SYNTHESIS OF ENVIRONMENTAL IMPACT STATEMENT

APPENDIX G

Contents

1 Introduction

1.1 Purpose of this document

This synthesis provides a technical summary of the Environmental Impact Statement. The main body of the Environmental Impact Statement should be referred to for further details. This synthesis includes:

- A brief description of the project including project uncertainties
- The key impacts of the project, based on the project description
- The consolidated mitigation measures for the project, as an outcome of the environmental impact assessment process
- The environmental performance outcomes for the project, based on the results of the assessment and the implementation of the mitigation measures
- The need for the project and a summary of the justification of the project.

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

Table 1-1 Secretary's environmental assessment requirements – synthesis of the Environmental Impact Statement

Ref.	Secretary's environmental assessment requirements	Where addressed
2. Environmental Impact Statement		
2.1 (o)	The EIS must include, but not necessarily be limited to, the following: (o) a chapter that synthesises the environmental impact assessment and provides:	
	• a succinct but full description of the project for which approval is sought;	A project description is provided in Section 2. A detailed project description is provided in Chapters 6 and 7 of the main Environmental Impact Statement document.
	• 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 list of the project uncertainties (design, construction methods and/or operational methods) that have been identified at this stage of the project development and that would be further considered / investigated in the next stages of the project are described in Section 2.9.
	• a compilation of the impacts of the project that have not been avoided;	Impacts that have not been avoided form the basis on which the assessment provided in the Environmental Impact Statement has been carried out. That is, the impacts that have not been avoided are effectively the actual impacts of the project. A summary compilation of key impacts is provided in Section 3.
	• 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;	The proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or to offset these impacts, are fully described in Chapter 27 of the Environmental Impact Statement. A summary compilation is provided in Section 4.

Ref.	Secretary's environmental assessment requirements	Where addressed
	• a compilation of the outcome(s) the proponent will achieve; and	The performance outcomes are described in Chapter 27 of the Environmental Impact Statement. A summary compilation is provided Section 5.
	• 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.	The justification of the project is fully described in Chapter 29 of the Environmental Impact Statement. A summary is provided in Section 6.

1.2 Environmental performance

The avoidance and minimisation of adverse environmental impacts is considered at all stages of the project. Figure 1 1 provides an overview of the project approach to environmental mitigation and management. This includes:

- Project design – measures which are inherent in the design of the project to avoid and minimise impacts. Further detail on these aspects of the project are provided in Section 3.1
- Mitigation measures – additional to the project design which are identified through the environment impact assessment in Chapters 8 to 26 of the Environmental Impact Statement. These measures are consolidated in Section 4
- Construction environmental management framework – details the management processes and documentation for the project. The construction environmental management framework is provided in Appendix D of the Environmental Impact Statement
- Construction noise and vibration strategy – identifies how Sydney Metro proposes to manage construction noise and vibration. The construction noise and vibration strategy is provided in Appendix E of the Environmental Impact Statement
- Design guidelines – provides an assurance of end-state design quality. The design guidelines are provided in Appendix B of the Environmental Impact Statement
- Environmental performance outcomes – which establish the intended outcomes which would be achieved by the project. The performance outcomes are identified in Section 5.

The construction environmental management framework, construction noise and vibration strategy and design guidelines would be reviewed and updated periodically throughout delivery of the project.

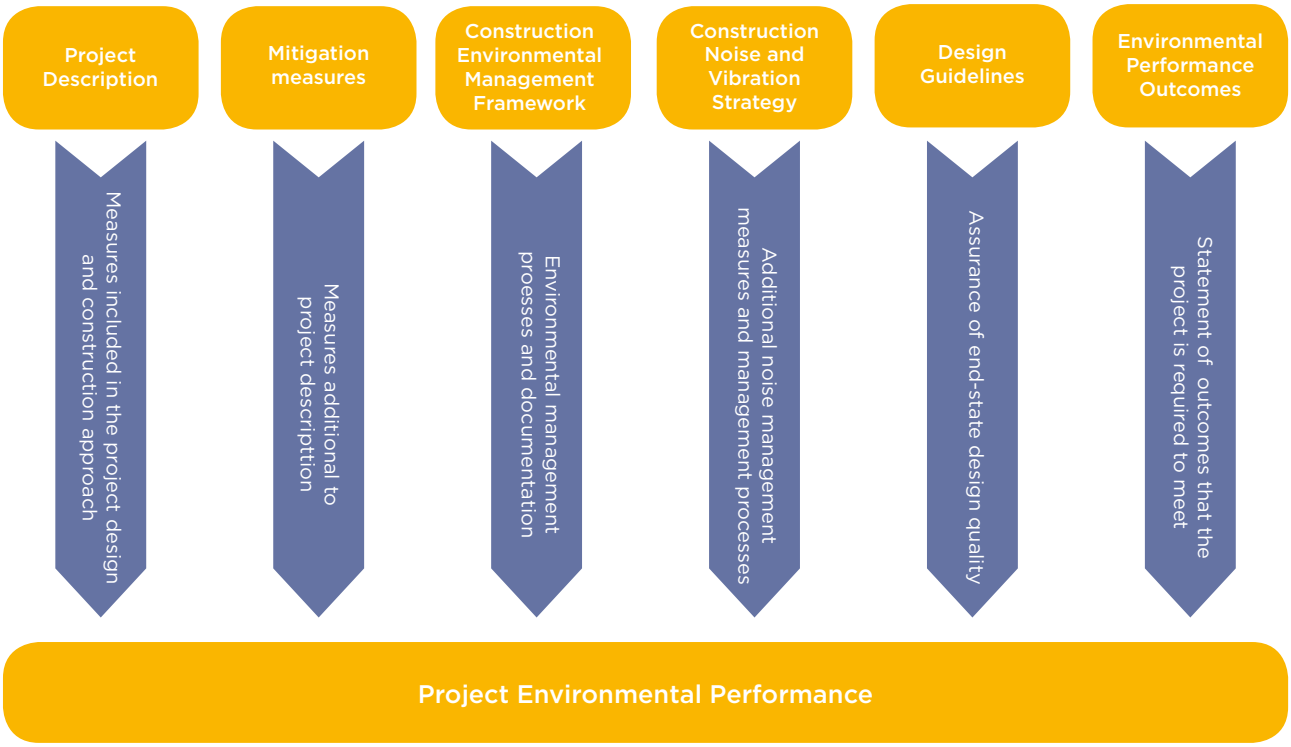

Figure 11 Project approach to environmental mitigation and management

2 Project overview

The Sydney Metro Chatswood to Sydenham project (the project) involves the construction and operation of a metro rail line and associated stations between Chatswood Station and just north of Sydenham Station. A summary of the key features of the project are described below and shown in Figure 2-1(a) to (h). A full description is provided in Chapters 6 and 7 of the Environmental Impact Statement.

Key features of the project include:

- About 15.5 kilometres of twin rail tunnels (that is, two tunnels located side-by-side) between Mowbray Road, Chatswood and Bedwin Road, Marrickville
- Realignment of T1 North Shore Line surface track within the existing rail corridor between Chatswood Station and Brand Street, Artarmon, including a new bridge for a section of the Sydney Trains 'down' (northbound) track to pass over the proposed Chatswood dive structure
- About 250 metres of aboveground metro tracks between Chatswood Station and the Chatswood dive structure
- A dive structure (about 400 metres long) and tunnel portal south of Chatswood Station and north of Mowbray Road, Chatswood (the Chatswood dive structure)
- A substation (for traction power supply) at Artarmon
- Metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street and Waterloo; and new underground platforms at Central Station
- A dive structure (about 400 metres long) and tunnel portal between Sydenham Station and Bedwin Road, Marrickville (the Marrickville dive structure)
- A services facility beside the Marrickville dive structure and tunnel portal, including a tunnel water treatment plant and a substation (for traction power supply).

The project would also include a number of ancillary components, including new and alterations to existing overhead wiring, signalling, access tracks / paths, rail corridor fencing, noise walls, fresh air ventilation equipment, temporary and permanent alterations to the road network, facilities for pedestrians, and other construction related works.

Corridor
Tunnel
Surface track
Proposed operational area at surface
Proposed dive structure
Proposed construction site area
Existing suburban rail
Existing rail station

Indicative only, subject to design development Page 1 of 8

0 500 m

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Figure 2-1a The project Map 1

