8 Concept environmental assessment

8 Concept environmental assessment

This chapter describes the existing environment of the Concept, how potential impacts have been avoided or minimised through strategic design, and where impacts have not been avoided, the types of impacts that could be expected during operation and construction of the Concept. Matters to be addressed in future stage applications have been provided.

8.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relevant to the Concept assessment, and reference to where they are addressed in this chapter and in the Environmental Impact Statement, are provided in Table 8-1. Scoping Report requirements are listed in Appendix A. Secretary's Environmental Assessment Requirements relating to the Concept assessment of Place and Design have been addressed in Chapter 7 (Placemaking).

Table 8-1: Secretary's Environmental Assessment Requirements – Concept assessment

Reference	Secretary's Environmental Assessment Requirements	Where addressed
General		
3. Assessment of Key Issues		
3.2	For each Concept key issue, to the extent it relates to the nature of the concept, the Proponent must: a. describe the overarching biophysical and socio-economic environment, as far as it is relevant to that issue;	Sections 8.4 to 8.20
	b. describe the policy context, as far as it is available and relevant to the issue;	
	c. address the listed matters in the 'Key Issues SEARs';	
	d. describe how potential negative impacts have been avoided (through strategic design);	Section 8.3
	e. identify how potential negative impacts that have not been avoided (through strategic design) will be minimised or managed;	Sections 8.4 to 8.20
	f. identification of potential positive impacts or benefits; and	
	g. outline further detailed assessment required to be carried out in subsequent stages (except Stage1).	
Key issues (Concept)		
3. Social and Economic (including property, land use and business impacts)		
3.1	Economic Commitments made in Section 7.11.3 of the Scoping Report, and strategic economic impacts.	Section 8.10
3.2	Social Commitments made in Section 7.10.3 of the Scoping Report, and how the community would experience the Proposal at a strategic level (from environmental, amenity and social changes).	Section 8.11
3.3	Property and Land Use Commitments made in Section 7.5.3 of the Scoping Report, and land use change potentially influenced by the Proposal.	Section 8.8
4. Noise and Vibration		
4.1	Commitments made in Section 7.2.4 of the Scoping Report; and the compatibility of the Concept with the adjoining noise environment.	Section 8.5
5. Transport and Traffic		
5.1	Commitments made in Section 7.1.3 of the Scoping Report.	Section 8.4
6. Aboriginal Heritage		
6.1	Commitments made in Section 7.4.3 of the Scoping Report.	Section 8.7
7. Non-Aboriginal Heritage		
7.1	Commitments made in Section 7.3.3 of the Scoping Report.	Section 8.6
8. Contamination and Soils		
8.1	Commitments made in Section 7.8.3 and 7.9.3 of the Scoping Report.	Sections 8.13 and 8.14
9. Water – Hydrology and Flooding		
9.1	Commitments made in Section 7.12.3 of the Scoping Report, including potential scale of impacts and where the Proposal will need to respond to the existing hydrological environment.	Section 8.15
10. Water - Quality		
10.1	Identify the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the Proposal, including the indicators and associated trigger values or criteria for the identified environmental values.	Section 8.13.3
11. Biodiversity		
11.1	Commitments made in Section 7.13.3 of the Scoping Report.	Section 8.16
12. Sustainability		
12.1	The sustainability of the Proposal in accordance with the Infrastructure Sustainability Council of Australia (ISCA) Infrastructure Sustainability Rating Tool and commit to an appropriate target rating.	Section 8.20 Chapter 26 (Sustainability and climate change – Stage 1)
13. Other Issues		
13.1	Air quality, greenhouse gas and energy, climate change adaptation, waste management and resource use, hazard and risk assessments should be undertaken in accordance with the commitments in Section 7 of the Scoping Report.	Sections 8.17, 8.20, 8.18 and 8.19

8.2 Overview

The Concept environmental assessment is generally based on a 'Concept corridor'. This is generally the area shown on Figure 6-1 in Chapter 6 (Concept description) and is defined as the area within which the Sydney Metro West alignment, stations and related infrastructure are likely to be located. For the Sydney CBD, this includes the Sydney CBD investigation area. Where the Concept assessment is based on different areas, this is specifically identified in the relevant section of this Chapter.

The Concept environmental assessment describes the legislative policy context (where available) and the overarching existing environment for each issue. Assessment of potential impacts associated with the Concept involved identifying potential types of impacts associated with each issue during both operation and construction of the Concept, and identifying performance outcomes for the Concept to be implemented during future stages.

