accordance with the conditions of approval, once determined.	Design	Chapter 6 (Construction work)
Cofferdams and extent of dredging works in Middle Harbour	<ul style="list-style-type: none"> The final location and layout of the Middle Harbour cofferdams (BL7 and BL8) would be confirmed during further design development and construction planning, with consideration of geotechnical conditions, the final construction methodologies for the project and in accordance with the conditions of approval The final extent of dredging works for the construction of the immersed tube tunnels would be confirmed during further design development and construction planning for the project, with consideration of additional geotechnical investigations and the final construction methodologies for the project. 	Design	Chapter 6 (Construction work)

Project uncertainties	Proposed resolution	Timing	Where discussed
<p>Spoil disposal management and encapsulation opportunities for contaminated material encountered on site</p>	<ul style="list-style-type: none"> • Further site investigations during the further design development and construction planning phases would inform contamination management including determining where encapsulation is appropriate • Any material that is not suitable for encapsulation would be loaded into sealed and covered trucks for disposal at a suitably licensed facility that would be confirmed during development of the detailed construction method for the project by the construction contractor, once appointed • A review of encapsulation, spoil transport and disposal options identified in the environmental impact statement would be carried out by the construction contractor, once appointed • Spoil transport options would be adjusted as required and the relevant construction management plans updated, in accordance with the relevant requirements of the conditions of approval • Confirmation of the location for a loadout facility for any dredged material not suitable for offshore disposal would be confirmed during further construction planning, in accordance with the relevant requirements of the conditions of approval • The location, design and configuration for encapsulating contaminated materials encountered on site during earthworks at Flat Rock Drive construction support site (BL2) and surface works associated with Balgowlah and Wakehurst Parkway would be confirmed during further design development and construction planning. 	<p>Design and construction</p>	<p>Chapter 6 (Construction work) Chapter 24 (Resource use and waste management)</p>

Project uncertainties	Proposed resolution	Timing	Where discussed
Construction method and staging	<ul style="list-style-type: none"> Final construction methodologies and staging plans including road possessions would be prepared by the construction contractor, once appointed. The staging plans would be based on further design development and refinement of the construction method. The plans would describe how construction areas associated with road works would be established to safely maintain traffic flows in areas of reduced traffic capacity, and to minimise delays to motorists, public transport, pedestrians and cyclists. 	Construction	Chapter 6 (Construction work) Chapter 8 (Construction traffic and transport)
Final noise mitigation requirements	<ul style="list-style-type: none"> Further noise modelling would be carried out during further design development to confirm the receivers eligible for at-property treatments. The operational noise performance of the project would be reviewed during further design development and operational noise mitigation (ie quieter noise pavement, noise barrier, at-property treatment or a combination) would be confirmed subject to a reasonable and feasible assessment in accordance with the <i>Noise Mitigation Guideline</i> (Roads and Maritime Services, 2015g) Ongoing community and stakeholder consultation to assist in informing and determining appropriate noise mitigation would be carried out during further design development and construction. 	Design	Chapter 11 (Operational noise and vibration)
The boundary and potential impacts to the Frenchs Bullock Track	<ul style="list-style-type: none"> Further detailed survey would be completed to confirm the heritage curtilage of the southern section of Frenchs Bullock Track prior to construction to determine if this section would be directly impacted Where the heritage curtilage of the Frenchs Bullock Track is within the construction footprint or the boundary of proposed permanent infrastructure, the track would be avoided where possible through further design development. 	Design	Chapter 14 (Non-Aboriginal heritage)

Project uncertainties	Proposed resolution	Timing	Where discussed
Extent and final design for fauna fencing along the Wakehurst Parkway	The extent and final alignment of fauna fencing along the Wakehurst Parkway would be confirmed during further design development by the construction contractor, once appointed.	Design	Chapter 5 (Project description)
The presence of, and potential impacts on registered Aboriginal Heritage Information Management System (AHIMS) sites and sites containing potential Aboriginal heritage significance	<ul style="list-style-type: none"> • Further consultation with Department of Premier and Cabinet (Heritage), the Metro Local Aboriginal Land Council (LALC) and Registered Aboriginal Parties would be carried out to determine appropriate management measures for previously recorded Aboriginal sites not assessed during archaeological surveys due to site accessibility constraints • Terrestrial Aboriginal site condition surveys would be completed using photogrammetry and 3D capture techniques employed to confirm where vibration monitoring at terrestrial AHIMS sites would be required. 	Design and construction	Chapter 15 (Aboriginal cultural heritage)
The presence of, and potential impacts on maritime heritage	<ul style="list-style-type: none"> • Any pre-dredge clearance of the bed of the harbour to include involvement by a maritime archaeologist to minimise the risk of impact to potential maritime heritage remains such as maritime infrastructure, shipwrecks or submerged heritage sites and items • Complete and review the sidescan sonar survey for areas to be affected by project works to identify any additional potential heritage items requiring investigation and assessment • Carry out high-resolution geophysical survey(s) to further investigate potential submerged cultural heritage material in consultation with a maritime archaeology advisor • Carry out controlled archaeological investigations to recover any artefacts if required and feasible. 	Design and construction	Chapter 14 (Non-Aboriginal heritage) Chapter 15 (Aboriginal cultural heritage)

Project uncertainties	Proposed resolution	Timing	Where discussed
Location and degree of contamination	<ul style="list-style-type: none"> Further investigations of potentially contaminated sites are required to quantify the exposure risk. These investigations would be carried out prior to construction activities so contamination (if present) can be adequately planned for and managed. 	Pre-construction and construction	Chapter 16 (Geology, soils and groundwater)
The potential presence of landfill generated gas which could impact on the construction and/or operation of the project	<ul style="list-style-type: none"> Ground gas investigations would be carried out in Flat Rock Reserve to assess for the potential presence of landfill generated gas which could impact on the construction and/or operation of the project Ground gas investigations would be carried out in accordance (where applicable) with the <i>Guideline for the Assessment and Management of Sites Impacted by Hazardous Ground Gases</i> (NSW EPA, 2012). 	Pre-construction and construction	Chapter 16 (Geology, soils and groundwater)
Groundwater inflow rates and water table drawdown associated with tunnelling in proximity to Middle Harbour	<ul style="list-style-type: none"> A tunnelling procedure that details a methodology to determine when and what type of waterproofing is required to be installed would be implemented during the further design development phase and outcomes monitored Groundwater inflows into the tunnels would be monitored during construction and compared to predictions from the updated groundwater model The groundwater model would be updated based on the results of the monitoring and if required, feasible and reasonable management measures to minimise groundwater inflows would be implemented to ensure that groundwater inflow performance criteria are met. 	Design and construction	Chapter 16 (Geology, soils and groundwater)

Project uncertainties	Proposed resolution	Timing	Where discussed
The locations and extent of potential settlement impacts	<ul style="list-style-type: none"> • Further assessment would be carried out with regards to settlement, including groundwater and geotechnical modelling during further design development to refine the level of predicted settlement, where required • Efforts to minimise impacts in areas where higher ground movement in excess of settlement limits is predicted would be carried out • Building condition surveys and monitoring of settlement during construction would be carried out by the construction contractor. 	Design and construction	Chapter 16 (Geology, soils and groundwater)
Construction and operational water treatment plant design local stormwater discharge capacity	<ul style="list-style-type: none"> • The local stormwater system capacity to receive construction and operational wastewater treatment plant inflows would be confirmed during further design development, and environmental management measures implemented in the event of a capacity issue. 	Design	Chapter 17 (Hydrodynamics and water quality)
Surface water drainage and management infrastructure	<ul style="list-style-type: none"> • The drainage design for the project would be continued to be refined during further design development and would include confirmation of capacity requirements and extent of scour protection • The type and design of the stormwater management system including permanent water quality basins, would continue to be refined and modelled as part of further design development with the aim of meeting or improving the existing water quality of receiving waters. This would also include consideration of best management practice guidelines including Transport for NSW's Water sensitive urban design guideline (Roads and Maritime Services, 2017d). 	Design	Chapter 17 (Hydrodynamics and water quality)