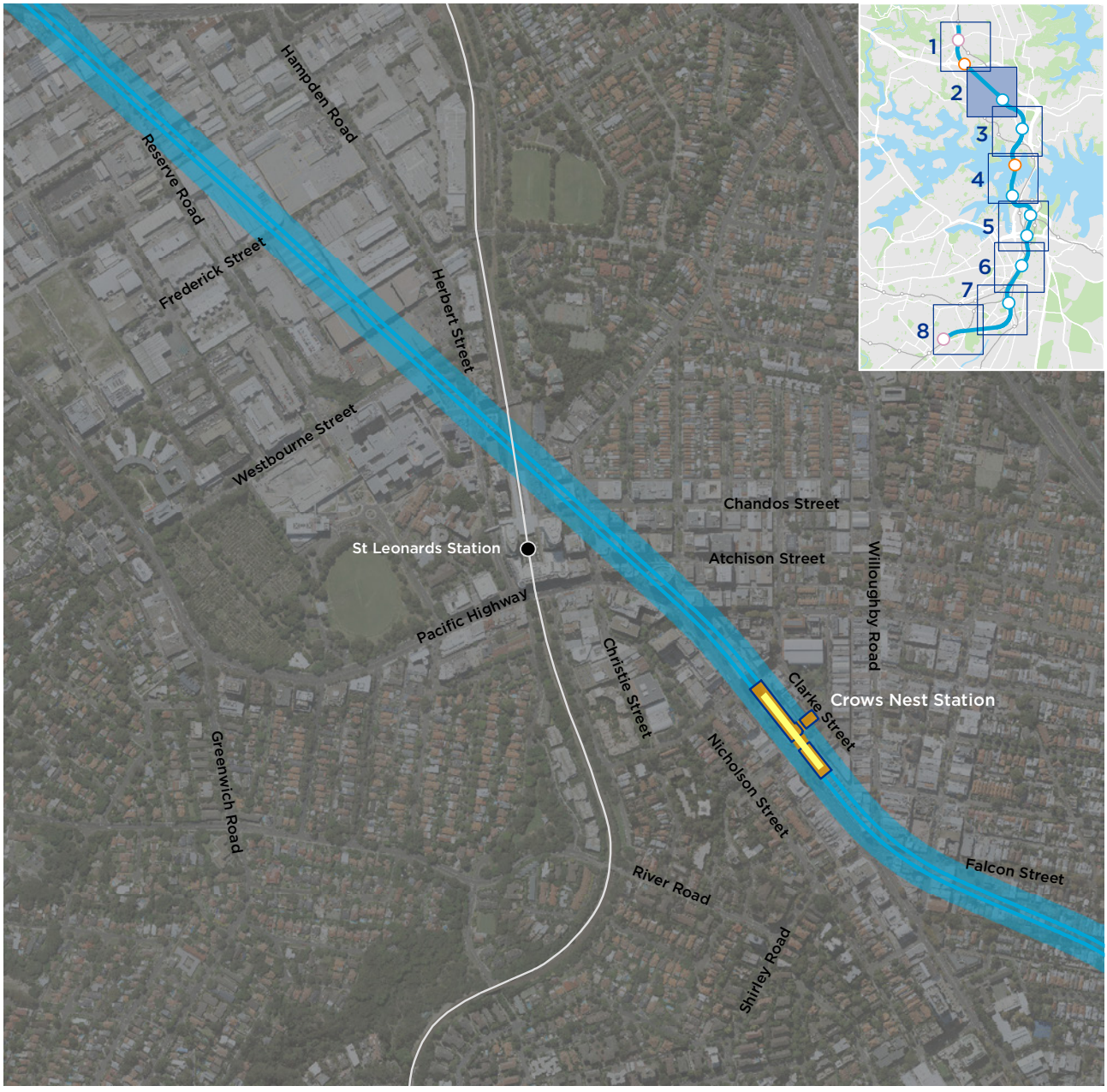

Figure 2-1b The project Map 2

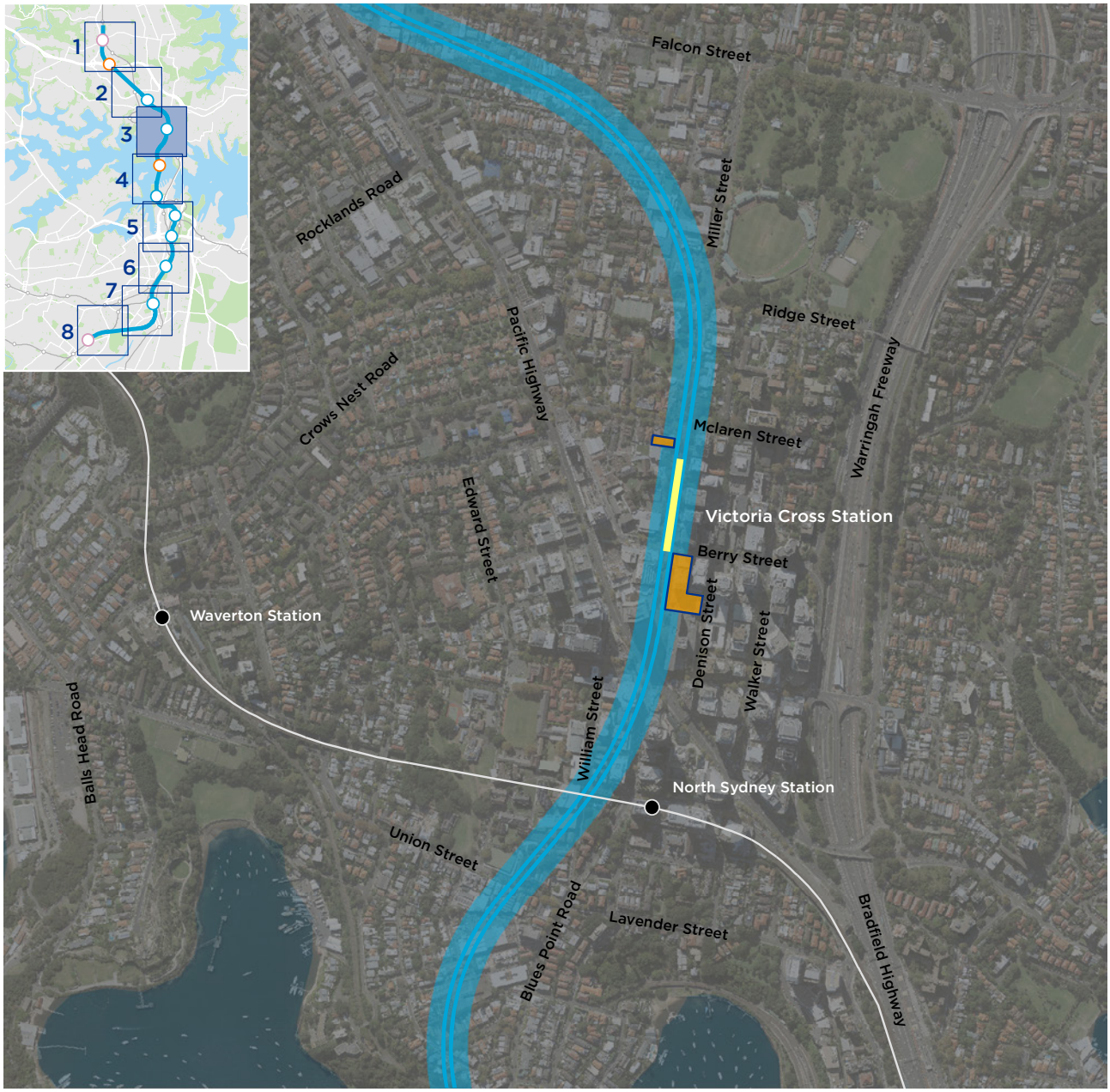

Figure 2-1c The project Map 3

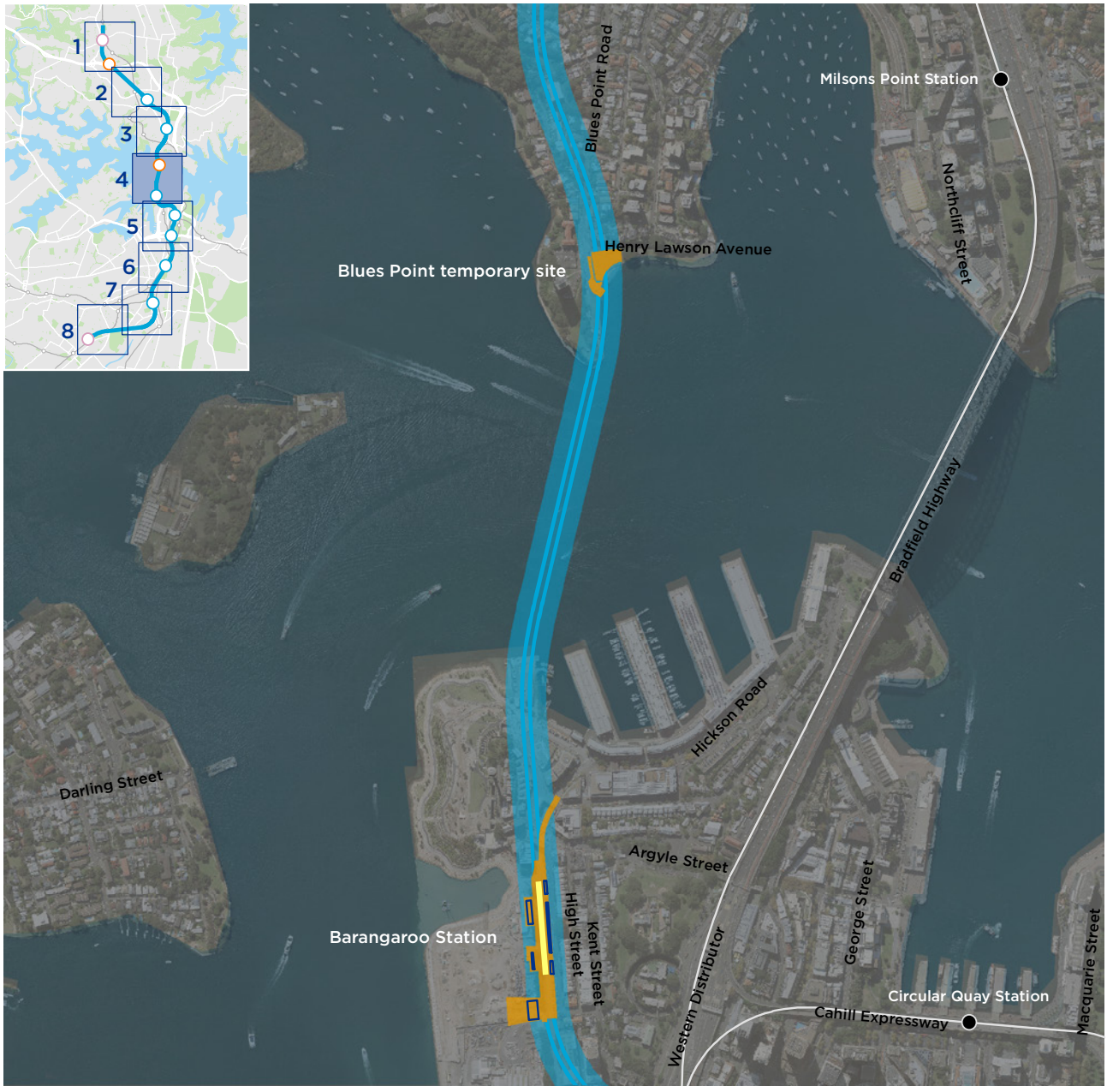

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Figure 2-1d The project Map 4

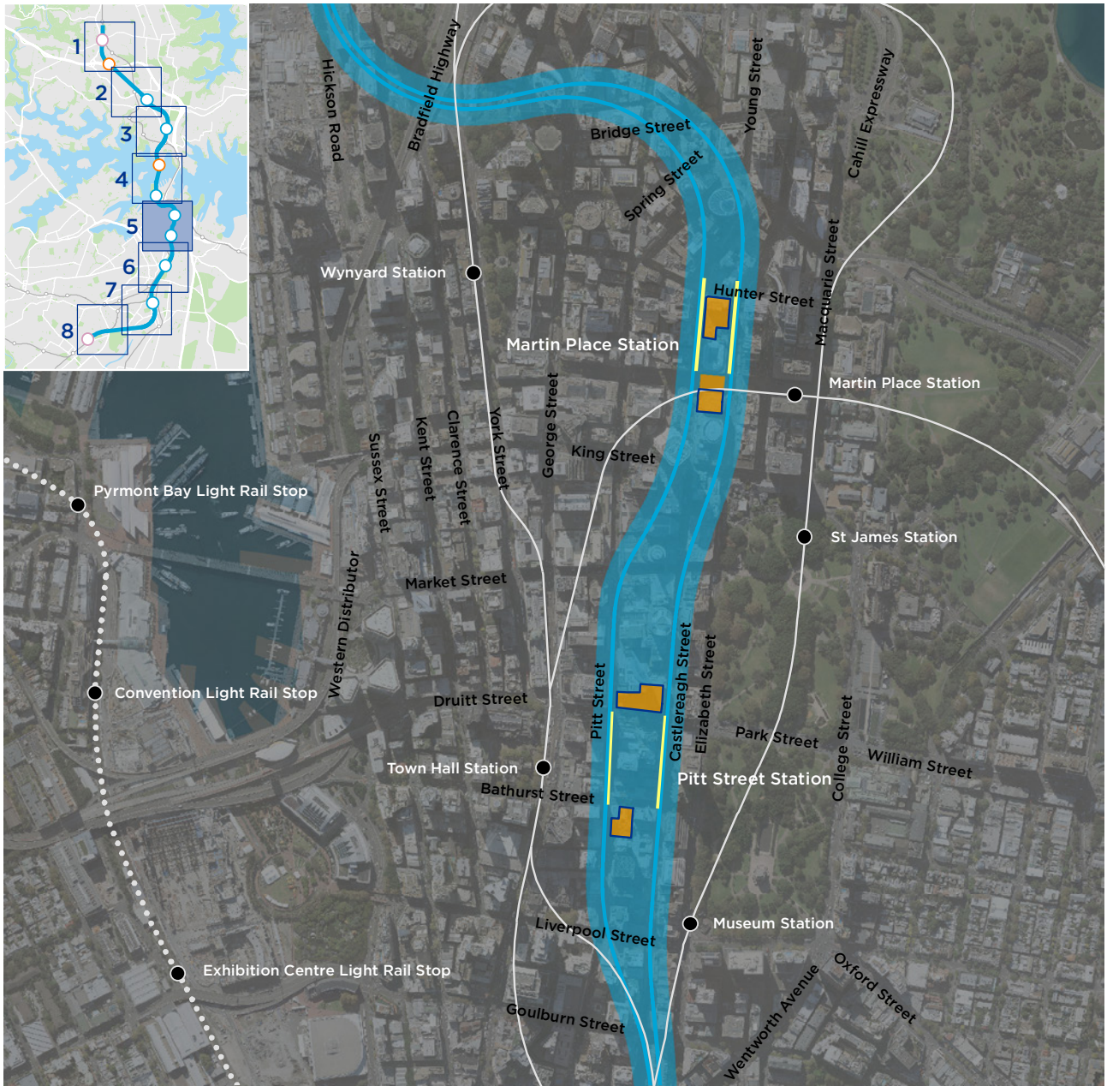

Figure 2-1e The project Map 5

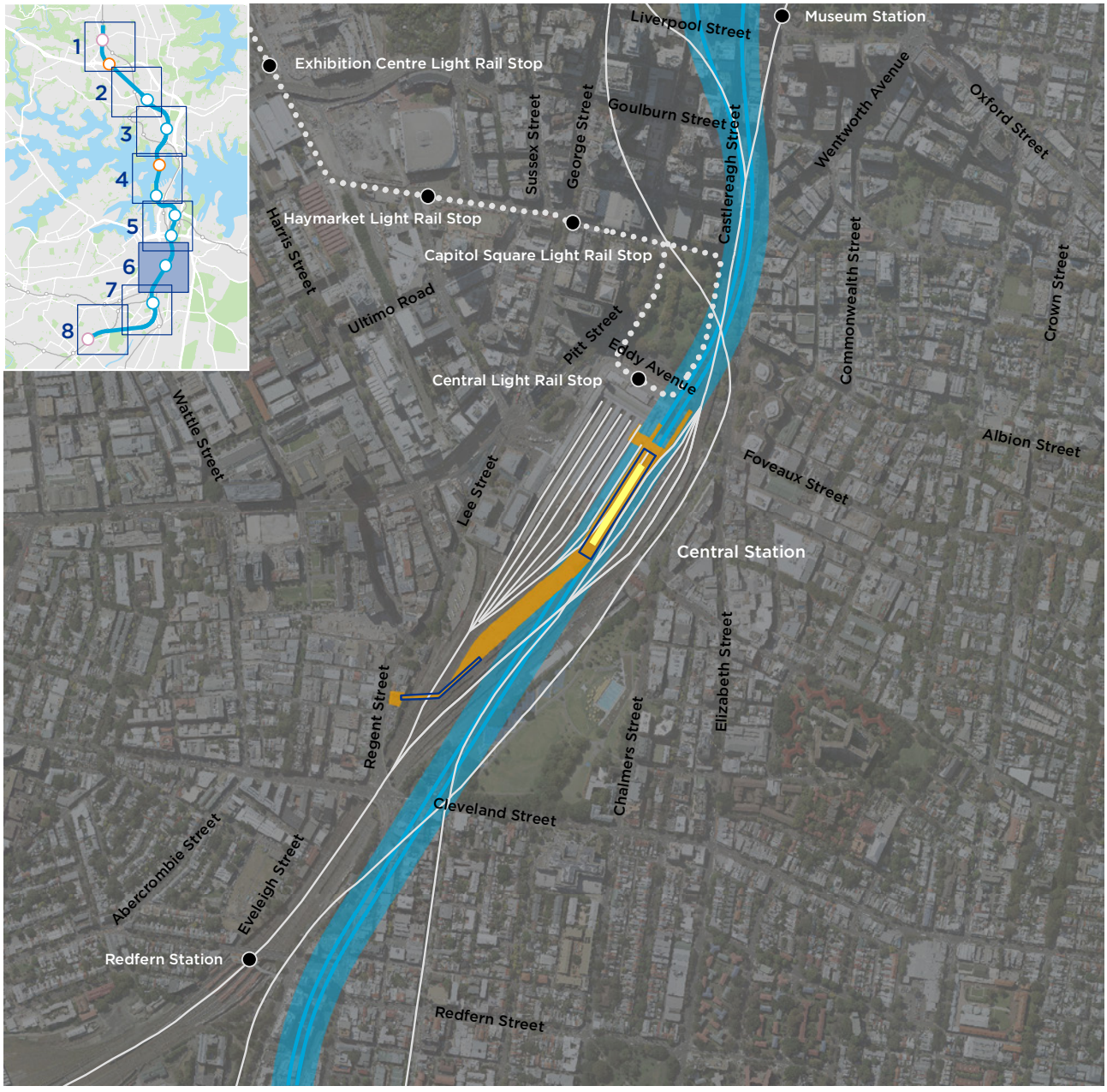

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Figure 2-1f The project Map 6

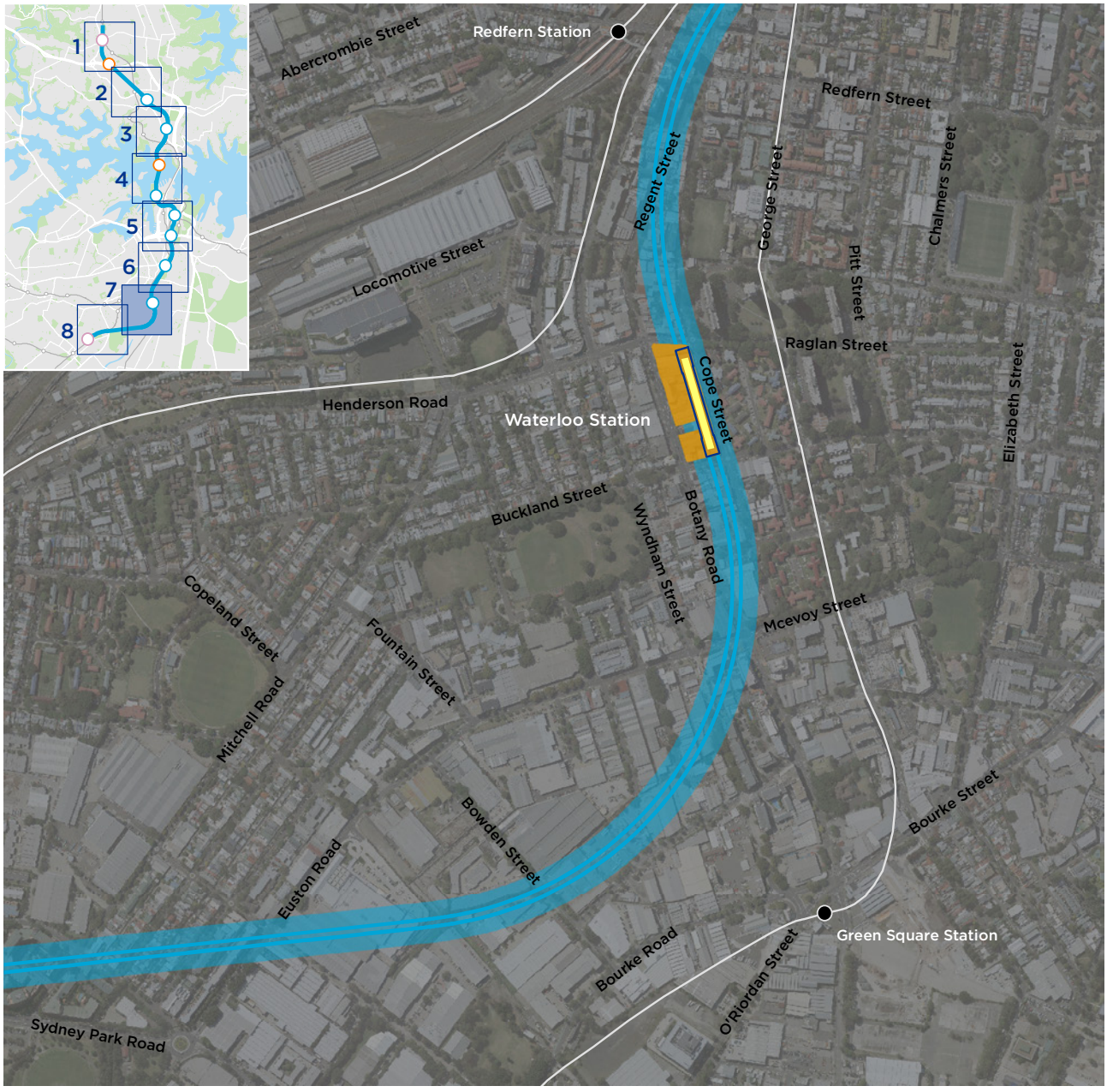

Figure 2-1g The project Map 7

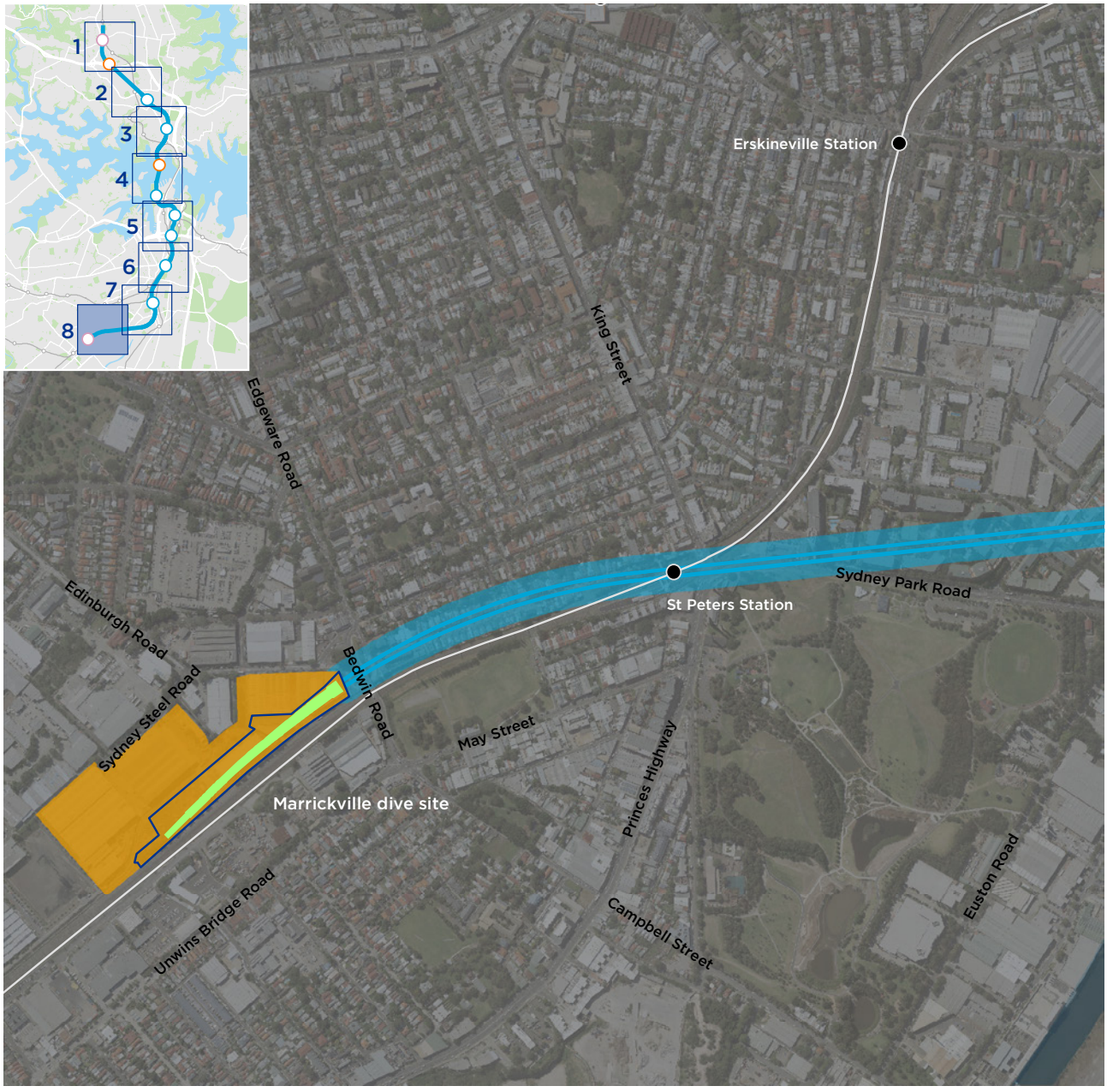

Figure 2-1h The project Map 8

2.1 Metro operations

The project would operate in conjunction with Sydney Metro Northwest (currently under construction) and the Sydenham to Bankstown upgrade project. All Sydney Metro operations would be controlled and monitored from the Sydney Metro Trains Facility at Tallawong Road, Rouse Hill.