Due to the varied nature of the environment within the Concept corridor and the breadth of issues to be assessed, the following three different approaches have been applied to the Concept assessment:

- Urban setting approach, where the types of impacts of a Concept issue would likely depend on the urban setting or broad land use pattern. Urban settings across the Concept corridor include CBDs, suburban areas, urban renewal precincts and industrial or urban services areas

- Natural process or features approach, where the types of impacts of a Concept issue are more likely to depend on the natural setting. This is most relevant for issues related to landscapes and natural sciences such as geology, hydrology, hydrogeology and biodiversity and also for Aboriginal heritage, where Aboriginal cultural patterns tend to follow natural landscapes and Country
- Strategic frameworks and guidelines approach, where the types of impacts of a Concept issue are governed mostly by compliance with relevant policies, guidelines and frameworks, irrespective of the urban or natural setting of the location.

These three approaches to the Concept assessment are described in more detail in Table 8-2.

Potential cumulative benefits and impacts of Concept issues are discussed in Section 8.21.

Table 8-2: Concept assessment approaches

Assessment approach	Description	Relevant assessments
Urban setting	This approach has been applied where the types of impacts would likely be similar within each setting, as the impacts are associated with sensitive receivers or built structures. Where there are similar types of land uses, receivers or commercial/social attributes within the Concept, these have been grouped into the following urban settings: • CBDs – Parramatta and Sydney CBDs. The CBDs are regional focal points for commerce, trade, employment, retail and recreation. They generally consist of medium to high density commercial, retail and residential • Suburban – North Strathfield, Burwood North, Five Dock and the services facility between Five Dock and The Bays. The suburban setting is characterised by a mix of low to medium rise retail, commercial, light industrial and residential uses, along with recreational and open space uses. These facilities are generally the focal point of the local neighbourhood • Urban renewal precincts – Westmead, Sydney Olympic Park and The Bays. Urban renewal precincts are areas of local re-development and/or transformation. They are generally mixed use precincts in the process of going through change from current land uses to new commercial, residential and recreational land uses • Industrial and urban services areas – Clyde and Silverwater. Industrial areas are centres of local industry and employment. They include a mix of general and heavy industrial uses, with industrial built form often including large warehousing buildings, heavy vehicle access roads and loading docks.	• Transport and traffic • Noise and vibration • Non-Aboriginal heritage • Property and land use • Landscape character and visual amenity • Business impacts • Social impacts • Contamination • Air quality.
Natural process or features	This approach has been applied where aspects or likely impacts are more associated with the natural environment or natural processes across the Concept and are generally not categorised by different types of urban settings.	• Aboriginal heritage • Groundwater and ground movement • Soils and surface water quality • Hydrology and flooding • Biodiversity • Hazards.
Strategic frameworks and guidelines	The assessment of spoil, waste management and resource use, and sustainability and climate change, is focussed on the relevant strategic frameworks, policies and guidelines that would be implemented to manage these processes through all stages of the Concept.	• Spoil, waste management and resource use • Sustainability and climate change.

Detailed environmental assessments would be carried out at each stage of the planning process, including:

- Stage 1 – major civil construction works between Westmead and The Bays (refer to Chapters 10 to 26 of this Environmental Impact Statement)
- Future stage(s) - related to major civil construction works from The Bays to the Sydney CBD, station fit-out and aboveground building construction and operation of the metro line (future applications).

8.3 Avoidance and minimisation of impacts

The design development process for the Concept aimed to avoid or minimise potential impacts. This included the following measures:

- Construction methodology:
  - Selection of tunnel boring machines to excavate the mainline tunnels rather than roadheaders. Tunnel boring machines cut a circular profile ideal for a rail tunnel and minimise spoil generation. Tunnel boring machines also operate faster than roadheaders/other excavation machinery, minimising the duration of impacts on the community
  - Selection of The Bays as a tunnel boring machine launch and support site to minimise the need for property acquisition by preferencing government-owned and under-utilised land
  - Selection of tunnel boring machine launch, retrieval and support sites where there is sufficient access to arterial roads, to enable efficient transportation of tunnel boring machines, segments, spoil and other materials, and minimise impact to local streets
  - Locating the stabling and maintenance facility construction site and services facilities within industrial areas where possible, and at distance from residential receivers, where sensitivity to noise, or landscape and visual impacts is lower
  - Inclusion of a concrete segment construction facility at Clyde to allow the manufacture of concrete segments away from sensitive receivers.
- Impacts to existing structures or development:
  - Development of tunnel alignment and surface sites to avoid direct impacts to World and National Heritage listed items and minimise impacts to State and Local Heritage listed items
  - Development of tunnel alignment to avoid underground structures such as major utilities and basements, where possible, and minimise the need to acquire property
  - Consideration of planning and land use plans, policies and strategies during station location selection in order to support planned development.
- Impacts to sensitive receivers:
  - Selection of station locations and locating the majority of the Concept underground to minimise impacts to businesses, residential and other sensitive receivers
  - Selection of sites for stabling, maintenance and services facilities with consideration to minimising potential noise and vibration impacts during both operation and construction by locating the facilities in existing high noise areas, or away from residential receivers.
- Impacts to natural features or processes:
  - Development of a tunnel alignment and site selection for stations and services facilities to avoid direct impacts to previously recorded Aboriginal sites, where possible
  - Inclusion of measures to avoid ongoing groundwater inflow and impacts to groundwater users, including tanking of tunnels and stations at Parramatta, Five Dock and The Bays
  - Development of design to avoid or minimise potential soil and surface water quality impacts where possible. This includes minimising the extent of soil disturbance and avoiding direct impact on watercourses where possible
  - Locating the majority of the Concept underground or in pre-existing built-up areas to largely avoid and/or minimise direct impacts to terrestrial biodiversity.
- Impacts to known hazards:
  - Development of a tunnel alignment and selection of construction sites at Clyde and Silverwater which avoids potential interaction with major hazard facilities, including Viva Energy's Clyde Terminal and associated high pressure fuel pipelines in the locality.