Project uncertainties	Proposed resolution	Timing	Where discussed
Flood behaviour during operation	<ul style="list-style-type: none"> Further flood modelling would be carried out during further design development to confirm the level of predicted impacts and ensure appropriate mitigation measures identified for areas where higher flooding is predicted, eg provision of flood walls and/or increased flood storage capacity. Further flood modelling would also include the consideration of future climate change and a partial blockage of the local stormwater drainage system. 	Design	Chapter 18 (Flooding)
Groundwater drawdown impact on groundwater dependent ecosystems and stream flows	<ul style="list-style-type: none"> A focused study confirming the potential groundwater drawdown and associated baseflow reductions at Burnt Bridge Creek, Flat Rock Creek and Quarry Creek due to tunnelling would be carried out. Where unacceptable ecological impacts are predicted, feasible and reasonable mitigation measures to address the impacts would be identified, incorporated into the detailed design, and implemented during construction. Monitoring of the vegetation within the mapped groundwater dependent ecosystem adjoining Flat Rock Creek and Quarry Creek would be carried out to assess how its health may be impacted by water table drawdown. This would be carried out in conjunction with monitoring of groundwater levels, groundwater quality and surface water flows If monitoring identifies potential long term detrimental effects to groundwater dependent ecosystem health, adaptive management measures would be implemented. 	Design and construction	Chapter 16 (Geology, soils and groundwater) Chapter 19 (Biodiversity)

Project uncertainties	Proposed resolution	Timing	Where discussed
Design details for motorway facilities and ventilation outlets	<ul style="list-style-type: none"> Refinement of the architectural design of the project motorway facilities and ventilation outlets would be confirmed during further design development. A design for the motorway facilities and ventilation outlets would be developed to incorporate the infrastructure component as an integral part of surrounding land use in accordance with the project's strategic urban design framework (refer to Appendix V (Technical working paper: Urban design, landscape character and visual impact) for more information). 	Design	Chapter 22 (Urban design and visual amenity)
Urban design detail of fixed infrastructure (motorway facilities, ventilation outlets, substations, portals, water treatment facilities and bridges) and other key features	<ul style="list-style-type: none"> The urban design for project infrastructure and key features would be refined during further design development in accordance with performance requirements for elements such as the motorway facilities and ventilation outlets, the objectives and principles for urban design and landscaping developed for the project, and the outcomes of consultation An urban design and landscape plan would be prepared during further design development and implemented in line with the strategic urban design framework for the project. The urban design and landscape plan would detail built and landscape features to be implemented during construction and rehabilitation of disturbed areas during construction of the project. 	Design	Chapter 22 (Urban design and visual amenity)

28.4 Summary of project impacts and management measures

This section provides a summary of the impacts of the project that could not be avoided. These impacts are discussed in detail in Chapter 8 (Construction traffic and transport) to Chapter 27 (Cumulative impacts) of this environmental impact statement.

28.4.1 Key impact avoidance

Many potential impacts have been avoided through the project development process which included input from key stakeholders and the community. A number of corridor alternatives were evaluated to identify the most technically, environmentally and socially acceptable alternative with the most efficient transport connections (refer to Chapter 4 (Project development and alternatives) for more information on the alternatives considered).

Following identification of the preferred corridor for the project, further design development and refinement has been carried out which has resulted in the avoidance or minimisation of environmental impacts; these include:

- Selection of roadheaders instead of tunnel boring machines for construction of the land-based tunnels, resulting in lower spoil volumes and fewer heavy vehicle movements
- The selection of precast immersed tube tunnel units on top, or within the top layers, of harbour rock and sediments as the preferred harbour crossing method, rather than the use of driven tunnel, thereby avoiding the need for tunnelling in challenging geology and enabling better grades and journey experience (eg safety, lower emissions)
- Refinements to the location of the Warringah Freeway, Gore Hill Freeway and Balgowlah surface connections, resulting in improved connectivity and network performance, improved constructability and design, and minimising environmental, community and traffic impacts
- Temporary construction support site location and layout alternatives were considered to minimise impacts to sensitive environments and community facilities, while minimising property impacts and acquisitions. Locations were also selected to maximise opportunities for direct access to arterial roads or water transport opportunities for construction traffic, to avoid use of local streets where possible
- Ventilation system design alternatives. A longitudinal system with elevated ventilation outlets was selected as the preferred option as it is able to meet the requirement to avoid portal emissions, most effectively manage smoke in the tunnel in the event of a fire, ensure emissions are dispersed and diluted so there is minimal or no effect on ambient air quality
- Alternatives for the transport of spoil were considered, including the use of rail, barge or truck. A combination of trucks and some barging was selected as the preferred spoil transport option for the project as it reduces the amount of double or triple handling of spoil required (ie transfer spoil to a loading facility) while also providing the ability to move large volumes of spoil, thereby reducing the number of heavy vehicle movements on the wider road network
- Dredged material management alternatives were considered. An application for offshore disposal of suitable dredged material will be submitted to the Australian Government Department of Agriculture, Water and the Environment. It is proposed that suitable dredged material would be transported by barge and disposed of at a designated offshore disposal site (in accordance with legislative requirements). Disposal of suitable dredged material at the designated offshore disposal site would minimise some environmental impacts at sensitive receivers and avoid the creation of a large volume of waste to be disposed on land
- Identification of the potential for residual land at Balgowlah to be repurposed as new and improved open space and recreation facilities in line with the *Northern Beaches Sportsground Strategy* (Northern Beaches Council, 2017a) and addressing the current under supply of sporting grounds available for public use in the local area

- Further refinement of the design including consideration of community issues through the environmental impact statement exhibition process may further reduce and if possible, avoid impacts.

Potential impacts would be further avoided and minimised, where possible, through the implementation of the environmental management measures complying with the performance outcomes identified in Chapter 4 (Project development and alternatives).

28.4.2 Key project impacts

The environmental impact statement has assessed the potential environmental impacts that may occur as a result of the project and recommends measures to manage these impacts. Table 28-3 provides a summary of potential impacts of the project that could not be avoided and the associated environmental management measures. Table 28-3 is not a comprehensive list of all environmental management measures proposed in this environmental impact statement. For further details refer to the individual chapters. Unavoidable impacts would be addressed through design refinements or ongoing management during construction and operation.

Table 28-3 Summary of key project impacts and management measures

Summary of key impact	Timing	Management measure
<p>Traffic and transport</p> <ul style="list-style-type: none"> Increased heavy vehicle movements around work sites during construction Increased traffic volumes and delays for traffic in the North Sydney, Balgowlah and Frenchs Forest areas during construction Temporary, partial closures of the Pacific Highway, Wakehurst Parkway and roads within the Gore Hill Freeway and Artarmon area, for short periods of time to carry out key construction activities which are located within the road corridor Temporary closures and detours of footpaths and shared user paths at Flat Rock Reserve, and within the Gore Hill Freeway, Artarmon, Spit West Reserve, Balgowlah and Wakehurst Parkway areas Temporary impacts on maritime traffic associated with the six closures (likely two full closures and four partial closures) of Middle Harbour for recreational, commercial and government users between Northbridge and Seaforth to enable construction works for the crossing of Middle Harbour. 	<p>Construction</p>	<ul style="list-style-type: none"> Ongoing consultation, as relevant to the location will be carried out with Greater Sydney Operations, the Port Authority of NSW, local councils, emergency services and bus operators to minimise traffic and transport impacts Directional signage, barriers and/or line marking will be used as required to direct and guide motorists, cyclists and pedestrians past construction sites and on the surrounding network. This will be supplemented by Variable Message Signs to advise all road users of potential delays, traffic diversions, speed restrictions, or alternative routes Any adjustments to existing bus stops will be determined in consultation with relevant stakeholders including other divisions of Transport for NSW and advanced notification will be provided to affected bus customers. Relocations will be as close to their existing position where feasible and reasonable Truck marshalling areas will be identified and used where feasible and reasonable to minimise potential queueing and traffic and access disruptions in the vicinity of construction support sites Activities requiring temporary partial road closures will be carried out outside of peak periods and/or during night time to minimise the impact of these activities on the road network where feasible and reasonable Direct impacts to existing pedestrian and cycle facilities will be minimised where reasonable and feasible. Any detours and adjustments will be designed with consideration of user safety and convenience Construction marine traffic activities will be scheduled to avoid times and locations of high recreational marine traffic where feasible and reasonable