The project is being designed as a 'turn up and go' service. The proposed service frequency at the time of opening would be:

- Weekday morning and evening peaks – a six car train at least every four minutes (20 trains per hour)
- Weekday daytime off-peak – a six car train every five minutes through the Sydney CBD (12 trains per hour)
- Weekday early mornings, late at night and on weekends – a six car train every ten minutes with options to increase based on level of demand (six trains per hour).

The project would be designed to cater for long term growth in travel demand. When required to meet increased demand, capacity would be increased by increasing from six car to eight car trains and increasing the service frequency from 20 trains per hour to up to 30 trains per hour through the Sydney CBD in peak periods. That is, at ultimate capacity the service frequency would be an eight car train every two minutes through the Sydney CBD. The assessment within this Environmental Impact Statement is based on this ultimate capacity.

2.2 Metro stations

The location and key features of the Metro stations are shown in Figure 2-2 to Figure 2-8 and summarised in Table 2-1.

Table 2-1 Metro Station design elements

Station Type	Transport interchange	Station entry / egress	Transport and access
Crows Nest Station			
Single-span (cut-and-cover) cavern with island platform	Walking, cycling, bus, taxi and kiss-and-ride	• On the corner of Hume and Clarke Streets • On the corner of Pacific Highway and Oxley Street	• New signalised pedestrian crossing on northern side of Pacific Highway / Oxley Street intersection • New pedestrian crossings on Clarke, Hume and Oxley streets • New bike parking on Hume and Oxley streets • New on-road marked cycle links on Hume Street • Existing bus stops close to the station retained on the Pacific Highway • New kiss-and-ride and taxi bays on Clarke Street
Victoria Cross Station			
Single-span (mined) cavern with island platform	Walking, cycling, bus, taxi and kiss-and-ride	• Via a pedestrian plaza opening to Miller, Denison and Berry streets	• New bike parking near the corner of Miller and Berry streets • Existing bus stops close to the station retained on Miller Street • New kiss-and-ride bays on Berry Street

Station Type	Transport interchange	Station entry / egress	Transport and access
Barangaroo Station			
Single-span (cut-and-cover) cavern with island platform	Walking, cycling, bus, taxi and ferry	• Within Central Barangaroo and Barangaroo Reserve	Transport and access arrangements would be developed in consultation with Barangaroo Delivery Authority. At this stage, they are expected to include: • New pedestrian crossings on Hickson Road, Little Clyde Street and Agar Street • New bike parking on Little Clyde and Agar streets • Relocation of bus stops on Hickson Road closer to the station entry • New kiss-and-ride and taxi bays on Hickson Road
Martin Place Station			
Binocular cavern (mined) with two single side platforms	Walking, cycling, taxi, bus, light rail and suburban rail	• A northern entry via a pedestrian plaza opening to Castlereagh, Hunter and Elizabeth streets • A northern entry via an underground pedestrian connection below Hunter Street to O'Connell Street and / or Bligh Street (subject to further investigation) • A southern entry via a pedestrian plaza opening to Martin Place and Castlereagh Street	• New underground pedestrian link between the existing suburban Martin Place Station platforms and the metro station platforms • New underground pedestrian connection between the station platform at O'Connell Street and / or Bligh Street (subject to further investigation) • New bike parking on Castlereagh Street at both station entries • Existing bus stops close to the station retained on Elizabeth and Castlereagh streets • Existing taxi ranks close to the station retained on Elizabeth and Castlereagh streets
Pitt Street Station			
Binocular cavern (mined) with two single side platforms	Walking, cycling, taxi, bus and light rail	• A northern entry via a pedestrian plaza opening to Pitt and Park streets • A southern entry via a pedestrian plaza opening to Bathurst Street	• New bike parking on Park and Bathurst streets • Existing bus stops close to the station retained on Park and Castlereagh streets • Existing taxi bays close to the station retained on Castlereagh and Pitt streets

Station Type	Transport interchange	Station entry / egress	Transport and access
Central Station platforms			
Single-span (cut-and-cover) cavern with island platform	Walking, cycling, intercity rail, suburban rail, light rail, bus taxi and kiss-and-ride	• Via the existing northern station entry from Eddy Avenue and the main northern concourse • Via the existing paid underground pedestrian connections	• Connect to the northern concourse and existing paid underground pedestrians links within Central Station for interchange • Existing bike parking retained • Existing bus stops retained • Existing kiss-and-ride and taxi ranks retained
Waterloo Station			
Single-span (cut-and-cover) cavern with island platform	Walking, cycling, bus, taxi, and kiss-and-ride	• At the northern end of the station on the corner of Raglan and Cope streets	• New pedestrian crossings on Raglan and Cope streets • New bike parking on Cope Street • New on-road marked cycle link on Raglan Street • Existing bus stops retained northbound along Botany Road • Relocation of the bus stops southbound on Botany Road closer to Raglan Street • Relocation of the bus stops on Cope Street to Botany Road • New taxi and kiss-and-ride bays on Cope Street

Figure 2-2 Crows Nest Station – location and indicative layout

Figure 2-3 Victoria Cross Station – location and indicative layout

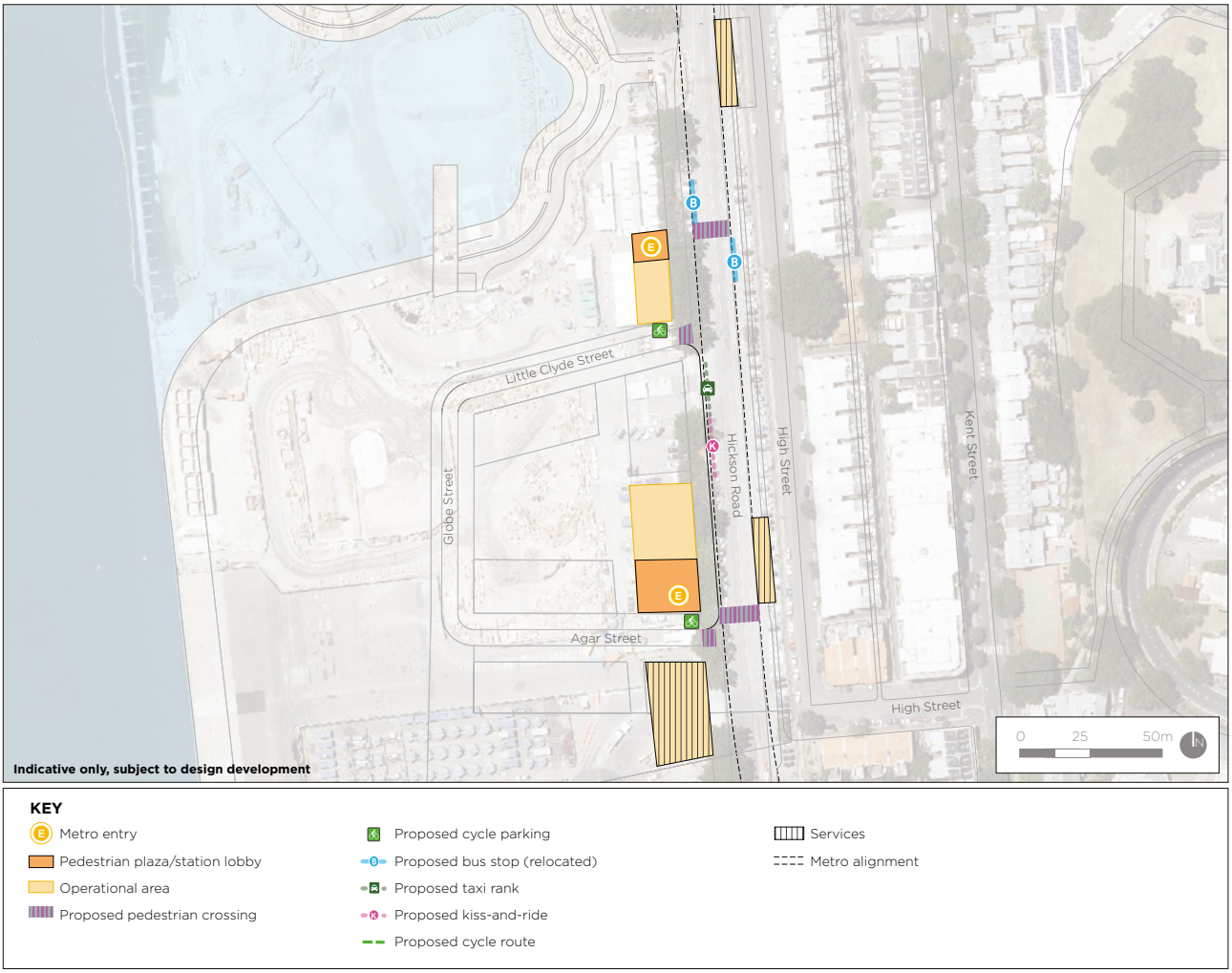

Figure 2-4 Barangaroo Station – location and indicative layout

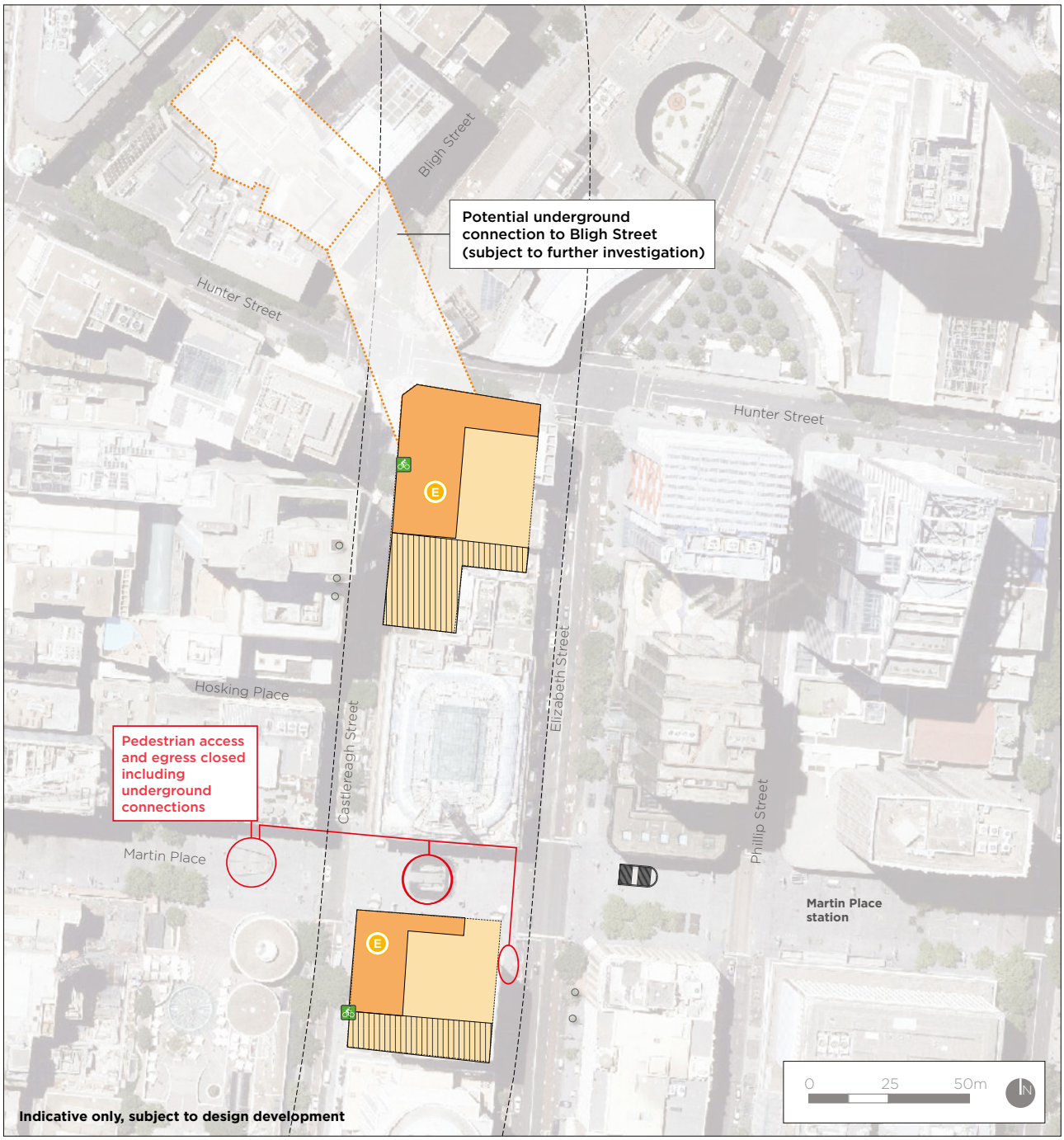

Figure 2-5 Martin Place Station – location and indicative layout

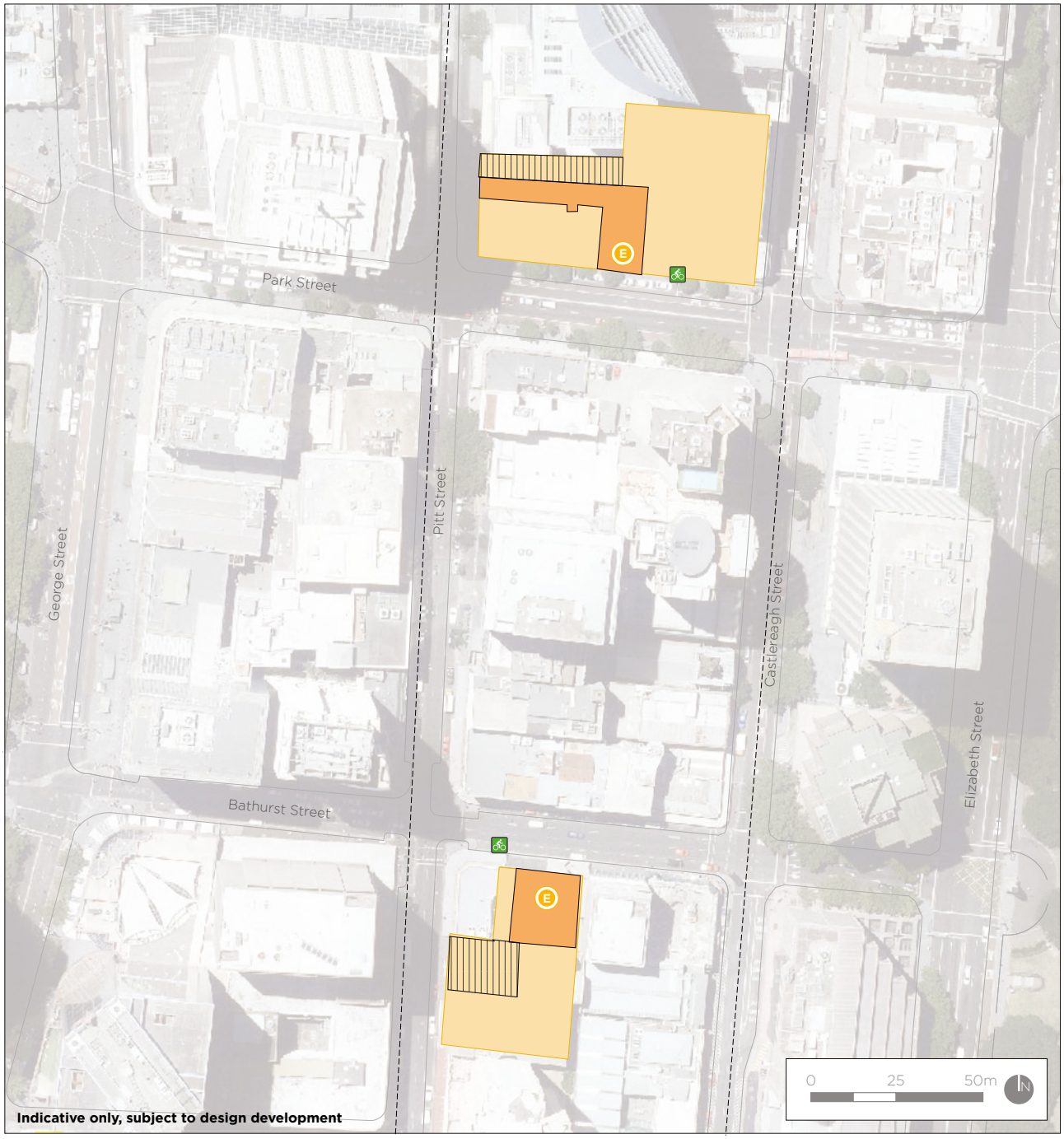

Figure 2-6 Pitt Street Station – location and indicative layout

Figure 2-7 Central Station – location and indicative layout

Figure 2-8 Waterloo Station – location and indicative layout

2.3 Metro rail tunnels

The twin underground metro rail tunnels would extend about 15.5 kilometres between the Chatswood tunnel portal (north of Mowbray Road, Chatswood) and the Marrickville tunnel portal (south of Bedwin Road, Marrickville).