Measures proposed to avoid and/or minimise potential impacts which are specific to Stage 1 are included in the relevant assessment chapters (refer to Chapters 10 to 26).

8.4 Transport and traffic

8.4.1 Legislative and policy context

Traffic modelling for the relevant stages of the Concept would be undertaken in line with Transport for NSW Traffic Modelling Guidelines (2013). The guidelines were developed to provide consistency in traffic modelling practice and promote high quality model outputs.

8.4.2 Assessment approach

This assessment involved:

- Identifying the existing active transport network, public transport network (including rail, bus, light rail and ferry services), regional road network and future planned changes to the transport and traffic network
- Considering the potential impacts of the Concept on the transport and traffic network during the construction and operation of Sydney Metro West
- Consultation with local Councils and other sections of Transport for NSW, including the former Roads and Maritime Services, in regard to transport integration
- Identifying performance outcomes
- Identifying the proposed scope of transport and traffic assessments for future stages.

8.4.3 Existing environment

The Concept corridor contains a number of transport modes, including those described in Table 8-3 and shown on Figure 8-1.

Table 8-3: Transport modes around the Concept

Transport mode	Description
Regional active transport network	The regional active transport network around the Concept consists of footpaths, shared paths, signalised road crossings and cycle networks. Recreational cycle and pedestrian facilities are located: • In Parramatta Park • In Sydney Olympic Park • Along Parramatta River • Along the foreshores of Iron Cove (known as the Bay Run), Rozelle Bay, Blackwattle Bay and Jones Bay. Key off-road cycle corridors include: • Rouse Hill to Parramatta via the North-West Transitway • Liverpool to Parramatta running parallel to the rail line • Parramatta to Sydney Olympic Park running parallel to the M4 Western Motorway • Drummoyne to Sydney CBD via Victoria Road and ANZAC Bridge.
Rail network	Rail services are operated by Sydney Trains and NSW TrainLink, providing connections throughout Sydney, regional NSW and interstate. Major interchanges between rail lines are located at: • Parramatta • Lidcombe • Strathfield • Redfern • Central • Town Hall • Wynyard.
Metro	The Sydney Metro City & Southwest (currently under construction) in the vicinity of the Concept in the vicinity of the Sydney CBD.
Bus network	The bus network generally consists of cross-regional services; services that connect to metropolitan centres and strategic centres; local services that connect to rail stations, shopping centres, school and hospitals; and on-demand services. Major bus corridors in the vicinity of the Concept include: • North-West Transitway • Liverpool to Parramatta Transitway • Windsor Road • Parramatta Road • Victoria Road. Major bus interchanges are located at Parramatta CBD, Strathfield, Burwood, Railway Square and various locations throughout the Sydney CBD.
Light rail	The following light rail lines are within the Concept: • The L1 Dulwich Hill Line operates between Dulwich Hill and Central via Lilyfield and Pyrmont. Light rail stops between Leichhardt North and Central are located in the vicinity of the Concept • The Sydney CBD and south-east light rail operates between Randwick and the Sydney CBD. Various stops are within the vicinity of the Concept throughout the Sydney CBD • Stage one of the Parramatta light rail is currently under construction. Once complete, there will be stations in the vicinity of Westmead and the Parramatta CBD.
Ferry	Ferry services operate along the Parramatta River, including the F3 Parramatta River Line between Parramatta and Circular Quay via Sydney Olympic Park and Balmain. Ferry stops located in the vicinity of the Concept include Parramatta, Rydalmere and Sydney Olympic Park.