Summary of key impact	Timing	Management measure
<p>Noise and vibration</p> <ul style="list-style-type: none"> • Construction noise levels predicted to exceed noise management levels at some sensitive receiver locations • Potential for sleep disturbance impacts during the night • Construction traffic movements has the potential to result in road traffic noise levels above the relevant criteria. 	Construction	<ul style="list-style-type: none"> • Harbour closures scheduling will be carried out in consultation with Port Authority of NSW, other divisions of Transport for NSW and other relevant stakeholders. • Monitoring will be carried out to confirm construction noise and vibration levels in relation to noise and vibration management levels • Where construction activities are predicted to exceed noise management levels at receivers mitigation measures will be implemented where feasible and reasonable including community consultation and engagement, detailed programming and respite protocols and the early implementation of operational noise barriers • An out-of-hours works protocol will be developed for the construction of the project. The protocol will be prepared in consultation with the Department of Planning, Industry and Environment and the NSW Environment Protection Authority. The project protocol will be implemented during the duration of the construction of the project.
<p>Human health and air quality</p> <ul style="list-style-type: none"> • Underwater noise and vibration impacts affecting water-based recreational users • Dust generated during works carried out for demolition, earthworks, construction and track-out • Odours potentially generated during handling and management of harbour sediments and material excavated from a former landfill site • Blast emissions generated by blasting, if required during construction • Potential impacts on ambient air quality due to changes in the distribution of surface traffic and operation of the tunnel ventilation facilities: 	Construction/ operation	<ul style="list-style-type: none"> • Opportunities to coordinate the piling program with the planned activities of key recreational stakeholders to minimise interaction with planned or peak activity periods of these stakeholders, where feasible and reasonable • An underwater noise monitoring program will be carried out during the early stages of impact piling activities at each location to measure underwater noise levels and compare against acoustic thresholds to confirm the extent of areas that need to be managed with respect to underwater noise, and to confirm appropriate management measures (as required). Appropriate management measures will be implemented during impact piling. • Communication and management measures will be implemented during construction to manage potential underwater noise impacts to water-based recreational users during dredging and piling activities in Middle Harbour

Summary of key impact	Timing	Management measure
<ul style="list-style-type: none"> – Generally minor increases in common ambient air quality air pollutants (CO, NO₂, PM₁₀, PM_{2.5}, benzene, polycyclic aromatic hydrocarbons, formaldehyde, 1,3-butadiene and ethylbenzene) predicted, with only a very small proportion of receivers predicted to experience larger increases – Some of the current exceedances of short-term NSW EPA ambient air quality criteria (1-hour NO₂, 24-hour PM_{2.5} and 24-hour PM₁₀ and annual mean PM₁₀ and PM_{2.5}) predicted to continue when the project is in operation, although total numbers of receivers experiencing exceedances predicted to decrease as a result of the project – Exceedances of PM₁₀ and PM_{2.5} air quality criteria predicted at potential future buildings above 30 metres in height within 300 metres of the Gore Hill Freeway ventilation outlet, but would not necessarily preclude such development – Odours generated by vehicle emissions. 		<ul style="list-style-type: none"> • Standard construction air quality mitigation and management measures will be detailed in construction management documents including minimisation and management of dust generation during construction. • Site investigations will be carried out during the detailed design and construction planning phase to determine the potential to encounter odorous gases or materials during the proposed excavations at the Flat Rock Drive construction support site (BL2). If unacceptable off-site impacts are predicted, appropriate mitigation and management measures will be identified to minimise potential impacts, with consideration of the investigation results, proposed site activities and meteorological conditions, and the identified measures will be implemented during relevant site activities • Blasting and associated activities will be carried out in a manner that does not generate unacceptable overpressure and vibration impacts or pose a significant risk impact to structures and sensitive receivers. Prior to any blasting all potentially affected sensitive receivers and features in the vicinity will be identified. The potentially affected community will be kept informed about proposed blasting activities.
<p>Non-Aboriginal heritage</p> <ul style="list-style-type: none"> • Direct and indirect impacts to non-Aboriginal heritage items near of the project including: <ul style="list-style-type: none"> – Moderate and permanent impacts to Cammeray Park (including Golf Course) as a result of the construction activities and the installation of permanent operational infrastructure within the heritage boundary – Major impacts at Balgowlah Golf Course as a result of the temporary establishment and operation of Balgowlah Golf Course construction support site (BL10) and the construction of 	Construction/operation	<ul style="list-style-type: none"> • Non-Aboriginal heritage awareness training will be provided for contractors prior to commencement of construction works to ensure understanding of potential heritage items that may be impacted during the project, and the procedure required to be carried out in the event of discovery of non-Aboriginal heritage materials, features or deposits, or the discovery of human remains • Archival recording will be carried out in accordance with the <i>Photographic Recording of Heritage Items Using Film or Digital Capture guideline</i> for areas/items subject to change • Delineation of restricted zones will be implemented to avoid inadvertent works occurring within the curtilage of heritage items

Summary of key impact	Timing	Management measure
<p>permanent road infrastructure and operational facilities</p> <ul style="list-style-type: none"> - Direct impacts to maritime heritage items near of the project 		<ul style="list-style-type: none"> • A Maritime Heritage Management Plan that details the objectives and methodologies to conserve maritime heritage and mitigate impacts will be prepared in consultation with a qualified and experienced maritime archaeologist and implemented during construction.
<p>Aboriginal heritage</p> <ul style="list-style-type: none"> • Direct and indirect impacts to Aboriginal heritage items near of the project including: <ul style="list-style-type: none"> – Five Aboriginal sites located within 50 metres of surface works including two sites that may be subject to indirect impacts associated with vibration and settlement – Five Aboriginal sites located above or within 50 metres of the tunnel alignment and may be subject to indirect impacts associated with vibration and settlement • Direct impacts from construction activities such as dredging, piling and excavation within the cofferdams to submerged sites • Indirect impacts associated with construction vibration generated by construction activities in proximity to Aboriginal sites. 	Construction	<ul style="list-style-type: none"> • Cultural and historic heritage awareness training will be carried out for personnel engaged in work that may impact heritage items before commencing works for the project. • Vibration monitoring will be carried out where required at terrestrial AHIMS sites. Where monitoring identifies vibration levels exceed 2.5 millimetres per second or following vibration intensive activities, a subsequent condition survey will be carried out to record any changes to the integrity of the site that may have resulted from construction vibration • The effectiveness of using high resolution geophysical survey to identify rock overhangs concealed by marine sediments will be assessed. If determined to be appropriate geophysical survey will be conducted to identify potential rock overhangs concealed by marine sediments.

Summary of key impact	Timing	Management measure
<p>Hydrodynamics and water quality</p> <ul style="list-style-type: none"> Discharges from construction and operation wastewater treatment facilities affecting fresh and marine water quality. Construction works leading to water quality and sedimentation issues in surrounding waterways. 	<p>Construction/ Operation</p>	<ul style="list-style-type: none"> Construction and operation wastewater treatment plants will be designed to meet the relevant requirements of ANZECC/ARMCANZ (2000) and ANZG (2018) Operational phase monitoring will be described in the operational water quality monitoring program, for both surface water and groundwater as appropriate, and carried out in line with the post construction phases requirements of the <i>Guideline for Construction Water Quality Monitoring</i> (RTA, 2003a). Should any of the discharge criteria be exceeded, a management response will be triggered and appropriate mitigation measures to address the exceedance will be identified and implemented A freshwater quality monitoring program for the construction of the project will be developed and implemented, with consideration of the freshwater monitoring being carried out for the Western Harbour Tunnel and Warringah Freeway Upgrade project and the completed Northern Beaches Hospital road upgrade project. If exceedances of the criteria established under the freshwater monitoring program are detected, a management response will be triggered and appropriate mitigation measures to address the exceedance will be identified and implemented Erosion and sediment control measures will be implemented at all work sites and surface road upgrades in accordance with the principles and requirements in <i>Managing Urban Stormwater – Soils and Construction, Volume 1</i> (Landcom, 2004), <i>Managing Urban Stormwater: Soils and Construction, Volume 2D Main Road Construction</i> (Department of Environment and Climate Change (DECC), 2008) and relevant guidelines, procedures and specifications of Transport for NSW.