The tunnel alignment (as shown on Figure 2-1(a) to (h)) is indicative at this stage, and has been used for the purposes of the environmental impact assessment including all specialist investigations. During detailed design the alignment may change (horizontally and / or vertically). Any changes to the alignment would be reviewed for consistency with the assessment contained in this Environmental Impact Statement including relevant mitigation measures, performance outcomes and any future conditions of approval.

There would be a future statutory corridor for the project established through the *State Environmental Planning Policy (Infrastructure) 2007*. Any future development within this corridor would be referred to Transport for NSW for concurrence. A preliminary project corridor, which extends 30 metres either side of the tunnel alignment, is shown on Figure 2-1(a) to (h). This corridor would be confirmed consistent with any changes to the alignment described above.

Key features of the metro rail tunnels include:

- The tunnels would have a circular cross-section with an internal diameter of about six metres (radius of about three metres)
- The tunnels would be lined with pre-cast concrete segments to maximise the tunnel lifespan and minimise groundwater inflow
- The tunnels would provide space for other equipment and services including rail signalling, controls and communication, overhead traction power, ventilation, fire and life safety systems, lighting and drainage.

2.4 Dive structures and tunnel portals

Dive structures and tunnel portals would be provided at each end of the project, as follows:

- The Chatswood dive structure would commence about 250 metres south of Chatswood Station, while the Chatswood tunnel portal would be located to the north of Mowbray Road
- The Marrickville dive structure would commence about 400 metres north of Sydenham Station and the Marrickville tunnel portal would be located in the suburb of Marrickville about 840 metres north of Sydenham Station (to the south of Bedwin Road).

The dive structures would comprise an initial length of open trough, which would then transition to a cut-and-cover structure (the tunnel portals). A fire protection wall would be installed along the entire length of the dive structures to provide separation between the two metro tracks.

2.5 Surface tracks

Surface metro tracks would be provided at the northern end of the project for about 250 metres of surface metro tracks between the Chatswood dive structure and Chatswood Station, connecting to the Sydney Metro Northwest tracks. The surface metro tracks would be located between the T1 North Shore Line tracks.

The T1 North Shore Line tracks and rail systems would also be adjusted between the southern end of Chatswood Station and Brand Street, Artarmon to accommodate the metro surface tracks and Chatswood dive structure. Between Chatswood Station and the Chatswood dive structure the T1 North Shore Line tracks would be re-located to the outside of the metro tracks. To accommodate the metro tracks, including the dive structure and tunnel portal, the T1 North Shore Line 'down' (northbound) track would be relocated to the west and would pass over the metro dive structure on a bridge.

2.6 Operational ancillary infrastructure

Operational ancillary infrastructure would be required for the project including:

- A substation at Artarmon (between the northern tunnel portal and Crows Nest Station) to provide traction power to the tunnels. The substation would be located above the tunnels near the edge of the Gore Hill Freeway
- A services facility adjacent to the Marrickville tunnel portal, including a tunnel water treatment plant and a traction substation.

2.7 Other operational features

2.7.1 Permanent closure of Nelson Street bridge

The Chatswood dive structure and tunnel portal would result in the demolition and permanent closure of the Nelson Street bridge. The primary role of the Nelson Street bridge is to enable motorists travelling south on the Pacific Highway to access Mowbray Road westbound via Orchard Road. Nelson Street also provides local vehicle access to residents of Nelson Street. To maintain this primary movement, it is proposed to construct an all vehicle right-turn movement from the Pacific Highway southbound to Mowbray Road westbound. This would require the widening of the Pacific Highway to the north of the Mowbray Road intersection.

As part of the project, Frank Channon Walk (a shared path currently connection Chatswood Station to Nelson Street) would be extended from Nelson Street to Mowbray Road on the western side of the rail line to provide an enhanced facility for pedestrians and cyclists and provide continued access between Chatswood Station and residential areas to the south.

2.7.2 Sydney Yard Access Bridge

To provide access for Sydney Metro and Sydney Trains once the project is operational, an access bridge for maintenance vehicles at Central Station would be provided from Regent Street to 'Sydney Yard', located between the suburban and intercity rail lines.

The bridge would be about 170 metres long with a central span of about 50 metres, crossing the Intercity rail lines. The bridge deck would be about nine metres above the ground.

Because of the prominence of the bridge and the heritage sensitivity associated with its setting, the following principles would guide its detailed design:

- The bridge would be of high quality design and integrate with the industrial rail context
- The bridge architecture would draw reference from the existing forms, materials and colours of Sydney Yard
- The bridge structure and abutments would be of masonry construction
- Where throw screens are required they would be of largely transparent material and construction
- Lighting of the bridge would be inconspicuous and not cause nuisance in the public domain or spill towards Mortuary Station.

2.8 Construction

2.8.1 Overview

The key construction activities to be carried out for the project include:

- Demolishing buildings and structures at the station sites and other construction sites
- Constructing dive structures and tunnel portals
- Constructing tunnels, adits and cross passages
- Excavating a shaft for a temporary tunnel boring machine retrieval site at Blues Point
- Excavating, constructing and fitting out metro stations
- Carrying out surface works between Chatswood Station and Brand Street, Artarmon
- Excavating a shaft, carrying out structural work and fitting out ancillary infrastructure at Artarmon
- Carrying out structural work and fitting out ancillary infrastructure at Marrickville
- Fitting out the tunnel with rail operating systems
- Testing and commissioning of stations, tunnels, ancillary infrastructure, rail systems and trains.

A number of construction sites would be required to construct the project (as shown on Figure 2-1(a) to 2.1(h)). These include locations for tunnel equipment and support, stations, surface track and ancillary facilities.

2.8.2 Program

Enabling works (preliminary construction activities required to facilitate substantial construction) would likely commence in early 2017, with substantial construction of the project planned to commence in early 2018. The total period for construction would be about seven years, with the project expected to be opened to the public in 2024. An indicative construction program is shown in Table 2-2.

Table 2-2 Indicative construction program

Construction activity	Indicative construction timeframe																											
	2017				2018				2019				2020				2021				2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling works																																
Tunnel construction																																
Station excavation and structural works																																
Ancillary facility excavation and structural works																																
Tunnel rail systems fit out																																
Station construction and fit out																																
Ancillary facility construction and fit out																																
Testing and commissioning																																

2.8.3 Tunnels

Tunnel excavation

Tunnel boring machines are likely to be used to excavate the majority of the twin tunnels. Each tunnel boring machine would typically consist of a shielded cutting head and trailing backup support services and mechanisms. At the front of the shield is a rotating cutter head, and behind the cutter head is a chamber where the excavated rock and sediments (spoil) are removed. The spoil is transferred to a conveyor or slurry pipe to transport the spoil to the tunnel boring machine launch site for removal.

Roadheaders would be used to excavate irregular shaped tunnels such as stub tunnels, niches and cross-passages. A roadheader is an excavation machine consisting of a boom mounted rotating cutter head mounted on bulldozer style tracks, a loading device, and a crawler track to move the machine forward into the rock face. Excavators with rock hammer attachments would also be used to excavate cross passages and niches within the tunnels.

It is anticipated that tunnelling would occur from three tunnel boring machine launch and support sites:

- A site in Chatswood (south of Chatswood Station and north of Mowbray Road), referred to as the Chatswood dive site (northern). This site would support two tunnel boring machines for the drive to Blues Point
- A site in Marrickville (north of Sydenham Station and south of Bedwin Road), referred to as the Marrickville dive site (southern). This site would support two tunnel boring machines for the drive to Barangaroo. A pre-cast facility would also be established at this site to manufacture the pre-cast concrete tunnel lining segments
- A site at the proposed Barangaroo Station for the crossing of Sydney Harbour (Barangaroo Station construction site). Due to the different ground conditions under Sydney Habour, this site would support a specialised tunnel boring machine for the drive Blues Point.

A temporary site would also be established at Blues Point for the retrieval of the cutter head and shields of the tunnel boring machine driven from the Chatswood dive site and the Barangaroo Station construction site.

Tunnelling from the tunnel boring machine launch sites would occur concurrently, with the use of five tunnel boring machines.

Sydney Harbour sediment ground improvement

Due the expected ground conditions underneath Sydney Harbour, ground improvement work is likely to be required prior to excavation of the tunnels to reduce construction risks and allow for maintenance of the tunnel boring machine cutters prior to driving through the rock-sediment transition zones. Ground improvement work is likely to involve the establishment of solid blocks (each about 35 metres wide by 20 metres long by 16 metres deep) at the two points where the tunnel alignment passes through a rock-sediment transition zone.

The preferred method of ground improvement is through jet grouting, although alternative approaches such as ground freezing may be considered during detailed design. Jet grouting would involve the injection of a cement grout from barges via a crane and drilling lead.

Tunnel fit-out

Tunnel fit-out would include the installation of fresh air ventilation equipment; the track slab and rail fasteners; rail fixing and welding; signaling, communications and power cables equipment; overhead traction power conductor bars; and other equipment such as lighting, drainage and fir and life safety systems.

The main access points for the tunnel fit-out would be via the Chatswood dive site and the Marrickville dive site. Secondary access via the underground stations would be possible, however this access would diminish as the station fit-out progresses.

2.8.4 Stations

Station construction would involve excavation, structural work, aboveground building and station fit-out.

Excavation

Station excavation would initially involve the use of rock hammers and excavators. Once appropriate offset depths are reached, blasting would be used to excavate the remainder of the stations and shafts (except for Central Station). Blast charge sizes would be designed to comply with the relevant blasting criteria.

For cut-and-cover stations (Crows Nest, Barangaroo, Central and Waterloo stations) excavation of the station would progress down to the level of the base slab. The base slab and permanent structural elements would then be built up from the bottom of the excavation. The last element of the structure would be the roof slab – leaving only discrete entry and exit points.

For mined stations (Victoria Cross, Martin Place and Pitt Street) shaft excavation would be carried out to an intermediate floor level. Roadheaders and other excavation equipment would then be lowered through the shaft to excavate the underground station and pedestrian connections.

Structural work

Following excavation, the station works would involve the construction of structural elements using cast in-situ or pre-fabricated concrete. Structural elements would include platforms, vertical supports, intermediate floors and roof slabs.

Aboveground building

Aboveground buildings associated with station entry and exit points, services and emergency egress would generally be constructed following the station structural works. Buildings would be constructed using conventional steel frame or reinforced concrete methods.

Fit-out

The station fit-out would involve:

- Mechanical and electrical fit-out including the tunnel rail systems located at the stations and the services required for the function of the stations. The initial fit-out of mechanical and electrical services would likely occur concurrently with the structural work via openings left in the floors and roof structure (for cut-and-cover stations) or through the vertical transport shaft (for mined stations). This would include the installation of large equipment such as fresh air ventilation fans. The final fit-out of services would occur after the completion of structural work
- Architectural fit-out would occur after completion of the station structural works. It would include elements such as glazing, wall and ceiling cladding, and floor finishes.

2.8.5 Surface works and dive structures

Construction of the Chatswood and Marrickville dive structures and tunnel portals would generally involve:

- Cast in-situ concrete piling along the edge of the dive structure to form the walls
- Excavating below track level
- Placing of pre-cast and cast in-situ concrete for the cut-and-cover section and to form the tunnel portal.

Surface works would be carried out at the northern end of the project between the southern end of Chatswood Station and the Chatswood dive structure. This would involve the relocation of the T1 North Shore Line and associated rail infrastructure, the construction of the metro rail tracks and associated rail infrastructure, and ancillary components such as access maintenance access points and noise barriers.

2.8.6 Ancillary infrastructure

Artarmon substation

Construction of the Artarmon substation would involve excavating a vertical shaft to the tunnels below, lining and reinforcing the shaft, building aboveground components, and installing electrical equipment.

Southern services facility

The southern services facility, located within the Marrickville dive site, would incorporate a tunnel water treatment plant and a traction substation for use during the operation of the project.

The tunnel water treatment plant would typically be a modular unit constructed on a concrete base slab. Drainage pipes would connect the water treatment plant with the tunnels.

The traction substation would consist of an aboveground building and installation of electrical equipment. Trenching and / or aboveground conduits would be provided to reticulate electrical cables into the tunnels.

2.8.7 Construction hours

Proposed construction hours are shown in Table 2-3. These hours have been developed based on a balanced consideration of the construction program and the need to minimise noise and traffic related impacts. As the tunnel boring machines would operate continuously, the tunnelling and associated support activities would need to be carried out up to 24 hours per day and seven days per week.

The majority of the station fit-out and other aboveground construction activities would be carried out during the following hours:

- 7 am to 6 pm Monday to Friday
- 8 am to 1 pm Saturdays
- No works on Sundays or Public Holidays.

However, other substantial activities (as identified in Table 2-3) would need to be carried out outside these hours.

Table 2-3 Proposed construction hours

Activity	Construction hours	Comments or exceptions
Underground construction activities		
Tunnelling	24 hours per day, seven days per week	Activities that support tunnelling may need to occur 24 hours per day, up to seven days per week. Rock hammering in the tunnel between 10 pm and 7 am would be precluded except where there would be no impact on sensitive receivers. Drill and blast, if required, would be carried out during periods anticipated to have the least impact on receivers.
Underground excavation at station and ancillary sites	24 hours per day, seven days per week	May need to occur outside standard daytime construction hours provided appropriate noise mitigation is in place. Drill and blast would be carried out during periods anticipated to have the least impact on receivers
Tunnel and station fit-out (underground)	24 hours per day, seven days per week	Activities that support tunnel and station fit-out may need to occur 24 hours per day, up to seven days per week.
Aboveground construction activities		
Demolition **Station and ancillary facility fit-out and construction (aboveground)**	• 7 am to 6 pm Monday to Friday • 8 am to 1 pm Saturdays • No works on Sundays and Public Holidays	Aboveground work supporting underground construction activities (eg concrete pumping, truck loading) are expected to be required 24 hours per day, up to seven days per-week where noise mitigation is in place. Non-disruptive preparatory work, repairs or maintenance may be carried out on Saturday afternoons between 1 pm and 5 pm or Sundays between 8 am and 5 pm. Activities requiring the temporary possession of roads or to accommodate road network requirements may need to be carried out outside the standard daytime construction hours during periods of low demand to minimise safety impacts and inconvenience to commuters. Activities requiring rail possessions may need to be carried out outside the standard construction hours up to 24 hours per day, seven days per week.

Activity	Construction hours	Comments or exceptions
Construction traffic for material supply to, and spoil removal from, tunnelling and underground excavation (station and ancillary facility sites)	24 hours per day, seven days per week	Restrictions would be in place during peak hours and special events. At locations where night-time sensitive noise receivers are close to construction sites, significant construction vehicle movements are likely to be restricted during evening and night-time periods.

Other activities that would be carried out outside of the standard daytime construction hours would include:

- Work determined to comply with the relevant noise management level (NML) at the nearest sensitive receiver
- Work required to be carried out during rail possessions
- The delivery of materials outside approved hours as required by the NSW Police or other authorities (including Roads and Maritime) for safety reasons
- Emergency situations where it is required to avoid the loss of lives and property and / or to prevent environmental harm
- Situations where agreement is reached with affected receivers.