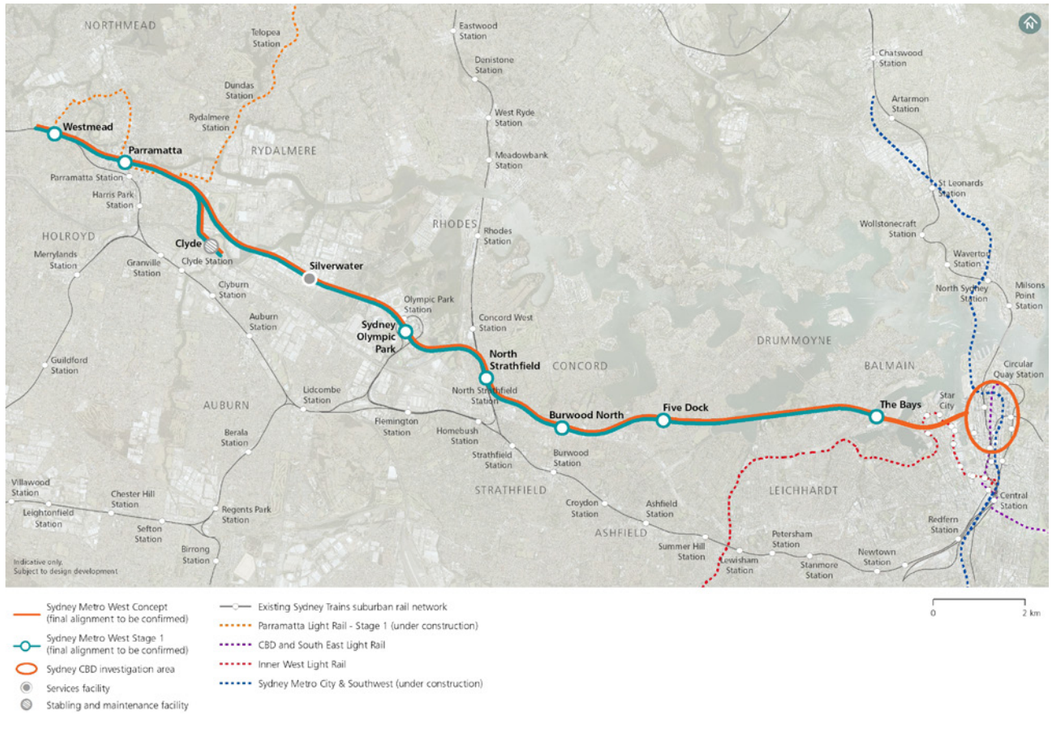

Figure 8-1: Existing public transport network surrounding the Concept corridor

The road network in the vicinity of the Concept is well-established. Most major roads carry high traffic volumes and experience significant congestion, particularly during peak periods. Motorways and principal arterial roads include (refer to Figure 8-2):

- The M4 Western Motorway, which is the major east-west high-capacity and high-speed corridor linking the Blue Mountains and Western Sydney with Sydney CBD
- The A4/A44 corridor consisting of Great Western Highway, Parramatta Road, City West Link and ANZAC Bridge, which is an alternative east-west corridor linking Western Sydney with Sydney CBD
- The A40 corridor consisting of Old Windsor Road, parts of James Ruse Drive and Victoria Road, which links Parramatta with the Hills District and Sydney CBD
- The A6 corridor, including Silverwater Road, which is a major north-south corridor linking Heathcote and Carlingford via Bankstown and Silverwater
- The A3 corridor, including Homebush Bay Drive, which is a major north-south corridor linking Blakehurst and Mona Vale via Hurstville, Ryde, Macquarie Park and Pymble
- WestConnex M4-M5 Link and Rozelle interchange (currently under construction) which will link the M4 and M5, along with connections to other major arterial roads such as the City West Link and Victoria Road.