Summary of key impact	Timing	Management measure
<p>Biodiversity</p> <ul style="list-style-type: none"> • Removal of native remnant and planted individuals of Netted Bottle Brush (<i>Callistemon linearifolius</i>) and Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) listed under the <i>Biodiversity Conservation Act 2016</i> and EPBC Act • Removal of about 15.4 hectares of native vegetation and native revegetation • Fragmentation of habitat and removal of hollow-bearing trees due to the realignment and upgrade of the Wakehurst Parkway. The fragmentation of vegetation would potentially adversely affect the movement patterns of a number of threatened terrestrial fauna species known or likely to occur in the area • Potential edge effects to vegetated habitats next to the Wakehurst Parkway • Potential for short-term noise impacts from surface works at Balgowlah to the Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>) camp identified in the vegetated area between Balgowlah Road and Burnt Bridge Creek Deviation, about 120 metres from the construction footprint • Potential noise and vibration impacts to Large-eared Pied Bat during the realignment and upgrade of the Wakehurst Parkway, particularly during blasting and/or rock hammering • Potential impacts to key fish habitats in Middle Harbour due to the removal of medium/high relief rocky reef habitat, turbidity and sedimentation from dredging, and underwater noise from dredging and piling 	<p>Construction</p>	<ul style="list-style-type: none"> • 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 • Credits will be required as part of the biodiversity offsets for the project for the removal of native vegetation and threatened species habitat impacted by the project • Vegetation removal along the Wakehurst Parkway will be timed to avoid the winter breeding period for the Eastern Pygmy-possum (May to July), where possible • Connectivity measures will be designed during further design development in accordance with the <i>Wildlife Connectivity Guidelines: Managing wildlife connectivity of road projects</i> (Draft) (Roads and Maritime Services, 2011c) and consider measures to facilitate the crossing of native fauna species • Adaptive management measures to minimise impacts on Grey-headed Flying-foxes will be developed prior to construction. 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. A person experienced in flying-fox behaviour will monitor disturbance levels within the Grey-headed Flying-fox camp at Balgowlah during construction activities • 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 developed by a suitably qualified and experienced microbat specialist and implemented during surfaced road works as required • Exclusion zones will be implemented to avoid disturbance to sensitive marine habitats not proposed to be directly impacted by the project. Routine inspections and maintenance of exclusion measures will be carried out

Summary of key impact	Timing	Management measure
<ul style="list-style-type: none"> Potential impacts on marine threatened species in Middle Harbour, such as the Black Rockcod and White's seahorse that reside in habitat affected during construction Potential impacts on some marine mammals, turtles and sharks, which may forage or transit through seagrass, rocky reef or deepwater soft sediment habitats Potential underwater noise impacts to marine fauna generated through construction dredging and piling activities. 		<ul style="list-style-type: none"> Silt curtains will be installed around seagrass patches and subtidal rocky reef contained within the Zone of Influence as described in Appendix T (Technical working paper: Marine ecology) 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 to nearby unaffected habitat 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 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.
<p>Land use and property</p> <ul style="list-style-type: none"> Temporary leasing of properties and land during construction Temporary land use changes to some areas associated with construction activities or construction support sites Temporary relocation of boat moorings to provide safe access to temporary construction support sites Permanent full or partial acquisition of properties and land Permanent land use changes where permanent project infrastructure is established 	Construction/operation	<ul style="list-style-type: none"> 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. Rehabilitation will be carried out in consultation with the relevant land owner, the local council and community (where appropriate) 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 Land acquisition for the project will be carried out in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> (NSW), the <i>Roads and Maritime Services Land Acquisition Information Guide</i> (Roads and Maritime Services, 2014b) and

Summary of key impact	Timing	Management measure
<ul style="list-style-type: none"> • Permanent closure of Balgowlah Golf Course and repurposing of the land for new and improved open space and recreation facilities for the community • Permanent land use change for part of Cammeray Golf Course used for operational facilities • Air quality impacts for future elevated receivers above 20 metres in height located within 300 metres of ventilation outlets. 		<p><i>Fact sheet: Property acquisition of subsurface lands</i> (Roads and Maritime Services, 2015b) and in accordance with the land acquisition reforms announced by the NSW Government in 2016</p> <ul style="list-style-type: none"> • 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. • 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.
<p>Urban design and visual amenity</p> <ul style="list-style-type: none"> • Visual impacts during construction as a result of the presence of construction works, plant and equipment and construction vehicles • Loss of vegetation providing screening and amenity • Temporary increases in exposure to built form. 	Construction	<ul style="list-style-type: none"> • Construction support sites will be developed to minimise visual impacts for adjacent receivers where feasible and reasonable • Existing trees adjacent to the works will be retained and protected where reasonable and feasible to screen construction works • Early planting works will be considered to provide a screening buffer that has time to mature before the project is fully operational. • The urban design and landscape plan will be further developed during further design development and implemented in line with the strategic urban design framework for the project. It will include appropriate operational mitigation measures • All areas disturbed by construction and not required for operation of the project will be restored as soon as practicable to their existing condition or in accordance with the urban design and landscape plan where applicable.

Summary of key impact	Timing	Management measure
<p>Geology, soils and groundwater</p> <ul style="list-style-type: none"> • Ground movement may occur as a result of the construction of the project or from settlement induced by groundwater drawdown • The project is situated adjacent to areas that are considered to have a ‘moderate’ or ‘high’ risk rating of containing contaminated material • Disturbance of sediments in Middle Harbour during dredging activities which could potentially pose a contamination risk due to the contamination associated with historical industrial use of the harbour. 	Construction	<ul style="list-style-type: none"> • Detailed predictive settlement models will be developed for areas of concern to guide tunnel design and construction methodology, including the selection of options to minimise settlement where required • Pre-construction building structure condition surveys will be offered and prepared for properties (and heritage assets) within the zone of influence of tunnel settlement where the degree of severity has been assessed as ‘slight’ or above and within the minimum working distances for cosmetic and structural damage due to vibration • Potentially contaminated areas directly affected by the project will be investigated and managed in accordance with the requirements of guidance endorsed under section 105 of the <i>Contaminated Land Management Act 2008</i> • The dredging methodology has been designed to minimise impacts on the marine environment and would include the use of a backhoe dredge with closed environmental bucket.
<p>Resource use and waste management</p> <ul style="list-style-type: none"> • About three million cubic metres of spoil would be produced from land-based construction activities (terrestrial spoil) during construction. In addition, marine construction works for the project within Middle Harbour would produce around 163,000 cubic metres of dredged and excavated material. 	Construction	<ul style="list-style-type: none"> • The resource management hierarchy principles established under the <i>Waste Avoidance and Recovery Act 2001</i> of avoid/reduce/reuse/recycle/dispose will be applied • Wastes will be appropriately transported, stored and handled according to their waste classification and in a manner that prevents pollution of the surrounding environment.

Summary of key impact	Timing	Management measure
<p>Socio-economic</p> <ul style="list-style-type: none"> • Loss of open space, parks and recreational facilities, due to use for temporary construction support sites and permanent project facilities • Property impacts and acquisitions affecting residential properties and businesses • Potential reduction in amenity at social infrastructure due to reduced visual amenity and increased air-borne construction noise, dust and traffic • Potential impacts on community cohesion due to temporarily restricting access to some social infrastructure and meetings places, which may reduce opportunities for social and community interaction • Changes in passing trade to business, employee and customer access, servicing and deliveries, business visibility, demand for services, displacement of business and potential impacts on maritime businesses and freight and efficiency. 	<p>Construction/operation</p>	<ul style="list-style-type: none"> • Ongoing engagement will be carried out with representatives of user groups and managers of social infrastructure located near to surface construction works/construction support sites and sensitive social infrastructure above the tunnel alignment about the timing and duration of construction works and management of potential impacts • Where businesses are affected by property acquisition, or lease cessation, the acquisition and compensation process will be implemented in line with the <i>Determination of compensation following the acquisition of a business guideline</i>. Compensation for a business conducted on land that is acquired should be determined in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> as relevant • Where feasible and reasonable, the extent of permanent impact on public open space areas will be minimised during further design development • Specific consultation will be carried out with businesses potentially impacted during construction. Consultation will aim to identify specific potential construction impacts for individual businesses.
<p>Cumulative impacts</p> <ul style="list-style-type: none"> • There is the potential for construction fatigue and complaint fatigue to be experienced by surrounding receivers as a result of concurrent and consecutive construction programs. 	<p>Construction</p>	<ul style="list-style-type: none"> • Multi-party engagement and cooperation will be established prior to construction to coordinate with the following projects to manage construction fatigue impacts where possible: <ul style="list-style-type: none"> - Western Harbour Tunnel and Warringah Freeway Upgrade project - Sydney Metro City & Southwest - Channel 9 site staged residential redevelopment • Complaint fatigue will be managed in accordance with Appendix E (Community consultation framework).