With the exception of emergencies, activities would not take place outside standard daytime construction hours without prior notification of local residents, businesses and the Environment Protection Authority.

2.8.8 Other key construction activities

Demolition

It is anticipated that construction would require the demolition of about 58 commercial buildings, six residential buildings and 15 industrial buildings. Some demolition would occur in the enabling works phase before substantial construction begins. This would result in less chance of vandalism and assist in managing potential conflicts between the scheduling of the metro station construction and the construction of the CBD and South East Light Rail.

Demolition would be carried out by licensed demolition contractors and in stages where possible. Typically, building demolition would involve:

- Establishment of hoarding, scaffolding and protection barriers around the perimeter of the site
- All services into the buildings would be decommissioned, made safe and redundant
- Soft stripping internal building materials
- Demolition of the building using an excavator, bobcat cranes or other conventional methods following a top-down approach. Temporary propping and / or waterproofing would be provided for structural integrity of adjacent structures as required during the demolition works.

A hazardous materials analysis would be carried out prior to stripping and demolition of the main structure. Any hazardous materials would be removed and disposed of in accordance with the relevant legislation, codes of practice and Australian Standards.

Materials such as bricks, tiles, timber, plastics and metals would be sorted where practicable and sent to a waste facility with recycling capabilities.

Structures other than buildings to be demolished, include:

- Nelson Street road bridge at the Chatswood dive site
- The pedestrian bridge across Denison Street connecting Berry Square and Tower Square adjacent to the Victoria Cross Station site
- The pedestrian connection beneath Martin Place between Castlereagh and Elizabeth streets
- Existing platforms, canopies, overhead supports and underground pedestrian connections at Central Station.

Power supply

High voltage (11 kV) power supply would be required for the operation of tunnel boring machines at the Chatswood dive site, the Marrickville dive site, Barangaroo Station and potentially at Pitt Street Station; and for roadheaders at the station sites. The power supply for each site would need to be brought in from a substation outside the project corridor. Table 2-4 describes the power supply required at each construction site. The supply route for the Pitt Street site would also be used to supply the permanent power supply to the Pitt Street traction substation. This would involve replacing the 11 kV cables with 33 kV cables within the same conduits.

Power supply routes would generally be located within existing road reserves. Construction of these power supply routes would generally be carried out by open trench. Underbores would be used when crossing major infrastructure or to avoid other major constraints.

Any construction power supply for Artarmon substation and Blues Point temporary site would be provided directly from the local grid.

Preliminary consultation has been carried out with energy suppliers. A program of ongoing consultation is underway to further assess the requirements for the project.

Table 2-4 Construction power for tunnel boring machines

Site	Supply source	Distance to site	Power (mega volt ampere)
Chatswood dive site (northern)	Chatswood substation	100 m	15
Crows Nest Station	Existing cables in Clarke Lane	30 m	3
Victoria Cross Station	Existing cables in Berry Street	50 m	6
Barangaroo Station	City North substation	950 m	12
Martin Place Station	City North substation	1.3 km	7
Pitt Street Station	Surry Hills substation or Pyrmont substation	1.5 km 1.7 km	15
Central Station	Belmore Park substation	600 m	3
Waterloo Station	Zetland substation	850 m	3
Marrickville dive site (southern)	Existing cables in Princes Highway	850 m	14

2.9 Project uncertainties and ongoing design development

The Environmental Impact Statement is based on the concept design developed for the project. The detailed design of the project in ongoing and may result in changes to the project. Any changes to the project would be reviewed for consistency with the assessment contained in the Environmental Impact Statement including relevant mitigation measures, environmental performance outcomes and any future conditions of approval.

In addition to the standard detailed design process, the current key project uncertainties that have been identified at this stage of the project for which Transport for NSW is continuing to investigate opportunities are:

- Requirements for track cross-overs for operational efficiency and flexibility
- The details of the underground pedestrian connection from the northern station entry at Martin Place Station to O'Connell Street and / or Bligh Street
- Enhancement of pedestrian facilities in Denison Street North Sydney with high pedestrian volumes at Victoria Cross Station
- Operational transport and access arrangement around Barangaroo Station which would be developed in consultation with Barangaroo Delivery Authority
- The location of a landside facility to support ground improvement work for the crossing of Sydney Harbour
- Options for barging of spoil rather than transport by road from the Barangaroo Station construction site and the Blues Point temporary site
- The heritage response of project infrastructure within Central Station and the potential re-use of heritage significant fabric with input from a heritage architect and the Sydney Metro Design Review Panel and in consultation with Sydney Trains and the Heritage Council of NSW
- Construction site layout including flow diversions to manage potential overland flows in flood events at the Marrickville dive site
- Cumulative impacts – particularly construction traffic in the Sydney CBD. Given the highly dynamic and time / activity specific nature are difficult to define in any detail at this stage of the assessment process.

Updates on these project scope issues would be provided at the Submissions Report stage of the assessment.

Notwithstanding these uncertainties, Transport for NSW has committed to performance based outcomes (refer to Section 5) to provide confidence that any impacts would be still meet best practice requirements and be within appropriate and acceptable criteria.

3 Summary of project impacts

This section provides a summary of the impacts of the project. These impacts are discussed in detail in Chapters 8 through to 26 in the Environmental Impact Statement.

Many potential impacts have been avoided through the earlier design and project development process which included input from key stakeholders. 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.

These potential impacts would also be further avoided and minimised, where possible, through the implementation of the mitigation measures identified in section 4 and complying with the performance outcomes identified in section 5.

3.1 Key impact avoidance strategies

The design and construction planning has been influenced by a number of community and environmental and engineering / design factors. In general, the project has been designed to:

- Avoid known structures including buildings, basements, utilities and infrastructure (including other rail and road infrastructure)
- Minimise the potential for direct and indirect impacts to heritage items
- Minimise direct impact on property.

Specific impact avoidance strategies are summarised in Table 3.1.

Table 3-1 Adverse impacts avoided or minimised through design

Environmental aspect	Design response
Operation	
Noise	• Provision of track form to meet ground-borne noise and vibration goals • Provision of new noise barriers and increases to the height of existing noise barriers at the northern end of the project to mitigate airborne noise from train operations • Location of the northern dive structure minimises the extent of surface track and potential airborne noise impacts.
Property and land use	• Provision of mined stations at Victoria Cross, Martin Place and Pitt Street to avoid more extensive property acquisition • Location of the Artarmon substation to avoid the need to acquire residential, commercial or industrial property • Location of the Marrickville dive structure to avoid potential impacts on Sydney Water assets and a Transgrid 330 kilovolt (kV) underground cable.

Heritage	• The design has avoided the following listed heritage items:
	  ◆ Mowbray House adjacent to the Chatswood dive structure
	  ◆ The brutalist building adjacent to Crows Nest Station
	  ◆ The Edinburgh Castle Hotel adjacent to Pitt Street Station
	  ◆ The Congregational Church adjacent to Waterloo Station
	  ◆ The Sydney Water Pit and Drainage Pumping Station near the Marrickville dive structure.
	• The design has minimised impacts to the Lost Property Office at Central Station.

Environmental aspect	Design response
Groundwater	• Provision of tanked tunnels, mined stations and cut-and-cover stations at Barangaroo and Waterloo to minimise the inflow of groundwater • Provision of a tanked station at Barangaroo to minimise the potential for contaminated groundwater inflow.
Biodiversity	• Location of the northern dive structure avoids impacts to Blue Gum High Forest at Artarmon Reserve.
Construction methodology	
Traffic and transport	• Two main tunnel support sites (at Chatswood and Marrickville) were selected because they are located at either end of the tunnel, allowing the majority of tunnelling spoil to be managed away from the critical Sydney CBD section • All three tunnel support sites (at Chatswood, Barangaroo and Marrickville) are located close to major arterial roads, which would minimise the use of local roads for spoil haulage • The location of the northern dive structure minimises the extent of construction works within the T1 North Shore Line corridor and disruption to customers at Artarmon Station • The location of Marrickville dive structure minimises the potential need for rail possessions within the T3 Bankstown Line corridor and the T4 Eastern Suburbs and Illawarra Line corridor • Development of haul routes to minimise impacts on the road network.
Noise	• Location of the two main tunnel boring machine support sites (at Chatswood and Marrickville) on light industrial land to minimise noise to residential areas • Arrangement of haul routes to minimise the use of local roads • Adoption of blasting as an excavation method at station sites to minimise the duration of impacts associated with rock hammering.
Property and land use	• Location of the two main tunnel boring machine support sites (at Chatswood and Marrickville) in light industrial areas to minimise acquisition of residential properties and changes in land use • Construction footprints consistent with operational footprint as much as feasible to minimise property acquisition • Barangaroo Station construction site arranged to minimise the potential to delay the adjacent Barangaroo development.
Groundwater	• A hybrid tunnel boring machine was in part selected for the section of tunnel beneath Sydney Harbour as it includes a slurry operation that pressurises the cut materials between the cutter head and the tunnel face, preventing uncontrolled sudden groundwater inflow and collapse of the tunnel face.
Social and community facilities	• Selection of tunnel boring machines to excavate the twin tunnels because they operate faster than other excavation machinery, resulting in a reduced construction timeframe and less disruption for the local community.
Waste	• Selection of tunnel boring machines to excavate the twin tunnels because they cut the ideal circular profile for a rail tunnel, thereby minimising spoil generation.

3.2 Key impacts

The impacts that have not been avoided effectively represent the actual impacts of the project. These impacts are assessed in detail in Chapters 8 through to 26 in the Environmental Impact Statement. A summary complication of the key impacts for each of the issues identified in the Environmental Impact Statement is provided in Table 3-2.

Table 3-2 Key project impacts

Key project impacts
Construction traffic and transport
○ The introduction of construction vehicles would result in the minor deterioration in the performance of some intersections near construction sites. ○ Construction works at the Chatswood dive site (northern) would require the permanent demolition of the Nelson Street bridge over the T1 North Shore Rail Line. To maintain the primary movement facilitated by Nelson Street, an all vehicle right-turn movement would be provided from the Pacific Highway southbound to Mowbray Road westbound ○ Key pedestrians impacts would include: ♦ Temporary closure of some of the paid underground pedestrian connections at Central (a temporary pedestrian bridge would be provided) ♦ Temporary closure of Devonshire Street pedestrian tunnel for a period of around two weeks ♦ Temporary partial closure of Martin Place and closure of entry / exits at Martin Place Station over a period of about six months ♦ Temporary closure of Hume Street over a period of about six months ♦ Short-term temporary (weekend) closures of Frank Channon Walk. ♦ Safe alternative surface pedestrian and cyclist access would be provided during these closures ○ Other general impacts identified include: ♦ Reduced pedestrian and cyclist access or flows due to construction ♦ Potential impacts to pedestrian, cyclist and motorist safety ♦ Temporary relocation of bus stops ♦ Impacts on reliability of public transport services (Sydney Trains and buses) ♦ Increased travel times for customers during rail possessions ♦ Short-term temporary road or lane closures (most likely to occur overnight) ♦ Loss of parking spaces ♦ Impacts on access to private property ○ Potential impacts on marine traffic and shipping channels.
Operational traffic and transport
○ When operational the project would provide significant improvements to the public transport network capacity and efficiency including new public transport interchange facilities at and around stations. It would improve reliability across the rail network by reducing train crowding, platform and station crowding. It is also expected to provide wider road network benefits by encouraging greater use of public transport. ○ Additional pedestrian load on existing infrastructure resulting in less efficient pedestrian movements, particularly around: ♦ Victoria Cross Station ♦ Martin Place Station ○ Minor deterioration in intersection performance at Pacific Highway / Mowbray Road. ○ Minor deterioration in intersection performance at Pacific Highway / Oxley Street.

Key project impacts
Construction noise and vibration
• Given the nature and duration of works and the close proximity of receivers, airborne noise during construction is expected the exceed noise management levels at all sites – and at some sites by possibly more than 20dB(A). During the night-time, airborne noise levels are expected to generally comply with the criteria though there would some moderate exceedances at some locations • Ground-borne noise during construction from excavation activities is expected to be very high at a number of the station excavation sites – and potentially higher than 75 dBA during the day and 45 dBA during the night. In order to reduce the duration of these impacts, blasting is proposed to be used as an excavation method at the majority of stations. Preliminary blasting scenarios developed to comply with the blasting criteria show substantial reductions in the duration of rock hammering impacts at most station sites. Further work would be carried out during detailed construction planning including trial blasts with small charge sizes to determine site specific characteristics and to assess the level of predictability. Blasts would be designed to comply with the relevant levels for air-blast overpressure and ground vibration. • For tunnelling, a number of exceedances for ground borne noise levels are also expected to occur – the highest exceedances (up to 10dB(A) above criteria), are predicted at residential receivers between the Chatswood tunnel portal and Artarmon substation, around Pitt Street and Waterloo stations and just north of the Marrickville dive site. These levels are not expected to occur for longer than a few days • Construction vibration levels are anticipated to remain below the cosmetic damage vibration screening criteria, with some exceptions • At Chatswood dive site, Crows Nest and Victoria Cross, construction traffic noise is predicted to exceed the relevant criteria.
Operation noise and vibration
• When operational, through the provision of measures incorporated into the design (such as track form in the tunnels and noise barriers) the project would generally comply with all relevant noise and vibration criteria • There are residual noise levels above guidelines at one receiver at Chatswood.
Land use and property

• 98 total property acquisitions and three partial property acquisitions would be required along the alignment including a mix of residential, commercial, mixed use, industrial, retail, and road and rail infrastructure
• During construction, land use issues would largely relate to indirect impacts associated with reduced amenity such as traffic, noise, air quality and access. These issues have been addressed in the specific topic areas
• There would be a temporary loss of open space areas associated with the temporary works at Blues Point Reserve
• Other impacts include:
  ♦ Direct impacts on other infrastructure during construction including utilities and Sydney Trains property
  ♦ Potential restrictions on future development within a defined corridor due to subsurface tunnels
• When operational, the project would have no major direct impacts on land use, though would offer substantial future development opportunities.

Key project impacts
Business impacts
• Construction of the project would result in broad economic benefits by way of job generation and construction multipliers. Locally, many businesses would receive positive impacts with construction workers requiring food and beverage services and other goods • Negative impacts during construction would include direct impacts to businesses where properties are to be acquired, and altered access and visibility to businesses • Indirect business impacts during construction would include temporary constraints or restrictions on servicing and delivery / access, amenity issues such as increased traffic congestion, noise, vibration and dust, changes to customer access and parking • When operational, impacts would be largely positive due to the enhanced capacity and frequency of transport services with improved access to the Sydney CBD including Barangaroo. The new stations at Victoria Cross, Crows Nest, Barangaroo and Waterloo would also enhance the appeal and attraction of visiting, investing, living and working in these precincts • Negative impacts during operation would include altered access and visibility to businesses, increased commercial rents and amenity related impacts.
Non-Aboriginal heritage

• Direct physical impact on three State heritage listed properties:
  ◆ Millers Point & Dawes Point Village Precinct (minor impact)
  ◆ Martin Place Railway (moderate impact)
  ◆ Sydney Terminal and Central Railway Station Group (moderate to major impact)
• Direct physical impact to seven local heritage items:
  ◆ Mowbray House (minor impact)
  ◆ Shop at 187 Miller Street (Major impact – complete demolition)
  ◆ North Sydney Bus Shelters (Moderate impact)
  ◆ Blues Point Waterfront Group (minor to moderate impact)
  ◆ McMahons Point South Heritage Conservation Area (minor to moderate impact)
  ◆ Flat building, including interior (7 Elizabeth Street) (Major impact – complete demolition)
  ◆ Martin Place (moderate impact)
• There would also be potential indirect impacts to, around eight State heritage listed properties and around 28 local heritage listed properties (ie vibration or visual changes)
• Potential for impacts on unknown heritage items (eg archaeological items) during construction
• Potential for unsympathetic design that detracts from the heritage significance of a nearby item.

Aboriginal heritage
• Construction of the project would not directly or indirectly impact on any previously recorded Aboriginal heritage sites. • There is a moderate to high potential for previously unrecorded items of Aboriginal heritage significance to be present in sub-surface contexts at Barangaroo Station, Blues Point temporary site, and portions of the construction sites for Martin Place, Pitt Street, Central and Waterloo stations and the Marrickville dive site (southern) in situations where there are surviving portions of 'A' horizon soils.