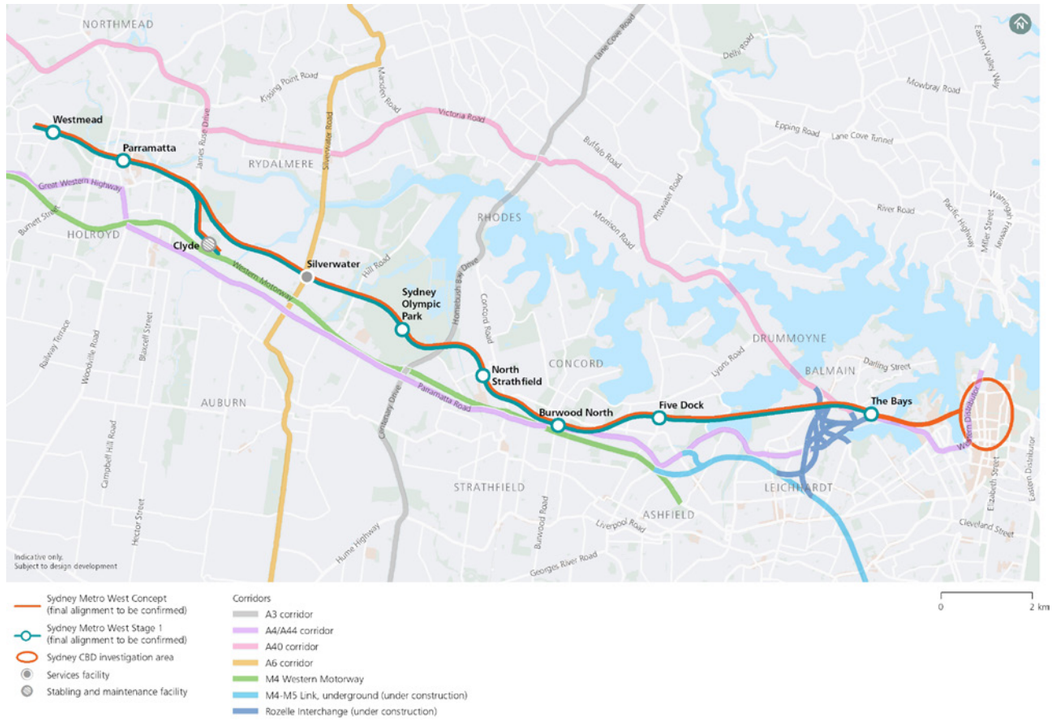

Figure 8-2: Road network surrounding the Concept corridor

The transport network is undergoing significant change to support the Greater Sydney Commission's vision for Greater Sydney as a metropolis of three cities, where people have access to jobs and services within 30 minutes by public transport. The substantial investment in the transport network seeks to respond to the challenges that will reshape Greater Sydney and the way people and goods move as population and employment continues to grow.

Key transport initiatives currently planned for within or adjacent to the Concept corridor include the Western Harbour Tunnel & Beaches Link.

The existing transport and traffic conditions within the Concept corridor are described in Table 8-4.

Table 8-4: Existing transport and traffic environment

Urban setting	Existing transport and traffic
CBDs • Parramatta • Sydney	The urban centres of Parramatta and Sydney CBDs have high pedestrian volumes which are well catered for through footpaths, shared paths and signalised road crossings. The urban centres are well serviced by public transport options with the T1 Western Line providing a connection between the Parramatta and Sydney CBDs. The Sydney CBD provides access to the Greater Sydney rail network, along with regional and interstate services. Both urban centres are serviced by ferry services, including the F3 Parramatta River Line. Light rail services are operating within the Sydney CBD and under construction in the Parramatta CBD. Parramatta and Sydney CBDs have well established road networks connecting the centres to the greater Sydney area and the Blue Mountains. Key links include the A4/A44 corridor, the A40 corridor and the M4 Western Motorway. Both Parramatta and Sydney CBDs are well serviced by both local and regional bus routes, with major interchanges near Parramatta Station and at various locations within the Sydney CBD.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	There are relatively high pedestrian volumes within the suburban settings, particularly within local town centres including North Strathfield and Five Dock. Pedestrians are generally catered for through footpaths, shared paths and signalised road crossings. The suburban centres are serviced by a number of public transport modes. North Strathfield is on the T9 Northern Line with Burwood North and Five Dock currently serviced by the regional bus network. The light rail services parts of Lilyfield and Rozelle. Arterial roads such as Parramatta Road, Victoria Road and the City West Link provide the major east-west network connection, with main roads such as Great North Road, Balmain Road and Concord Road providing north-south connections. There is generally direct access from the local road network to surrounding private properties, along with street access to commercial and retail properties. On-street parking is available at each of the suburban centres.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	There are well established pedestrian and cycle networks within Westmead and Sydney Olympic Park. High levels of pedestrian activity occur around the existing railway station and the health and education precinct in Westmead and within Sydney Olympic Park during special events. Pedestrian activity within the proposed site at The Bays is low given the port and industrial land uses present. However, there is a well-developed pedestrian network in the surrounding suburbs such as Rozelle, Balmain, Glebe and Annandale. The cycle network surrounding The Bays is well established with provision of a number of off-road shared paths and on-road cycle routes. Westmead is serviced by the T1 Western Line and T5 Cumberland Line services, along with some NSW TrainLink Blue Mountains Line services. Sydney Olympic Park is on the T7 Olympic Park Line which is connected to the T1 Western Line at Lidcombe. All precincts are serviced by local bus services. Westmead and Parramatta are also serviced by T-way bus services. Established road networks are present within each of the precincts, providing access to arterial roads and motorways such as the A4/A44 corridor and M4 Western Motorway. Car parking availability is generally associated with surrounding community facilities, such as Westmead hospital and sporting facilities within Sydney Olympic Park. Limited on-street parking is also available for public use.
Industrial and urban services • Clyde • Silverwater	There is limited pedestrian and cycle access within the industrial centres of Clyde and Silverwater. There are no railway stations in the vicinity of the industrial areas and there are limited bus services to these areas. The road network is important within these areas as the main mode of transportation. Key network connections include Silverwater Road and Parramatta Road. Parking is generally in dedicated carparks associated with industrial and business enterprises.