28.4.3 Residual impacts

An environmental risk analysis for the project has been carried out and is detailed in Appendix C (Environmental risk analysis). The risk analysis identifies an initial risk rating for each of the environmental issues and the residual risk rating derived after the application of environmental management measures developed and recommended by this environmental impact statement. It involved:

- Rating the risk of each identified potential impact by identifying the consequences of the impact and likelihood of each impact occurring
- Considering the probable effectiveness of the proposed environmental management measures to determine the likely residual risk of each impact.

The risk analysis outlined in Appendix C (Environmental risk analysis) has identified several 'medium' level residual risks. No potential impacts with a residual risk rating of 'high' were identified for the project. During further design development, opportunities would be identified for 'medium' level residual risks to:

- Resolve residual impacts and risks through further design refinement
- Develop suitable construction methodologies and carry out construction planning with the construction contractor to ensure that environmental management measures can be implemented effectively
- Implement a process of review, correction and audit for the management measures that were identified in this environmental impact statement and summarised in Appendix Y (Compilation of environmental management measures). This would be a process of continuous improvement that would form part of the construction environmental management plan and operational environmental management plan and would allow for environmental management measures to be updated or improved during the construction and operational phases, where practical.

Where 'medium' level residual risks are considered to still be likely after further design development, additional refined environmental management measures would be developed, where appropriate, to ensure those risks are suitably mitigated.

Where 'low' level residual risks are identified, an appropriate process of continuous improvement would be applied to address these potential impacts during construction and operation as far as is reasonable and feasible.

28.5 Environmental management plan framework

The implementation of environmental management measures during further design development, construction and operation of the project would minimise potential adverse impacts arising from the proposed work on the surrounding environment.

28.5.1 Construction environmental management

The environmental management framework provides a whole-of-construction life-cycle approach to construction environmental management and sets out the environmental requirements for construction. Construction environmental management documentation that would be prepared in accordance with the planning approval documents includes:

- Construction environmental management plan
- Construction environmental management plan sub-plans
- Performance and compliance reports.

This approach is illustrated in Figure 28.5 and has been developed to be consistent with legislative and regulatory requirements, including those described in Chapter 2 (Assessment process).

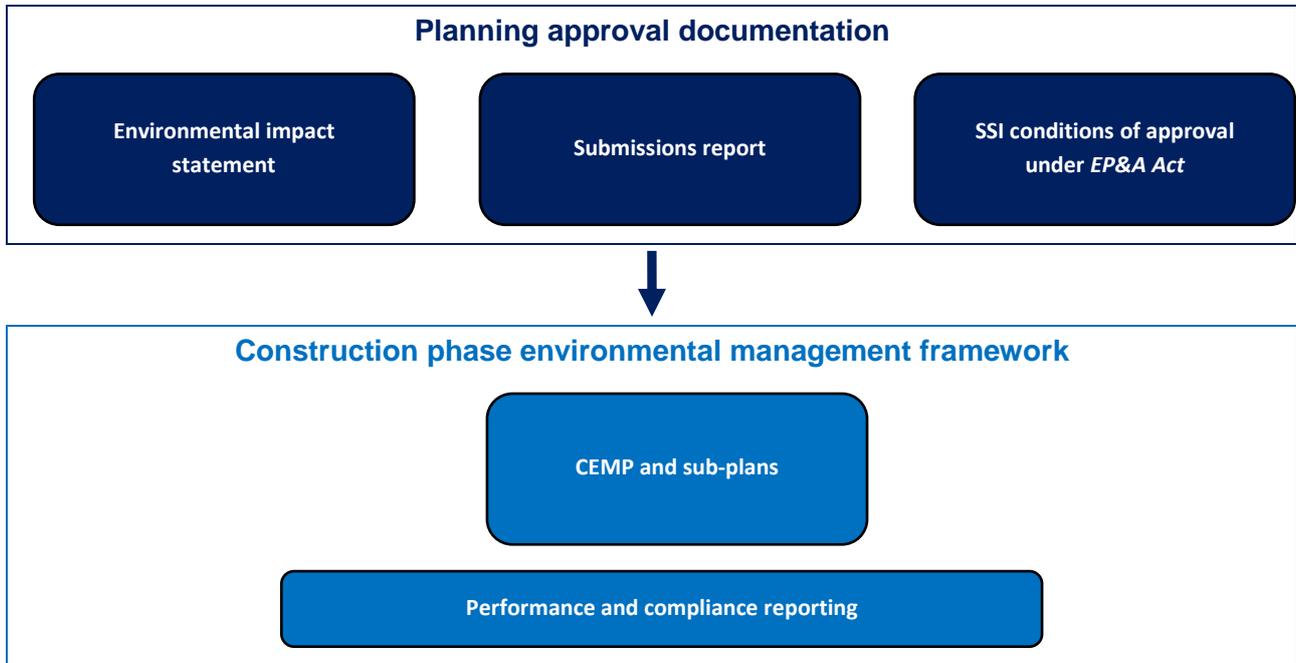


Figure 28.5 Construction environmental management approach

Construction environmental management plan

A construction environmental management plan would be prepared for the project in accordance with *QA Specification G36: Environmental Protection* (Transport for NSW, 2020h) prior to construction of the project and would be reviewed and approved by Transport for NSW and the Department of Planning, Industry and Environment, prior to the commencement of main construction work. It would provide the overarching framework for construction environmental management and would include the following:

- A description of applicable activities to be carried out during construction
- Construction methodologies and incorporation of relevant environmental management measures for applicable activities during construction
- An environmental risk and opportunities methodology
- A matrix of the relevant conditions of approval, as well as project specific commitments including environmental management measures, referencing where each requirement is addressed
- Outline the objectives and targets, in defined performance outcomes
- Environmental accountabilities or responsibilities
- Induction and training requirements
- Management strategies for reviewing the effectiveness of environmental management measures
- Processes and methodologies for surveillance and monitoring, auditing and reviewing and reporting on environmental and sustainability performance including compliance tracking
- Procedures for emergency and incident management, non-compliance management and corrective and preventative action
- Procedures for the control of environmental documents and records
- Environmental management measures table.

The construction environmental management plan would be a working document, subject to ongoing change and updated as necessary to respond to specific requirements.

Construction environmental management sub-plans

The construction environmental management plan would provide the overarching framework for construction environmental management. The following sub-plans which would likely be required to manage specific environmental impacts during construction:

- Traffic and transport management plan
- Marine works and marine traffic management plans
- Noise and vibration management plan
- Heritage management plan
- Air quality management plan
- Waste and resource management plan
- Soil and water management plan
- Groundwater management plan
- Flora and fauna management plan
- Dredge management plan.

The sub-plan structure identified above may be modified slightly during detailed construction planning to respond more effectively to particular contractor or stakeholder requirements.

In addition, a number of other management plans and strategies are likely to be required separate to the construction environmental management plan. These may include, but are not limited to:

- Site establishment management plan
- Utilities management strategy which would be prepared in accordance with Appendix D (Utilities management strategy)
- Blasting management strategy
- Sustainability management plan
- Community communication strategy which would be prepared in accordance with Appendix E (Community consultation framework).