Key project impacts
Landscape character and visual amenity
• In general the construction stage would result in minor to moderate adverse impacts • The exception would be high adverse visual impacts, due the sensitivity of these sites to visual changes, on viewpoints from Blues Point and McMahons Point associated with the obstruction of views to the open water of the Sydney Harbour and the incongruent character of the construction work • Viewpoints from Martin Place are considered to be of state visual sensitivity. Construction works would result in a considerable reduction in visual amenity for these viewpoints. In particular, the demolition of the 20 storey office tower at 39 Martin Place, which is visually prominent from Martin Place, would be a highly visible • When operational visual impacts are anticipated to be minor to moderate beneficial.
Groundwater and geology
• Potential groundwater drawdown levels during construction would generally be within the natural variation of groundwater levels. As such, impacts are not anticipated at any existing groundwater supply site • Ground settlement associated with groundwater drawdown or tunneling would be minor • When operational, groundwater captured from any drained station excavations and caverns would be transferred to a water treatment plant at Marrickville prior to discharge to stormwater. The discharge water quality level would be determined in consultation with the NSW Environment Protection Authority during detailed design, taking into consideration the current water quality of the receiving watercourse.
Soils, contamination and water quality
• Given the relatively small areas of surface disturbance anticipated during construction, soil erosion would be adequately managed in accordance with proven standard mitigation measures • There is a high probability of encountering acid sulfate soils at Barangaroo and between Waterloo Station and the Marrickville dive site • The project has a high likelihood of encountering contamination at construction sites at Chatswood and Barangaroo, and the ground improvement work in Sydney Harbour • Due to the expected ground conditions underneath Sydney Harbour, ground improvement to the seabed would be required prior to excavation of the tunnels. There is potential for water quality impacts due to disturbance of the seabed. In addition, the storage of materials (grout and spoil) would be required on barges on Sydney Harbour, which has the potential for spills or leaks.
Social impacts and community facilities
• Direct loss of community facilities, including a child care centre at Martin Place, and post shops at Crows Nest and Pitt Street • Temporary loss of public open space at Blues Point • Altered access to community facilities during construction • Reduced amenity such as traffic, noise, air quality and access. These issues have been addressed in the specific topic areas of the Environmental Impact Statement.
Biodiversity
• Removal and / or modification of hollow-bearing trees, buildings, and a bridge that could provide roosting and foraging habitat for the threatened Eastern Freetail Bat and Eastern Bent-wing Bat • Removal of planted fig trees that provide potential foraging habitat at Barangaroo and Chatswood for the threatened Grey-headed Flying-fox • Potential impacts to aquatic ecology from the mobilisation of contaminants with Sydney Harbour seabed sediments.

Key project impacts
Flooding and hydrology
○ The majority of construction sites are currently impervious to infiltration and have well-established drainage systems to cater for stormwater flows. At these sites construction activities would not result in any major increase in stormwater volumes or peak flow rates ○ At some sites, construction may result in minor changes to existing localised surface water and / or stormwater flow regimes ○ When operational, the aboveground station infrastructure would be located within the footprint of existing development and would have a negligible impact on the existing surface hydrology ○ The Marrickville dive site could result in overland flow impacts in flood events during construction ○ Flood modelling indicates that the permanent Marrickville dive structure would result in a worst case increase in flood levels within the existing rail corridor of about 470 mm in a 100 year annual recurrence interval flood event. These increases would only occur only in areas that already experience flooding – that is, no additional private properties would be flood-affected as a result of the project. The flood level increases would also be largely confined to the existing rail corridor and roads.
Air quality
○ In general air quality impacts (dust and exhaust emissions) are expected to be minor and manageable through well proven and established mitigation and management measures.
Hazard and risk
○ Potential impacts associated with the storage, use and transport of dangerous goods and hazardous substances. Construction site planning would ensure hazardous materials are stored appropriately and at an appropriate distance from sensitive receivers, in accordance with the thresholds established under Applying SEPP 33. ○ Risk of impacts to underground utilities. The risk would be minimised by carrying out utility checks (such as dial before you dig searches and non-destructive digging), consulting with the relevant utility providers and, if required, relocating and / or protecting utilities in and around the project prior to construction.
Waste management
○ Indicatively, the project would generate about 2.4 million cubic metres of spoil ○ Other waste material would include concrete, bricks, tiles, timber (treated and untreated), metals, plasterboard, carpets, electrical and plumbing fittings and furnishings (such as doors and windows), hazardous waste (including asbestos and insulation). Much of this would be associated with demolition activities.
Sustainability
○ Sustainability principles have been incorporated throughout the design development process. Key impacts identified include: ♦ Emissions of greenhouse gases from operational energy use and embodied energy in materials ♦ Emissions of greenhouse gases from construction activities including energy use for tunnel boring machines ♦ Impact of climate change on rail operations and infrastructure ♦ Impact of climate change on customer and staff comfort ♦ Increased electricity use during operation ♦ Increased demand on electricity and water supply during construction ♦ Increased demand on local and regional resources including sand and aggregate during construction ♦ Increased diesel use during construction.

Key project impacts
Cumulative impacts
● The cumulative impacts have been a particularly important consideration given the potential overlap of construction with a considerable number of large infrastructure projects particularly in the Sydney CBD. These cumulative impacts would be highly dynamic and time / activity specific, so are difficult to define in any detail at this stage of the assessment process ● Key issues identified include: ♦ Construction noise and traffic associated with CBD and South East Light Rail ♦ Construction noise and traffic associated with WestConnex ♦ Spoil management and disposal from multiple tunneling projects in Sydney (eg WestConnex and NorthConnex) ♦ Other stages of Sydney Metro such as Sydney Metro Northwest and Sydenham to Bankstown upgrade ♦ Construction noise and traffic associated with other developments.

4 Consolidated mitigation measures

This section provides a consolidated list of the mitigation measures (in Table 4-1) identified as a result of the assessments in Chapters 8 through to 26 in the Environmental Impact Statement. Further information regarding environmental mitigation and management is provided in Chapter 27 of the Environmental Impact Statement.

These mitigation measures are in addition to the measures which are inherent in the design of the project to avoid and minimise adverse impacts. Further details on these aspects of the project are provided in Section 3.1.

Based on the outcomes of the assessment and the implementation of the mitigation measures in Table 4-1, environmental performance outcomes have been established for the project. The environmental performance outcomes are identified in Section 5.

Table 4-1 Consolidated environmental mitigation measures

ID	Mitigation measure	Applicable location (s)[1]
Construction traffic and transport		
T1	Ongoing consultation would be carried out with (as relevant to the location) the CBD Coordination Office, Roads and Maritime Services, Sydney Trains, NSW Trains, local councils, emergency services and bus operators in order to minimise traffic and transport impacts during construction.	All except metro rail tunnels
T2	Road Safety Audits would be carried out at each construction site. Audits would address vehicular access and egress, and pedestrian, cyclist and public transport safety.	All except metro rail tunnels
T3	Directional signage and line marking would be used to direct and guide drivers and pedestrians past construction sites and on the surrounding network. This would be supplemented by Variable Message Signs to advise drivers of potential delays, traffic diversions, speed restrictions, or alternate routes.	All except metro rail tunnels
T4	In the event of a traffic related incident, co-ordination would be carried out with the CBD Coordination Office and / or the Transport Management Centre's Operations Manager.	All except metro rail tunnels

ID	Mitigation measure	Applicable location (s)[1]
T5	The community would be notified in advance of proposed road and pedestrian network changes through media channels and other appropriate forms of community liaison.	All except metro rail tunnels
T6	Vehicle access to and from construction sites would be managed to ensure pedestrian, cyclist and motorist safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasions, police presence.	All except metro rail tunnels
T7	Additional enhancements for pedestrian, cyclist and motorist safety in the vicinity of the construction sites would be implemented during construction. This would include measures such as: • Use of speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers • Shared experience educational events that allow pedestrians, cyclists or motorists to sit in trucks and understand the visibility restrictions of truck drivers, and for truck drivers to understand the visibility from a bicycle • Specific construction driver training to understand route constraints, expectations, safety issues and to limit the use of compression braking • Safety devices on construction vehicles that warn drivers of the presence of a vulnerable road user located in the vehicles' blind spots and warn the vulnerable road user that a vehicle is about to turn.	All except metro rail tunnels
T8	Access to existing properties and buildings would be maintained in consultation with property owners.	All except metro rail tunnels
T9	All trucks would enter and exit construction sites in a forward gear, where feasible and reasonable.	All except metro rail tunnels
T10	Any relocation of bus stops would be carried out by Transport for NSW in consultation with Roads and Maritime Services, the CBD Coordination Office (for relevant locations), the relevant local council and bus operators. Wayfinding and customer information would be provided to notify customers of relocated bus stops.	All except metro rail tunnels
T11	For special events that require specific traffic measures, those measures would be developed in consultation the CBD Coordination Office (for relevant locations), Roads and Maritime Services, and the organisers of the event.	BN, MP, PS, CS
T12	Construction sites would be managed to minimise construction staff parking on surrounding streets. The following measures would be implemented: • Encouraging staff to use public or active transport • Encouraging ride sharing • Provision of alternative parking locations and shuttle bus transfers where feasible and reasonable.	All except metro rail tunnels
T13	Construction site traffic would be managed to minimise movements in the AM and PM peak periods.	All except metro rail tunnels
T14	Construction site traffic immediately around construction sites would be managed to minimise movements through school zones during pick up and drop off times.	All except metro rail tunnels

ID	Mitigation measure	Applicable location (s)[1]
T15	Pedestrian and cyclist access would be maintained at Crows Nest during the temporary closure of Hume Street, and at Martin Place during the temporary partial closure of Martin Place. Wayfinding and customer information would be provided to guide pedestrians and cyclists to alternative routes.	CN, MP
T16	Timing for the temporary closure of the Devonshire Street tunnel would avoid periods of peak pedestrian demand. Wayfinding and customer information would be provided to guide pedestrians to alternative routes.	CS
T17	Consultation would occur with the Harbour Master, Roads and Maritime Services and Sydney Ferries to ensure shipping channels are maintained during the Sydney Harbour ground improvement works.	GI
T18	During the closure of existing entrances to Martin Place Station, marshalls would be provided during the AM and PM peak periods to direct customers to available access and egress points.	MP
T19	Where existing parking is removed to facilitate construction activities, alternative parking facilities would be provided where feasible and reasonable.	All except metro rail tunnels
T20	Alternative pedestrian routes and property access would be provided where these are affected during the construction of the power supply routes.	PSR
Operational traffic and transport		
OpT1	Enhancement of pedestrian infrastructure in the vicinity of Victoria Cross and Martin Place stations would be investigated further in consultation with (as relevant to the location) the CBD Coordination Office, Roads and Maritime Services and the relevant local council.	VC, MP
OpT2	Access would be maintained to neighbouring properties.	All except metro rail tunnels
Construction noise and vibration		
NV1	The Construction Noise and Vibration Strategy would be implemented with the aim of achieving the noise management levels where feasible and reasonable. This would include the following example standard mitigation measures where feasible and reasonable: • Provision of noise barriers around each construction site • Provision of acoustic sheds at Chatswood dive site, Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street, Waterloo and Marrickville dive site • The coincidence of noisy plant working simultaneously close together would be avoided • Offset distances between noisy plant and sensitive receivers would be increased • Residential grade mufflers would be fitted to all mobile plant • Dampened rock hammers would be used • Non-tonal reversing alarms would be fitted to all permanent mobile plant • High noise generating activities would be scheduled for less sensitive period considering the nearby receivers • The layout of construction sites would consider opportunities to shield receivers from noise.	All

ID	Mitigation measure	Applicable location (s)[1]
NV2	Unless compliance with the relevant traffic noise criteria can be achieved, night time heavy vehicle movements at the Chatswood dive site, Crows Nest Station and Victoria Cross Station sites would be restricted to: • The Pacific Highway and Mowbray Road at the Chatswood dive site • The Pacific Highway, Hume Street and Oxley Street at the Crows Nest Station construction site • McLaren Street, Miller Street and Berry Street at the Victoria Cross Station construction site.	CDS, CN, VC
NV3	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	All except metro rail tunnels
NV4	Feasible and reasonable measures would be implemented to minimise ground-borne noise where exceedences are predicted.	All
NV5	Feasible and reasonable mitigation measures would be implemented where power supply works would result in elevated noise levels at receivers. This would include: • Carrying out works during the daytime period when in the vicinity of residential receivers • Where out of hours works are required, scheduling the noisiest activities to occur in the evening period (up to 10 pm) • Use of portable noise barriers around particularly noisy equipment such as concrete saws.	PSR
Operational noise and vibration		
OpNV1	The height and extent of noise barriers adjacent to the northern surface track works would be confirmed during detailed design with the aim of not exceeding trigger levels from the *Rail Infrastructure Noise Guidelines* (Environment Protection Authority, 2013). At property treatments would be offered where there are residual exceedances of the trigger levels.	STW
OpNV2	Track form would be confirmed during the detailed design process in order to meet the relevant ground-borne noise and vibration criteria from the *Rail Infrastructure Noise Guidelines* (EPA, 2013) and the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (DECC, 2007).	Metro rail tunnels
OpNV3	Stations and ancillary facilities including train breakout noise from draught relief shafts would be designed to meet the applicable noise criteria derived from the *Industrial Noise Policy* (EPA, 2000).	All except metro rail tunnels

ID	Mitigation measure	Applicable location (s)[1]
Business impacts		
BI1	Specific consultation would be carried out with businesses potentially impacted during construction. Consultation would aim to identify and develop measures to manage the specific construction impacts for individual businesses.	All
BI2	A business impact risk register would be developed to identify, rate and manage the specific construction impacts for individual businesses.	All
BI3	Appropriate signage would be provided around construction sites to provide visibility to retained businesses.	All except metro rail tunnels
Non-Aboriginal heritage		
NAH1	Archival recording and reporting of the following heritage items would be carried out in accordance with the NSW Heritage Office's *How to Prepare Archival Records of Heritage Items* (1998), and *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006): • The internal heritage fabric and any non-original elements removed from within the curtilage of Mowbray House, Chatswood • The interior, exterior and setting of the shop at 187 Miller Street, North Sydney • The fabric and setting of the North Sydney bus shelters requiring removal and temporary relocation at Victoria Cross Station and Blues Point temporary site • Any component of the Blues Point Waterfront Group and the McMahons Point South heritage conservation area to be directly affected or altered, including vegetation and significant landscape features • Hickson Road wall in the vicinity of proposed ventilation risers and skylights for Barangaroo Station • The interior, exterior and setting of the 'Flat Building' at 7 Elizabeth Street, Sydney • Martin Place, between Elizabeth and Castlereagh streets, Sydney • The heritage fabric of areas of the existing Martin Place Station affected by the project • The Rolling Stock Officers Garden, Rolling Stock Officers Building and Cleaners Amenities Building in Sydney Yard and any other component of the Sydney Terminal and Central Railway Stations group to be removed or altered.	CDS, VC, BP, MP, CS
NAH2	An archaeological research designs would be prepared and implemented to identify the need for archaeological testing or monitoring. Archaeological mitigation measures recommended in the archaeological research design would be carried out in accordance with Heritage Council guidelines, and where identified in the archaeological research design, would be supervised by a suitably qualified Excavation Director with experience in managing State significant archaeology.	CDS, CN, VC, BP, BN, MP, PS, CS, WS, PSR
NAH3	An Exhumation Policy and Guideline would be prepared and implemented. It would be developed in accordance with the *Guidelines for Management of Human Skeletal Remains* (NSW Heritage Office, 1998b).	All except metro rail tunnels

ID	Mitigation measure	Applicable location (s)[1]
NAH4	The method for the demolition of existing buildings and / or structures at Chatswood dive site, Victoria Cross Station, Martin Place Station, Pitt Street Station, Central Station and Waterloo Station would be developed to minimise direct and indirect impacts to adjacent and / or adjoining heritage items.	CDS, VC, MP, PS, CS, WS
NAH5	Prior to total or partial demolition of heritage items at Victoria Cross and Martin Place stations, heritage fabric for salvage would be identified and reuse opportunities for salvaged fabric considered. This would include salvage and reuse of heritage tiles to be impacted at Martin Place Station.	VC, MP
NAH6	An appropriately qualified and experienced heritage architect would form part of the Sydney Metro Design Review Panel and would provide independent review periodically throughout detailed design.	All
NAH7	The project design would be sympathetic to heritage items and, where reasonable and feasible, minimise impacts to the setting of heritage items. The detailed design for Martin Place Station and Central Station would be developed with input from a heritage architect.	STW, CDS, CN, VC, BN, MP, PS, CS, WS, MDS
NAH8	Appropriate heritage interpretation would be incorporated into the design for the project in accordance with the *NSW Heritage Manual*, the NSW Heritage Office's *Interpreting Heritage Places and Items: Guidelines* (August 2005), and the NSW Heritage Council's *Heritage Interpretation Policy*.	CDS, CN, VC, BP, BN, MP, PS, WS
NAH9	A Central Station heritage interpretation plan would be developed and implemented in consistent with the *Central Station Conservation Management Plan* (Rappoport and Government Architects Office, 2013) and in accordance with the guidelines identified in NAH9.	CS
NAH10	The design of the Sydney Yard Access Bridge would be sympathetic to surrounding heritage items and minimise impacts to sight lines, views and setting of surrounding heritage items, including to Mortuary Station and the Sydney Terminal and Central Railway Stations group. As a minimum the design would: • Incorporate materials and finishes sympathetic to the heritage context of the railway station • Minimise height and bulk of the structure.	CS
NAH11	Except for heritage significant elements affected by the project, direct impact on other heritage significant elements within the following items would be avoided: • The Blues Point Waterfront Group (including the former tram turning circle, stone retaining wall, bollards and steps) • The Millers Point and Dawes Point Village Precinct • The existing Martin Place Station • Sydney Terminal and Central Railway Stations group • Sydney Yard (including the Shunters Hut and Prince Alfred Sewer).	BP, BN, MP, CS
NAH12	Power supply works would be designed and constructed to avoid impacts to the Tank Stream and Bennelong Stormwater Channel.	PSR