8.4.4 Potential operational benefits and impacts

Sydney Metro West would deliver a number of significant transport and traffic benefits. Chapter 2 (Strategic need and justification) details how these align with regional strategic plans and Chapter 7 (Placemaking) details how these align with local strategic plans These benefits are summarised as follows:

- Increased capacity and reliability of Sydney's rail network
- Improved travel times and customer comfort between key destinations within the Greater Parramatta to Sydney CBD corridor
- Reduced crowding on trains and at some stations on the existing Sydney rail network
- Improved journey times for bus customers and other road users
- Improved connectivity and transfer opportunities between public transport modes.

To provide integration of transport modes at metro stations, there may also be alterations to the transport and traffic network during operation. This may include potential changes to:

- Traffic arrangements on the surrounding road network due to required changes to local roads or traffic light phasing
- Availability, location or number of loading zones and/or parking spaces
- Pedestrian and cyclist arrangements, which are expected to be primarily positive
- Property access arrangements
- Bus stop locations, routes and timetables
- Special event access arrangements
- Emergency vehicle access arrangements.

Where possible, the design would aim to avoid or reduce impacts associated with operational transport and traffic.

The potential operational transport and traffic benefits and impacts for each setting within the Concept corridor are described in Table 8-5. Cumulative impacts are discussed in Section 8.21.

Table 8-5: Potential operational transport and traffic benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney	Improved pedestrian and cyclist arrangements would likely be required to provide safe and convenient access and egress from the new metro stations within the Parramatta and Sydney CBDs. These improvement would be made as part of station design and placemaking objectives. There is also potential for permanent changes to property access for commercial and retail properties located adjacent to the stations due to altered pedestrian routes, removal or relocation of parking or loading zones, and changes to traffic conditions.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Improved pedestrian and cyclist arrangements would likely be required to access the new metro stations at North Strathfield, Burwood North and Five Dock. Station designs would take into account the need for pedestrian and cyclist integration with the surrounding network and provide safe, high quality and clearly signposted walking paths to stations, and between the stations and other transport modes. There would likely be some loss of on-street parking in the immediate vicinity of the stations, as well as loss or relocation of loading zones. Permanent changes to bus stop locations, routes and timetables may be required to better integrate the new metro service with the existing public transport network and continue to provide safe, convenient transitions between modes of transport. There is also potential for permanent changes to property access, particularly for adjacent commercial and retail properties, due to altered pedestrian routes, removal or relocation of parking or loading zones, and changes to traffic conditions.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Improved pedestrian and cyclist arrangements would likely be required to access the new metro stations at Westmead, Sydney Olympic Park and The Bays. These would allow for ease of access, along with improved pedestrian and cyclist safety and accessibility. There is also potential for changes to the local road networks around Westmead and Sydney Olympic Park. These may require some localised and minor changes to the emergency access arrangements to Westmead Hospital and special event access arrangements to Sydney Olympic Park.
Industrial and urban services • Clyde • Silverwater	Permanent changes to traffic arrangements have the potential to result in some minor impacts on workers, customers and visitors to industrial and business premises. There may be impacts to car parking, due to the lack of public parking facilities and reliance on on-street parking in these locations.

8.4.5 Potential construction impacts

Potential construction transport and traffic impacts would be appropriately managed in accordance with the performance outcomes in Section 8.4.6. Construction sites would be managed in accordance with the Construction Environmental Management Framework (CEMF) and Construction Traffic Management Framework (CTMF). The CEMF is a Sydney Metro project framework which sets out the environmental, stakeholder and community management requirements for construction. The CTMF provides an overall strategy and approach for construction traffic management for Sydney Metro West, and an outline of the traffic management requirements and processes that would be common to each of the proposed construction sites. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Potential transport and traffic impacts anticipated to occur during the construction of the Concept include:

- Temporary changes to traffic performance on the road network in some locations around construction sites including a reduction in the level of service at some intersections due to construction vehicle access and egress from site, delivery of construction materials, spoil haulage routes and temporary road or lane closures
- Temporary changes to on-street parking or removal or relocation of loading zones, servicing access, taxi ranks, and/or kiss and ride areas
- Temporary removal or relocation of existing bus stops
- Temporary delays or other impacts to existing bus services including the potential diversions of bus services and/or the need to change bus timetables
- Temporary changes to pedestrian and cyclist access or flows including potential diversions. This would also include potential temporary altered access to and from the existing Westmead and North Strathfield stations
- Temporary access changes to private properties
- Increased construction vehicles on roads around construction sites and potential conflicts with motorists, pedestrians and cyclists, particularly in the Parramatta and Sydney CBDs
- Temporary changes to emergency access arrangements
- Temporary access changes during special events
- Temporary changes to the availability of rail services to allow works to occur safely within the rail corridor. These works would occur during planned rail possessions, generally at night or on the weekend, although some extended rail possessions may be required.