28.5.2 Operational environmental management

Maintenance of the project and its environmental performance during operation would be managed under the existing Transport for NSW environmental management system for asset maintenance (or similar) prepared in accordance with the *AS/NZS ISO 14000 Environmental Management System* series and developed to be consistent with the broad environmental objectives and policies set out in the Transport for NSW environmental management system. Transport for NSW is committed to managing its impacts on the environment and carrying out its activities so as to avoid, minimise or mitigate environmental impacts. Accordingly, any project-specific operational environmental management practices and procedures would be incorporated into the existing environmental management system.

28.6 Performance outcomes

The project's performance outcome as measured against those identified for key issues in the Secretary's environmental assessment requirements is provided in Table 28-4, along with a summary of how each performance outcome would be achieved by the project.

Table 28-4 Design performance outcomes and project outcome

Desired performance outcome	How performance outcomes would be achieved
<p>Environmental impacts assessment process</p> <ul style="list-style-type: none"> The process for assessment of the proposal is transparent, balanced, well focussed and legal. 	<ul style="list-style-type: none"> This environmental impact statement has been prepared in accordance with Part 3 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 Based on the results of the environmental investigations carried out for this environmental impact statement, it is considered that matters of national environmental significance set out in the <i>Environment Protection Biodiversity Conservation Act 1999</i> are not likely to be significantly impacted by the project. Accordingly, Transport for NSW has decided a referral to the Commonwealth is not required at this stage.
<p>Environmental impact statement</p> <ul style="list-style-type: none"> The project is described in sufficient detail to enable clear understanding that the project has been developed through an iterative process of impact identification and assessment and project refinement to avoid, minimise or offset impacts so the project, on balance, has the least adverse environmental, social and economic impact, including its cumulative impacts. 	<ul style="list-style-type: none"> The project has been described in detail in Chapter 5 (Project description) The merits of the project, and the design options were considered in the context of a range of alternatives based on how well they performed with reference to transport, environmental, engineering, social and economic factors (refer to Chapter 4 (Strategic context and project need)). The preferred design provides a combination of benefits compared with other options assessed, including improved access, minimised impacts on properties and on future development potential.
<p>Assessment of key issues</p> <ul style="list-style-type: none"> Key issue impacts are assessed objectively and thoroughly to provide confidence the project would be constructed and operated within acceptable levels of impact. 	<ul style="list-style-type: none"> The assessment of key issues has been conducted objectively and thoroughly. The implementation of environmental management measures would ensure the project is constructed and operated within acceptable levels of impact. Refer to Chapter 8 (Construction traffic and transport) to Chapter 26 (Climate change risk and greenhouse gas) for further details.
<p>Consultation</p> <ul style="list-style-type: none"> The project is developed with meaningful and effective engagement during project design and delivery. 	<ul style="list-style-type: none"> Consultation has been carried out to inform the design process and project development (refer to Chapter 7 (Stakeholder and community engagement)) The construction contractor would respond to complaints in a timely and appropriate manner, to ensure all stakeholders' concerns are addressed effectively and promptly.

Desired performance outcome	How performance outcomes would be achieved
<p>Transport and traffic</p> <ul style="list-style-type: none"> • Network connectivity, safety and efficiency of the transport system near of the project are managed to minimise impacts • The safety of transport system customers is maintained • Impacts on network capacity and the level of service are effectively managed • Works are compatible with existing infrastructure and future transport corridors. 	<p>With respect to transport and traffic, the project has been developed such that it would:</p> <ul style="list-style-type: none"> • Minimise impacts to local streets from loss of parking, road closures and heavy vehicle movements during construction • Minimise impacts to road network efficiency during construction • Enable access to properties to be maintained during construction and operation • Improve the performance and capacity of Sydney’s road network • Provide an efficient motorway link which improves traffic flow on Sydney’s motorway network • Relocate a substantial volume of through traffic underground • Improve traffic conditions, and ease future congestion on the road network • Provide functional connectivity between the subsurface and surface road network • Provide future motorway connections to support a growing Sydney • Maintain pedestrian and cyclist safety along surface roads near the project • Provide considerable travel time savings for motorists and freight vehicles using Sydney’s motorway network • Provide opportunity to develop faster and more reliable express bus services to connect the Northern Beaches to strategic centres such as North Sydney, St Leonards, Sydney CBD and Macquarie Park, with the potential for links to strategic stations on the rail network • Improved travel times and reliability for buses travelling along existing key corridors including Warringah Freeway, Warringah Road, Eastern Valley Way and Military Road due to a reduction in traffic • Enable long-term development of Sydney’s motorway network, including connections to and from the Northern Beaches.
<p>Air quality</p> <ul style="list-style-type: none"> • The project is designed, constructed and operated in a manner that minimises air quality impacts (including nuisance dust and odour) to minimise risks to human health and the environment to the greatest extent 	<p>With respect to air quality, the project has been developed that it would:</p> <ul style="list-style-type: none"> • Provide effective management of dust, odour and other emissions during construction • Result in zero portal emissions during normal operations • Provide effective dispersion of emissions from the tunnels to ensure negligible contributions to air quality at ground level. <p>Tunnel ventilation design would be developed to maintain in-tunnel air quality in accordance with relevant criteria.</p>

Desired performance outcome	How performance outcomes would be achieved
<p>Health and safety</p> <ul style="list-style-type: none"> The project avoids or minimises any adverse health impacts arising from the project The project avoids, to the greatest extent possible, risk to public safety. 	<p>With respect to health and safety, the project has been developed that:</p> <ul style="list-style-type: none"> Incidents, crashes and risks to public safety would be minimised during construction The motorway design would achieve safe and efficient road user movements including diverting many heavy vehicles into the tunnels and off the surface road network Establishment and operation of temporary construction support sites and ancillary infrastructure would ensure the protection of road users and the public The project avoids, to the greatest extent possible, risk to public safety Hazardous materials within project areas would be managed to protect human health.
<p>Noise and vibration – Amenity</p> <ul style="list-style-type: none"> Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community. 	<p>With respect to noise and vibration (amenity), the project has been developed that it would:</p> <ul style="list-style-type: none"> Relocate a considerable volume of through traffic on surface arterial roads underground, improving surface road noise Divert many heavy vehicles into the tunnels and off the surface road network Comply with the relevant criteria from the <i>NSW Industrial Noise Policy</i> Minimise increases in road traffic noise, where possible Include effective implementation of noise management measures during operation Include effective management of construction noise and vibration in accordance with relevant guidelines, for example through the use of acoustic sheds Minimise surface activity and associated noise at tunneling sites, as once tunneling starts the majority of the work at these sites would be underground Minimise impacts to the local community by: <ul style="list-style-type: none"> Controlling noise and vibration at the source Controlling noise and vibration on the source to receiver transmission path Controlling noise and vibration at the receiver Implementing practicable and reasonable measures to minimise the noise and vibration impacts of construction activities on local sensitive receivers.

Desired performance outcome	How performance outcomes would be achieved
<p>Noise and vibration – Structural</p> <ul style="list-style-type: none"> Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage Increases in noise emissions and vibration affecting environmental heritage as defined in the <i>Heritage Act 1977</i> during operation of the project are effectively managed. 	<p>With respect to noise and vibration (structural), the project would minimise impacts to structures by:</p> <ul style="list-style-type: none"> Controlling vibration at the source Controlling vibration on the source to receiver transmission path Implementing practicable and reasonable measures to minimise vibration impacts of construction activities on structures Carrying out building/structure condition surveys for properties (and heritage assets) within the zone of influence of tunnel settlement prior to the commencement of construction.
<p>Biodiversity</p> <ul style="list-style-type: none"> The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation. 	<p>With respect to biodiversity, the project has been developed that:</p> <ul style="list-style-type: none"> It would minimise impacts on biodiversity Where practicable, the design minimises the need to clear vegetation Potential impacts on biodiversity would be managed in accordance with relevant legislation, including the <i>Environmental Planning and Assessment Act 1979</i> and the <i>Biodiversity Conservation Act 2016</i> and relevant guidelines Offsets would be provided for the project in accordance with NSW Biodiversity Offsets Scheme, established under Part 6 of the <i>Biodiversity Conservation Act 2016</i> and the <i>Policy and guidelines for fish habitat conservation and management</i> (NSW Department of Primary Industries (DPI), 2013).
<p>Place Making and Urban Design</p> <ul style="list-style-type: none"> The project design complements the visual amenity, character and quality of the surrounding environment The project contributes to the accessibility and connectivity of communities. 	<p>With respect to place making and urban design, the project has been developed that:</p> <ul style="list-style-type: none"> It would connect disconnected communities A substantial volume of through traffic on surface arterial roads would be diverted underground, improving urban amenity Sympathetic urban design would integrate with adjacent and historical land uses It would establish and operate ancillary infrastructure to minimise adverse impacts on the visual amenity of the local community It would provide for new and improved active transport links It would provide for new and improved open space and recreation facilities at Balgowlah.