ID	Mitigation measure	Applicable location (s)[1]
NAH13	The design and detailed construction planning of work at Central Station would consider the requirements of the *Central Station Conservation Management Plan* (Rappoport and Government Architects Office, 2013) and include consideration of opportunities for the retention, conservation and / or reuse of original and significant heritage fabric. Consultation would be carried out with Sydney Trains and the Heritage Council of NSW during design development.	CS
Aboriginal heritage		
AH1	Aboriginal stakeholder consultation would be carried out in accordance with the NSW Office of Environment and Heritage's *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*.	All
AH2	An Aboriginal cultural heritage assessment report would be prepared in accordance with the OEH *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW*. The Aboriginal cultural heritage assessment report would include: • Details of Aboriginal stakeholder consultation conducted in accordance with AH1 • An assessment of cultural significance for the project area and identification of any specific areas of cultural significance based on consultation with Aboriginal stakeholders • A methodology for archaeological management including test excavation and salvage (refer to AH3).	All
AH3	Archaeological test excavation (and salvage when required) would be carried out where intact natural soil profiles with the potential to contain significant archaeological deposits are encountered at the Blues Point temporary site, Barangaroo Station, Martin Place Station, Pitt Street Station, Central Station, Waterloo Station and Marrickville dive site. Excavations would be conducted in accordance with the methodology outlined in the Aboriginal cultural heritage assessment report	BP, BN, MP, PS, CS, WS, MDS
AH4	Appropriate Aboriginal heritage interpretation would be incorporated into the design for the project in consultation with Aboriginal stakeholders.	All
AH5	Feasible and reasonable mitigation at the ground improvement locations would be identified in consultation with the Office of Environment and Heritage.	GI
AH6	The Aboriginal cultural heritage assessment report would address areas of archeological potential associated with the power supply routes.	PSR
Landscape character and visual amenity		
Construction		
LV1	Where feasible and reasonable, the elements within construction sites would be located to minimise visual impacts, for example materials and machinery would be stored behind fencing.	All except metro rail tunnels
LV2	Existing trees to be retained would be protected prior to the commencement of construction in accordance with Australian Standard *AS4970 the Australian Standard for Protection of Trees on Development Sites and Adjoining Properties.*	All except metro rail tunnels
LV3	Lighting of construction sites would be oriented to minimise glare and light spill impact on adjacent receivers.	All except metro rail tunnels

ID	Mitigation measure	Applicable location (s)[1]
LV4	Visual mitigation would be implemented as soon as feasible and reasonable after the commencement of construction, and remain for the duration of the construction period.	All except metro rail tunnels
LV5	Opportunities for the retention and protection of existing street trees would be identified during detailed construction planning.	All except metro rail tunnels
LV6	The design and maintenance of construction site hoardings would aim to minimise visual amenity and landscape character impacts, including the prompt removal of graffiti. Public art opportunities would be considered.	All except metro rail tunnels
LV7	The selection of materials and colours for acoustic sheds would aim to minimise their visual prominence.	CDS, CN, VC, BN, MP, PS, WS, MDS
LV8	Tunnel boring machine retrieval works at the Blues Point temporary site would be timed to avoid key harbour viewing events.	BP
LV9	Benching would be used where feasible and reasonable at Blues Point temporary site to minimise visual amenity impacts.	BP
Operation		
LV10	Cut off and direct light fittings (or similar technologies) would be used to minimise glare and light spill onto private property.	CDS, AS, MDS
LV11	Where feasible and reasonable, vegetation would be provided to screen and visually integrate sites with the surrounding area.	CDS, AS, MDS
LV12	Identify and implement appropriate landscape treatments for Frank Channon Walk.	STW, CDS
LV13	The architectural treatment of Artarmon substation would minimise visual amenity and landscape character impacts.	AS
LV14	The Harbour cycles sculpture at North Sydney would be reinstated at a location determined in consultation with North Sydney Council.	VC
LV15	The P&O Fountain at 55 Hunter Street would be reinstated at a location determined in consultation with City of Sydney Council.	MP
LV16	Opportunities would be investigated to provide a permanent wall for street art at Marrickville dive site in consultation with Marrickville Council.	MDS
LV17	Noise barriers would be transparent where they are augmenting existing transparent noise barriers.	STW

ID	Mitigation measure	Applicable location (s)[1]
Groundwater and geology		
GWG1	A detailed geotechnical model for the project would be developed and progressively updated during design and construction. The detailed geotechnical model would include: • Assessment of the potential for damage to structures, services, basements and other sub-surface elements through settlement or strain • Predicted changes to groundwater levels, including at nearby water supply works. Where building damage risk is rated as moderate or higher (as per the CIRIA 1996 risk-based criteria), a structural assessment of the affected buildings / structures would be carried out and specific measures implemented to address the risk of damage. With each progressive update of the geotechnical model the potential for exceedance of the following target changes to groundwater levels would be reviewed: • Less than 2.0 metres – general target • Less than 4.0 metres – where deep building foundations present • Less than 1.0 metre – residual soils • Less than 0.5 metre – residual soils (Blues Point) (fill / Aeolian sand). Where a significant exceedance of target changes to groundwater levels are predicted at surrounding land uses and nearby water supply works, an appropriate groundwater monitoring program would be developed and implemented. The program would aim to confirm no adverse impacts on groundwater levels or to appropriately manage any impacts. Monitoring at any specific location would be subject to the status of the water supply work and agreement with the landowner.	All
GWG2	Condition surveys of buildings and structures in the vicinity of the tunnel and excavations would be carried out prior to the commencement of excavation at each site.	All
Soil, contamination, water quality		
Construction		
SCW1	Updated desktop contamination assessments would be carried out for Chatswood dive site, Blues Point temporary site, Barangaroo Station, Central Station and Waterloo Station. If sufficient information is not available to determine the remediation requirements and the impact on potential receivers, then detailed contamination assessments, including collection and analysis of soil and groundwater samples would be carried out. Detailed contamination assessment would also be carried out for the Barangaroo power supply route within Hickson Road and the Marrickville power supply route adjacent to Sydney Park and Camdenville Oval. In the event a Remediation Action Plan is required, these would be developed in accordance with *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998) and a site auditor would be engaged.	CDS, BP, BN, CS, WS, PSR

ID	Mitigation measure	Applicable location (s)[1]
SCW2	Prior to ground disturbance in high probability acid sulfate areas at Barangaroo Station, Waterloo Station and Marrickville dive site, testing would be carried out to determine the presence of acid sulfate soils. If acid sulfate soils are encountered, they would be managed in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee, 1998).	BN, WS, MDS
SCW3	Erosion and sediment control measures would be implemented in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction Volume 2* (Department of Environment and Climate Change, 2008). Measures would be designed as a minimum for the 80th percentile; 5-day rainfall event.	All except metro rail tunnels
SCW4	Discharges from the construction water treatment plants would be monitored to ensure compliance with the discharge criteria in an environment protection licence issued to the project.	All except metro rail tunnels
SCW5	A silt curtain would be used around the Sydney Harbour ground improvement work barges.	GI
SCW6	A water quality monitoring program would be implemented to monitor water quality within Sydney Harbour during ground improvement work. The water quality monitoring program would be carried out to detect any potential impacts on the water quality of Sydney Harbour from the ground improvement work and inform management responses in the event any impacts are identified. Specific monitoring locations and frequencies would be determined during the development of the program in consultation with the Environment Protection Authority.	GI
Operation		
SCW7	Discharges from the tunnel water treatment plant would be monitored to ensure compliance with the discharge criteria determined in consultation with the NSW Environment Protection Authority.	MDS
Social impacts and community infrastructure		
SO1	Direct impacts to public open space at the Blues Point temporary site would be minimised.	BP
SO2	Specific consultation would be carried out with sensitive community facilities (including aged care, child care centres, educational institutions and places of worship) potentially impacted during construction. Consultation would aim to identify and develop measures to manage the specific construction impacts for individual sensitive community facilities.	All except metro rail tunnels
Biodiversity		
B1	An ecologist would be present during the removal of any hollow-bearing trees.	CDS
B2	Potential bat roosting locations at Central Station, Waterloo Station and Marrickville dive sites would be checked by a qualified ecologist or wildlife handler prior to demolition. Any bats found would be relocated.	CS, WS, MDS
B3	The local WIRES group and / or veterinarian would be contacted if any fauna are injured on site or require capture and / or relocation.	All except metro rail tunnels

ID	Mitigation measure	Applicable location (s)[1]
B4	Procedures would be developed and implemented, in accordance with the National System for the Prevention and Management of Marine Pest Incursions, during Sydney Harbour ground improvement works to avoid transportation of marine pests from other locations, particularly the marine alga *Caulerpa taxifoli*.	GI
Flooding and hydrology		
Construction		
FH1	Detailed construction planning would consider flood risk at Barangaroo Station, Martin Place Station and the Waterloo Station construction sites. This would include identification of measures to avoid, where feasible and reasonable, construction phase flooding impacts on the community and on other property and infrastructure.	BN, MP, WS
FH2	The site layout and staging of construction activities at Marrickville dive site would avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required.	MDS
FH3	Overland flow diversions during construction at the Marrickville dive site would meet the following criteria: • Increases in flood levels during events up to and including the 100-year average recurrence interval would be minimised particularly within private properties • Any increase in flow velocity for events up to and including a 100-year average recurrence interval event would not increase the potential for soil erosion and scouring • Dedicated evacuation routes would not be adversely impacted in flood events up to and including the probable maximum flood. Construction planning for the Marrickville dive site would be carried out in consultation with the State Emergency Services and Marrickville Council.	MDS
Operation		
FH4	Where feasible and reasonable, detailed design would result in no net increase in stormwater runoff rates in all storm events unless it can be demonstrated that increased runoff rates as a result of the project would not increase downstream flood risk.	STW, AS, MDS
FH5	Where space permits, on-site detention of stormwater would be introduced where stormwater runoff rates are increased. Where there is insufficient space for the provision of on-site detention, the upgrade of downstream infrastructure would be implemented where feasible and reasonable.	STW, AS, MDS
FH6	Detailed design would occur in consultation with Marrickville Council to ensure future drainage improvement works around the Marrickville dive site would not be precluded.	MDS
FH7	Consultation would be carried out with Marrickville Council to ensure flood-related outcomes of the project are consistent with any future floodplain risk management study and / or plan developed for the Marrickville Valley Catchment.	MDS
FH8	The frequency of Sydney Trains rail service disruptions due to flooding would not be increased in the vicinity of the Marrickville dive structure.	MDS

ID	Mitigation measure	Applicable location (s)[1]
FH9	Design of the Marrickville dive structure would be reviewed to, where feasible and reasonable, further reduce flood levels for events up to and including the 100-year annual recurrence interval, including at private properties, within the road reserve at Bolton Street and around Sydenham Station. Flood modelling to support detailed design would be carried out in accordance with the following guidelines: • *Floodplain Development Manual* (NSW Government, 2005) • *Floodplain Risk Management Guideline: Practical Consideration of Climate Change* (DECC, 2007) • *Floodplain Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW, 2010) • *New guideline and changes to section 117 direction and EP&A Regulation on flood prone land, Planning Circular PS 07-003* (NSW Department of Planning, 2007).	MDS
Air Quality		
AQ1	The engines of all on-site vehicles and plant would be switched off when not in use for an extended period.	All
AQ2	Plant would be well maintained and serviced to minimise emissions. Emissions from plant would be considered as part of pre-acceptance checks.	All
AQ3	Construction site layout and placement of plant would consider air quality impacts to nearby receivers.	All except metro rail tunnels
AQ4	Hard surfaces would be installed on long term haul routes and regularly cleaned.	All except metro rail tunnels
AQ5	Unsurfaced haul routes and work area would be regularly damped down in dry and windy conditions.	All except metro rail tunnels
AQ6	All vehicles carrying loose or potentially dusty material to or from the site would be fully covered.	All except metro rail tunnels
AQ7	Stockpiles would be managed to minimise dust generation.	All except metro rail tunnels
AQ8	Demolition would be managed to minimise dust generation.	All except metro rail tunnels
AQ9	Ventilation from acoustic sheds would be filtered.	CDS, CN, VC, BN, MP, PS, WS, MDS
Hazard and risk		
Construction		
HR1	All hazardous substances that may be required for construction would be stored and managed in accordance with the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005) and *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011).	All
HR2	Dial before you dig searches and non-destructive digging would be carried out to identify the presence of underground utilities.	All

ID	Mitigation measure	Applicable location (s)[1]
HR3	A hazardous material survey would be completed for those buildings and structures suspected of containing hazardous materials (particularly asbestos) prior to their demolition. If asbestos is encountered, it would be handled and managed in accordance with relevant legislation, codes of practice and Australian standards.	CDS, CN, VC, MP, PS, CS, WS, MDS
HR4	The method for delivery of explosives would developed prior to the commencement of blasting in consultation with the Department of Planning and Environment and be timed to avoid the need for on-site storage.	CN, VC, BN, MP, PS, WS
Operation		
HR5	All hazardous substances that may be required for operation would be stored and managed in accordance with the Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW, 2005) and *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011).	All
Waste management		
Construction		
WM1	All waste would be assessed, classified, managed and disposed of in accordance with the *NSW Waste Classification Guidelines.*	All
WM2	100 per cent of spoil that can be reused would be beneficially reused in accordance with the project spoil reuse hierarchy.	All
WM3	A recycling target of at least 90 per cent would be adopted for the project.	All
WM4	Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	All
Operation		
WM5	Generation of operation phase waste would be minimised.	All
Sustainability		
Construction		
SUS1	Sustainability initiatives would be incorporated into the detailed design and construction of the project to support the achievement of the project sustainability objectives.	All
SUS2	A best practice level of performance would be achieved using market leading sustainability rating tools during design and construction.	All
SUS3	A workforce development and industry participation strategy would be developed and implemented during construction.	All

ID	Mitigation measure	Applicable location (s)[1]
SUS4	Climate change risk treatments would be incorporated into the detailed design of the project including: • Ensuring that adequate flood modelling is carried out and integrated with design • Testing the sensitivity of air-conditioning systems to increased temperatures, and identify potential additional capacity of air-conditioning systems that may be required within the life of the project, with a view to safeguarding space if required • Testing the sensitivity of ventilation systems to increased temperatures and provide adequate capacity.	All
SUS5	An iterative process of greenhouse gas assessments and design refinements would be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance would be measured in terms of a percentage reduction in greenhouse gas emissions from a defined reference footprint.	All
SUS6	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	All
Operation		
SUS7	Sustainability initiatives would be incorporated into the operation of the project to support the achievement of the project sustainability objectives.	All
SUS8	Periodic review of climate change risks would be carried out to ensure ongoing resilience to the impacts of climate change.	All
SUS9	A workforce development and industry participation strategy would be developed and implemented during operation.	All
SUS10	100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation would be offset.	All

ID	Mitigation measure	Applicable location (s)[1]
Cumulative impacts		
CU1	Transport for NSW would manage and co-ordinate the interface with projects under construction at the same time. Co-ordination and consultation with the following stakeholders would occur, where required: ○ CBD Coordination Office ○ Department of Planning and Environment ○ Roads and Maritime Services ○ Sydney Trains ○ NSW Trains ○ Sydney Buses ○ Sydney Water ○ Port Authority of NSW ○ Willoughby Council ○ North Sydney Council ○ City of Sydney Council ○ Marrickville Council ○ Sydney Motorways Corporation ○ Barangaroo Delivery Authority ○ Emergency service providers ○ Utility providers ○ Construction contractors. Co-ordination and consultation with these stakeholders would include: ○ Provision of regular updates to the detailed construction program, construction sites and haul routes ○ Identification of key potential conflict points with other construction projects ○ Developing mitigation strategies in order to manage conflicts. Depending on the nature of the conflict, this could involve: ♦ Adjustments to the Sydney Metro construction program, work activities or haul routes; or adjustments to the program, activities or haul routes of other construction projects ♦ Co-ordination of traffic management arrangements between projects.	All

5 Environmental performance outcomes

The Secretary's environmental assessment requirements identify a number of desired performance outcomes. These desired performance outcomes outline the broader objectives to be achieved by the proponent in the design, construction and operation of the project.