Impacts to regional road networks and public transport routes are not expected during construction. If construction is required within the existing rail corridor, or where work in the vicinity of existing railway stations cannot be undertaken safely with trains operating, these activities would be undertaken during scheduled rail possessions to minimise disruption to suburban and intercity rail services.

The potential construction transport and traffic impacts for each land use type within the Concept corridor are described in Table 8-6. Cumulative impacts are discussed in Section 8.21.

Table 8-6: Potential construction transport and traffic impacts

Urban setting	Potential construction impacts
CBDs • Parramatta • Sydney	Construction in the vicinity of existing railway stations has the potential to temporarily impact on the reliability of suburban and intercity rail services. These activities would be undertaken during scheduled rail possessions to minimise disruption to services.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Construction within the suburban setting would likely temporarily impact on the surrounding road network due to the requirement for heavy vehicles, construction equipment and construction personnel to access the sites. It is also likely that there would be temporary loss of on-street parking in the immediate vicinity of the construction sites. Reduced and/or altered pedestrian and cycle access may be temporarily required to provide ongoing public safety and access to nearby businesses and transport connections. Bus stops, taxi ranks and/or kiss and ride areas may require temporary relocation. Construction traffic and temporary road diversions may also result in delays to local bus services or require route diversions. Construction in the vicinity of the existing railway station at North Strathfield has the potential to temporarily impact on the reliability of suburban and intercity rail services. These activities would be undertaken during scheduled rail possessions to minimise disruption to services. There is also the potential for temporary changed access arrangements at North Strathfield Railway Station however, access would be maintained. There may also be the need to provide temporary alternative access to private properties and businesses where there are disruptions to local roads and access points.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Construction within the urban renewal precincts would likely have temporary impacts on the surrounding road network due to the requirement for heavy vehicles, construction equipment and construction personnel to access the sites. There may also be temporary loss of on-street parking in the immediate vicinity of the construction sites. Reduced and/or altered pedestrian and cycle access may be temporarily required to provide ongoing public safety and access to nearby businesses and transport connections. Bus stops, taxi ranks and/or kiss and ride areas may require temporary relocation. Construction traffic and temporary road diversions may also result in delays to local bus services or require route diversions. Construction in the vicinity of the existing railway station at Westmead has the potential to temporarily impact on the reliability of suburban and intercity rail services. These activities would be undertaken during scheduled rail possessions to minimise disruption to services. There is also the potential for temporary changed access arrangements at Westmead Railway Station however, access would be maintained. There may also be the need to provide temporary alternative access to private properties and businesses where there are disruptions to local roads and access points. Alternate access for emergency vehicles accessing Westmead Hospital may be required to avoid temporary road closures or diversions due to construction traffic or activities. Temporary changes to special event access may also be required at Sydney Olympic Park.
Industrial and urban services • Clyde • Silverwater	Access to the industrial areas is heavily reliant on the local road network. Construction traffic has the potential to temporarily reduce the level of service at surrounding intersections and increase the number of heavy vehicles on local and main roads surrounding the sites. Due to increased construction traffic, there is also the potential for temporary delays to existing bus services and potential diversions of bus services.

8.4.6 Performance outcomes

Identified performance outcomes in relation to transport and traffic for operation and construction of the Concept are provided in Table 8-7.

Table 8-7: Transport and traffic performance outcomes

Operational performance outcomes	Construction performance outcomes
• The modal access hierarchy is implemented at stations • Sufficient customer capacity in stations and station plazas is provided to limit crowding or queuing in accordance with Fruin's Level of Service C (for 2056 demand) • Stations and interchanges are fully accessible and compliant with the *Disability Discrimination Act 1992* and the Disability Standards for Accessible Public Transport 2002.	• Construction traffic and transport impacts on special events are minimised • Safe routes for pedestrians and cyclists are provided around construction sites • Safe access to properties is maintained • Road occupancy is minimised, particularly in the Parramatta and Sydney CBDs • Changes to the travel paths of road users, including bus routes, are minimised • Affected emergency services and public transport operators are provided early communication on changes in traffic conditions • Loss of on-street parking and loading zones is minimised • Heavy vehicle routes are developed in consultation with Sydney Coordination Office and relevant parts of Transport for NSW • The use of local roads by heavy vehicles is minimised • Safe access and egress is provided to and from construction sites.