Desired performance outcome	How performance outcomes would be achieved
<p>Socio-economic, land use and property</p> <ul style="list-style-type: none"> • The project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities • The project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure. 	<p>With respect to socio-economics, land use and property, the project has been developed to:</p> <ul style="list-style-type: none"> • Minimise property acquisition • Manage the property acquisition process to minimise impacts to community and businesses • Minimise impacts to businesses during construction • Make provision for social infrastructure • Reduce congestion on the road network, supporting future urban regeneration • Avoid barriers and division of the community through the tunnel solution.
<p>Water – Hydrology</p> <ul style="list-style-type: none"> • Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised • The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved) • Sustainable use of water resources. 	<p>With respect to water (hydrology), the project has been developed that:</p> <ul style="list-style-type: none"> • Design and construction of the tunnels minimises groundwater inflow • Opportunities for reuse of treated water during construction have been considered throughout project development • The environmental values of nearby, connected and affected water sources would be improved and/or maintained.
<p>Water – Quality</p> <ul style="list-style-type: none"> • The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable). 	<p>With respect to water (quality), the project has been developed to:</p> <ul style="list-style-type: none"> • Operate under water quality discharge criteria with consideration of the NSW Water Quality Objectives • Effectively treat water to meet water quality discharge criteria.

Desired performance outcome	How performance outcomes would be achieved
<p>Flooding</p> <ul style="list-style-type: none"> The project minimises adverse impacts on existing flooding characteristics Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure. 	<p>With respect to flooding, the project has been developed that:</p> <ul style="list-style-type: none"> Construction would be carried out in a manner that minimises the potential for adverse flooding impacts, through staging of works and the implementation of mitigation measures Temporary construction support sites and construction sites would be laid out so flows are not substantially impeded Flood levels would be maintained or reduced at residential, commercial and industrial properties adjacent to the alignment during a 1% AEP event.
<p>Soils</p> <ul style="list-style-type: none"> The environmental values of land, including soils, subsoils and landforms, are protected Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination. 	<p>With respect to soils, the project has been developed that:</p> <ul style="list-style-type: none"> Erosion and sediment controls would be implemented in accordance with <i>Managing Urban Stormwater – Soils and Construction, Volume 1</i> (Landcom 2004) and <i>Managing Urban Stormwater: Soils and Construction, Volume 2D: Main Roads</i> (DECC 2008), commonly referred to as the ‘Blue Book’ Acid sulfate soils would be managed in accordance with good practice measures Contamination would be managed to protect environmental values and human health.
<p>Heritage</p> <ul style="list-style-type: none"> The design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places. 	<p>With respect to heritage, the project has been developed that it would:</p> <ul style="list-style-type: none"> Establish archival recording of items of heritage significance that would be subject to change Minimise impacts on heritage items during construction Incorporate key heritage values and stories into the final urban design and landscaping outcome Minimise impacts to features of heritage conservation significance from vibration. <p>The design would be sympathetic to the heritage significance of surrounding listed heritage items, and where practicable, avoid and minimise impacts to heritage.</p> <p>Impacts on heritage would be managed in accordance with relevant legislation, including the <i>Environmental Planning and Assessment Act 1979</i>, the <i>Heritage Act 1977</i>, and relevant guidelines.</p>

Desired performance outcome	How performance outcomes would be achieved
<p>Sustainability</p> <ul style="list-style-type: none"> The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources Conservation of natural resources is maximised. 	<p>With respect to sustainability, the project has been developed that:</p> <ul style="list-style-type: none"> Sustainability considerations would be integrated throughout design, construction, and operation The project would seek to achieve an 'Excellent' Design and 'As Built' Infrastructure Sustainability rating The project would be carried out in accordance with the Sustainability Framework developed for the project Activities to implement the sustainability framework, including requirements from the Infrastructure Sustainability rating scheme, would be implemented through a Sustainability Management Plan.
<p>Waste</p> <ul style="list-style-type: none"> All wastes generated during the construction and operation of the project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects environmental values. 	<p>With respect to waste, the project has been developed that:</p> <ul style="list-style-type: none"> Where feasible and reasonable, the project would recycle or reuse clean spoil either on site or off site Disturbed contaminated material would be encapsulated on site where appropriate and in accordance with relevant regulatory requirements. Off-site waste reuse would be managed in accordance with relevant NSW Environment Protection Authority resource recovery exemptions and requirements Waste would be disposed of at appropriately licensed facilities.
<p>Climate change risk</p> <ul style="list-style-type: none"> The project is designed, constructed and operated to be resilient to the future impacts of climate change. 	<p>With respect to climate change risk, the project has been developed that it:</p> <ul style="list-style-type: none"> Would incorporate climate change and sea level rise adaptation measures into the further design development and construction planning for the project.

28.7 Project justification and conclusion

28.7.1 Biophysical, economic and social considerations

The environmental impact statement has been prepared with regard to the key issues associated with the project and the integration of biophysical, economic and social considerations.

While the development of the project would have some unavoidable impacts (associated with, for example, construction impacts from heavy vehicle traffic, noise, vibration and dust, access disruptions and visual impacts) overall, the project would deliver a large number of benefits and opportunities including:

- Reducing pressure on congested road corridors, leading to faster and more reliable journeys to, from and around the Northern Beaches and North Shore
- Improving public transport journey times, travel time reliability and connectivity between the Northern Beaches and strategic centres, enabling new express bus service routes
- Improving access for local businesses to Greater Sydney, making it easier and safer to move goods and provide services
- Increasing the resilience of the Northern Beaches road network to traffic incidents by providing a new alternate underground bypass route of existing congested arterial road corridors

- Improving the amenity of local streets and local town centres by freeing up local streets for local traffic
- Creating opportunities to enhance local communities by improving active transport links and providing new and improved public open space.

28.7.2 Sustainable development

Facilitating ecologically sustainable development is adopted as an object of the *Environmental Planning and Assessment Act 1979*. This object requires the integration of "relevant economic, environmental and social considerations in decision making about environmental planning and assessment".

Ecologically sustainable development is defined under the *Protection of the Environment Administration Act 1991* (NSW) and Environmental Planning and Assessment Regulation 2000 and includes four principles. The project is consistent with these principles of ecologically sustainable development:

- **Precautionary principle:** The environmental impact statement was prepared adopting a conservative approach, which includes an assessment of the worst case impacts and scenario and using the best available technical information and has adopted best practice environmental standards, goals and measures. The design and development of the project included consideration of potential environmental impacts associated with the project alternatives and options analysis, and opportunities were identified to avoid and minimise surface disturbance. In addition, sustainability workshops and meetings were held during design development with planning and design teams to develop draft sustainability targets and objectives for the project
- **Intergenerational equity:** The project is designed to meet the needs of both current and future generations with a design life of about 100 years and would contribute to an increase in the resilience and capacity of the Sydney transport network. During construction and operation of the project, opportunities would be taken to reduce resource and material use and maximise the use of materials with low embodied environmental impact, where feasible
- **Conservation of biological diversity and ecological integrity:** The design and assessment of the project has been carried out with the aim of identifying, avoiding, minimising and mitigating impacts to biodiversity and ecological integrity. Consistent with the *Biodiversity Conservation Act 2016* and the Secretary's environmental assessment requirements, a biodiversity offset strategy has been developed to compensate for the unavoidable loss of ecological values as a result of the project
- **Improved valuation and pricing and incentive mechanisms:** The value placed on avoiding and minimising environmental impacts is demonstrated in the design features incorporated into the project (for example identifying opportunities to improve local amenity, improve public transport access and active transport connections, and create additional green spaces). The costs of planning, design and implementation of avoidance and environmental management measures have been incorporated into the project cost.