Table 5-1 identifies the environmental performance outcomes based on the outcomes of the assessment (identified in Section 3) and the implementation of the mitigation measures (identified in Section 4). Future design development and any design changes would be considered against these environmental performance outcomes.

Table 5-1 Environmental performance outcomes

Relevant Secretary's environmental assessment requirements desired performance outcomes	Environmental performance outcome
Construction traffic and transport	
Transport and traffic Network connectivity, safety and efficiency of the transport system in the vicinity 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.	• The project would minimise impacts to the road network • Pedestrian and cyclist safety would be maintained • Effective coordination would be carried out to minimise cumulative network impacts • Access to properties would be maintained.
Operational traffic and transport	
Transport and traffic Network connectivity, safety and efficiency of the transport system in the vicinity 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.	• The project would appropriately integrate with existing and planned future transport infrastructure including active transport • Access to properties would be maintained • Metro customers would be provided with a safe and secure service • The project would reduce station crowding, increase rail network reach and use, improve network resilience, and improve travel times within the global economic corridor.
Construction noise and vibration	
• Noise and vibration – amenity Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimize adverse impacts on acoustic amenity. **Noise and vibration – structural** Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimize adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage.	• Noise levels would be minimised with the aim of achieving the noise management levels where feasible and reasonable • The project would avoid any damage to buildings from vibration.

Relevant Secretary's environmental assessment requirements desired performance outcomes	Environmental performance outcome
Operational noise and vibration	
Noise and vibration – 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. **Noise and vibration – structural** Increases in noise emissions and vibration affecting environmental heritage as defined in the *Heritage Act 1977* during operation of the project are effectively managed.	• Noise levels would comply with the *Rail Infrastructure Noise Guidelines* (Environment Protection Authority, 2013). • The project would avoid any damage to buildings from vibration.
Landuse and property	
Socio-economic, land use and property 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.	• The project would be appropriately integrated into local landuse planning strategies • The surface footprint of the project would be minimised • The project would provide substantial future development opportunities.
Business impacts	
Socio-economic, land use and property 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.	• The project would minimise impacts on businesses during construction • During operation, the project would improve access to businesses for employees and customers, and connectivity between businesses within the global economic corridor.
Non-Aboriginal heritage	
Heritage 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. The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.	• The project would be sympathetic to heritage items and, where feasible and reasonable, avoid and minimise impacts to non-Aboriginal heritage items and archaeology • The design of the project would reflect the input of an independent heritage architect, relevant stakeholders and the design review panel.

Relevant Secretary's environmental assessment requirements desired performance outcomes	Environmental performance outcome
Aboriginal heritage	
Heritage 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. The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.	• The project would be sympathetic to heritage items and, where feasible and reasonable, avoid and minimise impacts to Aboriginal heritage items and archaeology • The design of the project would reflect the input of an independent heritage architect, relevant stakeholders and the design review panel.
Landscape character and visual amenity	
Urban design The project design complements the visual amenity, character and quality of the surrounding environment. The project contributes to the accessibility and connectivity of communities. **Visual amenity** The project minimises adverse impacts on the visual amenity of the built and natural environment (including public open space) and capitalises on opportunities to improve visual amenity.	• During operation, the project would make a positive contribution to the quality of the urban environment at each station site • During operation, the project would minimise change to landscape character in the vicinity of the dive structures and Artarmon substation • The project would be visually integrated with its surroundings.
Groundwater and geology	
Water – hydrology 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.	• The project would make good any impacts on groundwater users • The project would avoid any damage to buildings from settlement.

Relevant Secretary's environmental assessment requirements desired performance outcomes	Environmental performance outcome
Soils, contamination and water quality	
Soils 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. **Water – quality** 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).	• Erosion and sediment controls during construction would be implemented in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction Volume 2* (Department of Environment and Climate Change, 2008a) • There would be no impacts on aquatic environments associated with the disturbance of acid sulfate soils during construction • Any contamination on project sites would be remediated to suit future land use • The project would protect or contribute to achieving the Water Quality Objectives, during construction and operation • Construction water quality discharge would comply with the requirements of an environment protection licence issued to the project • Operation water quality discharge would comply with a discharge criteria determined in consultation with the NSW Environment Protection Authority.
Social impacts and community facilities	
Socio-economic, land use and property 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.	• The project would avoid long term impacts (during operation) on the availability and quality of public open space and community facilities • The project, during operation, would help to improve access to local facilities, services and destinations, supporting opportunities for community interaction.

Relevant Secretary's environmental assessment requirements desired performance outcomes	Environmental performance outcome
Biodiversity	
Biodiversity The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.	○ The biodiversity outcome would be consistent with the Framework for Biodiversity Assessment ○ The project would minimise impacts to biodiversity.
Flooding and hydrology	
Flooding 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. **Water – hydrology** 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.	○ Changes to overland flow diversions during construction would meet the following criteria: ♦ Increases in flood levels during events up to and including the 100-year average recurrence interval would be minimised particularly within private properties ♦ Any increase in flow velocity for events up to and including a 100-year average recurrence interval event would not increase the potential for soil erosion and scouring ♦ Dedicated evacuation routes would not be adversely impacted in flood events up to and including the probable maximum flood. ○ There would be no additional private properties affected by flooding up to and including the 100-year average recurrence interval event during operation ○ Flood levels would be increased by a maximum of 470 mm during the 100-year average recurrence interval event in the vicinity of the Marrickville dive structure during operation ○ The performance of the downstream drainage network would be maintained during operation.

Relevant Secretary's environmental assessment requirements desired performance outcomes	Environmental performance outcome
Air quality	
There are no Secretary's environmental assessment requirements relevant to air quality.	• Dust and exhaust emissions during construction would be minimised.
Hazard and risk	
There are no Secretary's environmental assessment requirements relevant to hazard and risk.	• The storage, use and transport of dangerous goods and hazardous substances would comply with *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011) • There would be no unplanned or unexpected disturbance of utilities.
Waste Management	
Waste 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.	• All waste would be assessed, classified, managed and disposed of in accordance with the NSW Waste Classification Guidelines • 100 per cent of spoil that can be reused would be beneficially reused in accordance with the project spoil reuse hierarchy. • A recycling target of at least 90 per cent would be adopted for the construction of the project.
Sustainability	
Sustainability The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources. Conservation of natural resources is maximised.	• The project would be carried out in accordance with the Sydney Metro City & Southwest Environment and Sustainability Policy • 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset • 100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation would be offset.

6 Justification and conclusions

Rail is, and will continue to be, the dominant mode of public transportation for commuters traveling to and from the Sydney CBD. It is projected that travel by rail will experience the highest growth in demand when compared to buses and car use. Sydney Metro, together with signalling and infrastructure upgrades across the existing network, would increase the capacity of the rail network through the Sydney CBD from about 120 per hour during peak periods today, to up to 200 services per hour beyond 2024, including capacity for up to 60 metro trains per hour during peak periods (or 30 trains per hour in each direction). This would equate to an increase of up to 60 per cent capacity across the network. Sydney Metro would also result in travel time improvements and a reduction in congestion on trains and platforms.

Alternative transport modes would have limited capacity to absorb Sydney's forecast long-term travel demand growth. For example while extra buses can carry more people, these services would not be necessarily faster or more reliable. Without measures to improve journey times, adding more buses would add to congestion and each bus becomes less effective in meeting customer needs.

The justification of the project has been based on project need, how well the project satisfies its project objectives, having regard to the biophysical, economic and social considerations including the principles of ecologically sustainable development and cumulative impacts.

6.1 Project need

The project has been developed within the framework of the transport and planning strategies identified in State government policies. In particular this includes the 12 NSW Premier priorities (established to grow the economy, deliver infrastructure, and improve health, education and other services across NSW), *Sydney's Rail Future: Modernising Sydney's Trains, Draft Metropolitan Strategy for Sydney 2031* and the *NSW Long Term Transport Master Plan.*

These polices indicate a strategic need to:

- Significantly increase transport capacity in key parts of the network, especially to the Sydney CBD and the Global Economic Corridor
- Drive productivity through integrated transport and land use planning to realise the productivity benefits of having businesses close together enabling increased interaction, knowledge sharing and collaboration
- Effectively develop infrastructure to cement Sydney's position among the world's most liveable cities and Australia's only global city.

Sydney Metro would deliver a step-change in the capacity of Sydney's rail network by providing a fully automated rail system across Sydney, supporting high demand with a high capacity, turn-up-and-go service.

Sydney Metro, together with signalling and infrastructure upgrades across the existing network, would increase the capacity of the rail network through the Sydney CBD from about 120 per hour during peak periods today, to up to 200 services per hour beyond 2024, including capacity for up to 60 metro trains per hour during peak periods (or 30 trains per hour in each direction). This would equate to an increase of up to 60 per cent capacity across the network. This means that the railway network across greater Sydney would have room for an extra 100,000 train customers per hour in the peak. The fully automated, Sydney Metro network would have the ultimate capacity to operate 30 trains an hour through the Sydney CBD in each direction – a train every two minutes each way. The proposed new stations would alleviate congestion at Wynyard, Town Hall, Central, Redfern and Green Square stations.

Other key benefits of the project include:

- Doubling the number of train paths available from the north
- Strengthening connections and access across Sydney, particularly within the Global Economic Corridor
- Providing new connections to the rail network – including connections to the T4 Eastern Suburbs Line, and direct connections between the Sydney CBD with the north west
- Improving the capacity, reliability and efficiency of the existing transport system, by relieving the pressure on existing rail lines, Sydney CBD train stations, Sydney CBD, North Sydney and Sydney South bus routes, and the Sydney CBD road network
- Providing the opportunity for urban development opportunities particularly around the new stations at Crows Nest, Victoria Cross, Barangaroo and Waterloo
- Providing the opportunity for the progressive renewal of the ageing Waterloo social housing estate including a mix of private, affordable and social housing
- Improving network resilience through the Sydney CBD and across Sydney Harbour by providing an additional route during planned and unplanned events affecting other Sydney CBD and harbour links
- Health benefits with the creation of safer and more appealing conditions for pedestrians, cyclists and other transit users in the areas around the stations.

Sydney Metro would also provide important urban renewal and development opportunities through the application of transit oriented development principles that support government objectives to achieve a more sustainable and efficient use of land to meet Sydney's growth.

6.2 Project objectives

Table 6-1 provides a summary assessment of how project would satisfy its objectives.

Table 6-1 Summary assessment of project objectives

Project objectives	Assessment
Improve the quality of the transport experience for customers	• New Sydney CBD stations and platforms provided at Barangaroo, Martin Place, Pitt Street and Central would spread station loading and decrease crowding at Wynyard and Town Hall Stations • The project is being developed with an emphasis on supporting the needs of customers for 'door to door' journeys from origin to destination. It would deliver a new tier for Sydney's rail network, supporting high demand with a high-capacity, turn-up-and-go service. 'Turn up and go' frequencies means there is no need for a timetable • Operational performance requirements that include 98 per cent on time running and clean platforms and trains • Wheelchair spaces, separate priority seating and emergency intercoms inside trains • Safety benefits including security cameras on trains and the ability for customers to see inside the train from one end to the other • Video help points at platforms, connecting directly with train controllers – an Australian first • Level access between the platform and train and three double doors per side per carriage for faster loading and unloading.
Provide a transport system that is able to satisfy long-term demand	• Provides the largest increase in capacity to the Sydney rail network for 80 years • At ultimate capacity, the Sydney Metro network would be able to run up to 30 trains per hour in each direction through Sydney's CBD, providing the foundation for a 60 per cent increase in the number of trains that could operate in the peak periods and catering for an extra 100,000 customers per hour. At ultimate capacity, the Chatswood to Sydenham component would provide additional capacity for more than 40,000 passengers per hour through the Sydney CBD in each direction.
Grow public transport patronage and mode share	• The railway network across greater Sydney would have room for an extra 100,000 train customers per hour.
Support the productivity of the Global Economic Corridor	• Provides faster and more reliable access and by fostering clusters of activities that support more economic growth. In particular this would include improvement to links to the strategic centres of Chatswood, Macquarie Park, Castle Hill, Norwest and Rouse Hill.
Serve and stimulate urban development	• Provides opportunities for a higher intensity of land use around new stations, including potential higher density residential areas which could offer more affordable housing options with better access to services and employment, and support more liveable, vibrant communities.
Improve the resilience of the transport network	• Provides an additional route during planned and unplanned events affecting other Sydney CBD and harbour links.
Improve the efficiency and cost effectiveness of the public transport system	• Increases service accessibility and rail capacity across the Sydney CBD, particularly at Wynyard and Town Hall stations, through the provision of new stations at Barangaroo, Martin Place and Pitt Street • Provides extra connectivity and interchange capacity at Central Station and Martin Place.

Project objectives	Assessment
Implement a feasible solution recognising impacts, constraints and delivery risk.	• Impacts have been reduced through a comprehensive assessment process including close iteration and interactions between the design and environment specialists. Previous, current and ongoing stakeholder and community consultation would also help to improve project outcomes and reduce impacts • The project represents the best value for money.

6.3 Biophysical, economic and social considerations

Sydney Metro would significantly improve reliability across the rail network by addressing current and emerging constraints such as train crowding, platform and station crowding, and network complexity. It would be capable of carrying more people, more quickly, than any other form of public transport ever seen in Sydney.

Sydney Metro would improve travel times for customers by providing more direct connections to higher capacity Sydney CBD stations (such as Martin Place and Pitt Street) and improved interchange capability at key locations such as Central Station, including reduced train and station crowding on the existing rail network. It would also result in benefits for customers using the existing bus network as there would be fewer buses accessing the Sydney CBD.

Sydney Metro would provide important urban renewal and development opportunities through the application of transit oriented development principles that support government objectives to achieve a more sustainable and efficient use of land to meet Sydney's growth. Medium and higher density dwellings realised by transit oriented development are demonstrated to have a lower average consumption profile of electricity, gas and water when compared to lower density dwellings and therefore result in improved resource use / conservation and savings for household budgets.

In addition to the broader Sydney transport operational benefits, the 'door-to-door' experience provided by Sydney Metro would result in major health benefits with the creation of safer and more appealing conditions for pedestrians, cyclists and other transit users.

Specific biophysical, economic and social issues have been considered and assessed in the impact assessment as summarised in Section 3. Key biophysical, economic and social considerations have also been incorporated in the principles of ecologically sustainable development as identified in Section 6.4.

6.4 Principles of ecologically sustainable development

Table 6-2 provides a summary assessment of how project would meet the principles of ecologically sustainable development.

Table 6-2 Summary assessment of the principles of ecologically sustainable development

Principle	Assessment
Precautionary principle	The detailed assessment carried out in preparing this Environmental Impact Statement indicates that there would be no threat of serious or irreversible damage to the environment. In addition the lack of full scientific certainty has not been used as a reason for postponing measures to prevent environmental degradation. For example targeted threatened species which were not found during the field surveys have, in line with the precautionary principle, been assumed to be present in the study area.

Principle	Assessment
Intergenerational equity	Once operational, the project would leave a positive legacy for future generations. It would provide long term benefits by strengthening connections and access across Sydney, providing improved connectivity on the rail network and improving the capacity, reliability and efficiency of the existing transport system.
	In addition to the broader Sydney transport operational benefits, the 'door-to-door' experience provided by Sydney Metro would also result in long-term health benefits with the creation of safer and more appealing conditions for pedestrians, cyclists and other transit users. These benefits would also flow through to future generations.
Conservation of biological diversity and ecological integrity	The project construction footprint has been developed to avoid or minimise impact to areas of high ecological value. Detailed assessments have been carried out to identify flora and fauna impacts and a range of mitigation measures identified for implementation. Impacts on biological diversity and ecological integrity have been assessed as minor.
Improved valuation and pricing of environmental resources	Economic appraisal of the project draws on a number of established methodologies which provide for the valuation of externalities, including environmental externalities, and their inclusion in the appraisal process. Environmental parameters which can be valued include air pollution, greenhouse gas emissions, noise pollution, water run-off, nature and landscape and urban separation.
	The value placed on the environment was inherent in the development of the project design. In addition the costs associated with the planning and design of measures to avoid or minimise adverse environmental impacts and the costs to implement them have been built into the overall project costs. Ongoing and detailed design of the project together with specific issue-based management plans would represent further commitment to the recognition of the value of protecting environmental resources.

6.5 Conclusions

The project has been justified in relation to its strategic transport need and its anticipated benefits, taking into account the objectives of the *Environmental Planning and Assessment Act 1979* and matters of ecologically sustainable development. The project is considered to best meet the objectives when compared to all other alternatives considered.

Key environmental issues have been examined throughout the design development process. Consultation has been carried out with affected stakeholders to identify key potential impacts at an early stage, and where possible, avoided or appropriate mitigation measures developed. This has resulted in a number of design changes that have mitigated many of the potential significant impacts. Provided the measures and commitments specified in the Environmental Impact Statement are applied and effectively implemented during the design, construction and operational phases, the identified environmental impacts are considered to be acceptable and manageable.