28.7.3 Objects of the *Environmental Planning and Assessment Act 1979* (NSW)

A consideration of the project against the objects of the *Environmental Planning and Assessment Act 1979* is outlined in Table 28-5.

Table 28-5 Objects of the *Environmental Planning and Assessment Act 1979* (NSW)

Objects of the <i>Environmental Planning and Assessment Act 1979</i>	Project attributes
<p>(a) To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources,</p>	<p>The project would provide benefits for local businesses and commuters by enabling better and more efficient access between the Northern Beaches region and major centres across Greater Sydney. By connecting the Northern Beaches to the Sydney motorway network, the project would provide faster connections to strategic commercial and industrial centres across Greater Sydney including Chatswood, St Leonards and Macquarie Park, as well as the international gateways of Sydney Airport and Port Botany.</p> <p>Increased network capacity and connectivity as a result of the project would result in travel time savings for freight movements, further servicing the growth of Sydney's Eastern Economic Corridor. The combination of freight and business travel time savings would be integral to the economic growth of Sydney's Eastern Economic Corridor, enabling sustained growth and productivity.</p> <p>During construction and operation, the following opportunities would be taken to reduce material use and maximise the use of materials with low embodied environmental impact, where practical:</p> <ul style="list-style-type: none"> • Water efficiency measures would be implemented where possible, with the reuse of non-potable water from stormwater harvesting and on-site reuse of treated water from groundwater inflows, where water quality and volume requirements are met • The design of the project has included careful consideration of the construction methodology and selection of materials and resources to minimise resource consumption • Consistent with the resource management hierarchy under the <i>Waste Avoidance and Resource Recovery Act 2001</i>, solid wastes would be reused and recycled where feasible and reasonable. <p>Where possible, the project has been designed to avoid impacts on the natural environment and to minimise the need for land acquisition, as well as impacts on existing development and local communities.</p>
<p>(b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment,</p>	<p>The project is consistent with the principles of ecologically sustainable development as outlined in Section 28.7.2.</p>

Objects of the <i>Environmental Planning and Assessment Act 1979</i>	Project attributes
(c) to promote the orderly and economic use and development of land,	<p>The project has been designed to:</p> <ul style="list-style-type: none"> • Provide improved efficiency of the road network, in particular for freight and commercial users, resulting in economic benefits for NSW • Provide an additional underground motorway alternative, enhancing the resilience of the road network, supporting wider network improvements • Minimise impacts to the surrounding natural and built environments where possible, for example by integrating design features such as tunnel portals and motorway facilities and ventilation outlets into the existing road corridors as far as practical • Integrate with, and thereby minimise disruption to, existing development and other projects.
(d) to promote the delivery and maintenance of affordable housing,	<p>Not applicable to this project.</p> <p>The residual land created as a result of the project would largely continue to remain suitable for future development in accordance with the relevant land use zonings and applicable development standards. Land use considerations would be required to manage any interaction between the project and future development for buildings with habitable structures above 20 metres and within 300 metres of ventilation outlets.</p>
(e) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats,	<p>Construction would result in the clearing of native vegetation, and some areas of planted vegetation would also be removed. Management measures have been proposed to minimise the potential for direct and indirect impacts.</p> <p>Some terrestrial fauna species would be impacted by the project. Management measures including pre-clearing surveys and monitoring to minimise the risk of impacts to native species.</p> <p>Mitigation and rehabilitation works would be carried out to protect and restore subtidal rocky reef and intertidal rocky shore habitat removed along the shoreline.</p> <p>In accordance with the Secretary's environmental assessment requirements and the requirements of the <i>Biodiversity Conservation Act 2016</i>, a biodiversity offset strategy has been developed to compensate for the loss of ecological values as a result of the project.</p>
(f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage),	<p>Impacts on heritage items would be minimised during construction where possible, and works would be carried out in accordance with relevant management strategies where impacts are unavoidable.</p> <p>Possible indirect impacts associated with vibration and settlement from tunnelling works or surface works beneath or near to Aboriginal sites would be managed in accordance with relevant management measures.</p>

Objects of the <i>Environmental Planning and Assessment Act 1979</i>	Project attributes
(g) to promote good design and amenity of the built environment,	<p>The project would provide:</p> <ul style="list-style-type: none"> • New and upgraded active transport infrastructure (pedestrian and cyclist facilities) • Reduction in traffic noise at receivers surrounding the project surface road works, due to the redistribution of traffic. The project is expected to lead to an overall improvement in noise levels within the community (compared with the existing situation). Noise mitigation (such as at-property treatment) would be implemented where required • Improved access and connectivity through improved travel time and improved travel time reliability, including to local and regional infrastructure within and near the project • New and improved open space and recreation facilities at Balgowlah.
(h) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants,	<p>The construction of the project, including motorway facilities, ventilation outlets and tunnel portals would be completed in line with the applicable Australian and international safety standard as well as any applicable Transport for NSW Safety in Design guidelines.</p>
(i) to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State,	<p>Consultation has been carried out with the relevant local councils and government agencies throughout the development of the project and the preparation of this environmental impact statement. All levels of government have been encouraged to be actively involved in and to contribute to the evolution of the project through consultation to date and continuing consultation activities.</p>
(j) to provide increased opportunity for community participation in environmental planning and assessment.	<p>Consultation has been carried out through all stages of the project development, with targeted community consultation periods carried out in 2017 and 2018, consultation with key community and interest groups, and a business survey carried out in November 2017 across ten local centres potentially affected by the project.</p> <p>Community feedback has been considered at each stage of the project development to inform the selection of the preferred corridor alignment and subsequent design development and refinements. Community consultation would continue through public exhibition of this environmental impact statement and during further design development and construction, should the project be approved, in accordance with the Community consultation framework.</p> <p>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 to the final layout of the new and improved open space and recreation facilities at Balgowlah.</p>

28.7.4 Cumulative impacts

Once operational, the Western Harbour Tunnel and Beaches Link program of works is expected to deliver beneficial cumulative impacts including substantial increases in travel speeds through sections of the surface road network, increased reliability, and a reduction in average travel times.

Adverse cumulative impacts could occur when impacts from the project interact or overlap with impacts from other projects and potentially result in a larger overall impact. Cumulative impacts may also occur when there are projects that are constructed consecutively, resulting in construction fatigue for local receivers. Cumulative impacts for the project are presented in Chapter 27 (Cumulative impacts).

The implementation of environmental management measures for the project would avoid, to the greatest extent possible, cumulative impacts with surrounding development. In particular, the design of the project has carefully considered minimising construction fatigue as far as practical. The intent is to reduce the overall cumulative or consecutive impacts on the community over a longer period.

28.7.5 Conclusion

This environmental impact statement addresses the key issues identified in the Secretary's environmental assessment requirements issued under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* and the relevant provisions of Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

The project is part of the NSW Government's commitment to investing in and delivering efficient and effective transport systems including road infrastructure that would relieve congestion, improve travel times, improve road safety and enhance and expand capacity on key road corridors. In particular, the project would provide additional capacity across Middle Harbour, relieving congestion on existing key routes and providing connections including via planned new express bus services within the tunnels to other key existing and future proposed transport projects.

The merits of the project were considered in the context of a range of other alternatives including do-nothing, based on the extent to which they could meet the project objectives and how well they performed with reference to other transport, environmental, engineering, social and economic factors. No other alternative would satisfy the need and objectives as effectively as the project.

As for any major infrastructure project to be constructed through the middle of a major urban area, there are expected to be impacts. Designing and constructing the project mainly underground has considerably reduced impacts and largely confined these to the construction stage. The design and construction method would continue to be developed with the objective of further minimising potential impacts taking into account the input of stakeholders and the local community.

Notwithstanding there would be a range of residual impacts. With the implementation of the proposed environmental management measures, the potential residual environmental impacts of the project are considered manageable and the project would be in the public interest.