8.4.7 Matters to be addressed in staged applications

Transport and traffic impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Transport and traffic assessments will include, as relevant to the stage:

- Assessment of construction traffic including number, frequency and size of construction-related vehicles, potential routes for construction traffic and spoil haulage, and impact on existing traffic conditions
- Assessment of access constraints and impacts on public transport, pedestrians, cyclists and road network performance arising from construction
- Assessment of cumulative traffic impacts
- Consideration of operational maintenance access requirements
- Assessment of how the transport network supports placemaking outcomes
- Assessment of the performance of existing and future operational transport network for all modes, including analysis of travel times
- Assessment of intersection performance during operations at locations where changes are required to facilitate access to new stations
- Consideration of opportunities to improve public transport links to stations
- Consideration of opportunities to integrate cycling and pedestrian elements with surrounding networks
- Further consultation with local Councils and other sections of Transport for NSW.

An assessment of transport and traffic impacts for Stage 1 is provided in Chapter 10 (Transport and traffic – Stage 1).

8.5 Noise and vibration

8.5.1 Legislative and policy context

The policy context for noise and vibration within the Concept is outlined in Table 8-8.

Table 8-8: Noise and vibration policy

Guideline/policy name	Description
Rail Infrastructure Noise Guideline (NSW Environment Protection Authority, 2013)	The Rail Infrastructure Noise Guideline was developed to ensure that potential noise impacts associated with rail infrastructure projects are managed effectively. The guideline specifies noise and vibration trigger levels and applies to both heavy and light rail infrastructure projects, including the construction of new rail lines.
Noise Policy for Industry (NSW Environment Protection Authority, 2017)	The Noise Policy for Industry (NSW Environment Protection Authority, 2017) replaced the NSW Industrial Noise Policy (NSW Environment Protection Authority, 2000). The policy applies to noise from stations and ancillary facilities.
NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011)	The NSW Department of Planning, Industry and Environment's Road Noise Policy (Department of Environment, Climate Change and Water, 2011) aims to identify the strategies that address the issue of road traffic noise and defines criteria to be used in assessing the impact of such noise. This policy applies to any roads that require reconfiguration as part of the Concept.
Sydney Metro Construction Noise and Vibration Standard (Transport for NSW, 2020)	The Sydney Metro Construction Noise and Vibration Standard sets out the assessment and management protocols for construction of Sydney Metro projects. The standard is based on the requirements of the NSW Environment Protection Authority's Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009), as appropriate to Sydney Metro.
Assessing Vibration: a technical guideline (Department of Environment and Conservation, 2006)	The NSW Environment Protection Authority's Assessing Vibration: a technical guideline (Department of Environment and Conservation, 2006) presents preferred and maximum vibration values that should not be exceeded; and recommends effective measurement and evaluation techniques. It is based on guidelines contained in BS 6472-1992, Evaluation of human exposure to vibration in buildings (1-80 Hz). The guideline applies to the assessment of vibration for the Concept.
Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (Australian and New Zealand Environment Council, 1990).	The NSW Environment Protection Authority's Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) requires vibration and overpressure from blasting to be assessed against this guideline. Criteria in the ANZECC standard are, however, applicable to long-term operations, such as those at mining sites. The Sydney Metro CNVS recognises the restrictive nature of the ANZECC criteria and recommends have applied the following vibration and overpressure limits (as outlined in the Sydney Metro CNVS): • Vibration (PPV): 25 mm/s • Overpressure: 125 dBL.

8.5.2 Assessment approach

This assessment involved:

- Describing the existing noise environment surrounding the Concept corridor, including the types and sensitivity of receivers in the area surrounding the Concept
- Identifying features of the Concept which have the potential to produce noise and vibration impacts, including station sites, services facilities, stabling and maintenance facilities, tunnels and road reconfigurations
- Undertaking a qualitative assessment (see below) of the potential noise and vibration impacts due to construction and operation of the Concept
- Consultation with the NSW Environment Protection Authority to discuss the approach to the noise and vibration assessment
- Identifying performance outcomes
- Identifying the proposed scope of noise and vibration assessments for future stages.

As the Concept noise and vibration assessment is qualitative (i.e. no modelling has been undertaken), potential impacts are described in terms of the likely subjective response of people affected by the impacts during standard construction hours. These are described further in Chapter 11 (Noise and Vibration – Stage 1). The ratings have been applied based on experience on similar projects, such as Metro North West Line, and are representative only of potential exceedances that may be experienced during operation and construction of the Concept.

8.5.3 Existing environment

The existing noise environment varies along the length of the Concept. Sources of background noise within the Concept corridor are described in Table 8-9.

Table 8-9: Sources of background noise within the Concept corridor

Noise source	Description
Road traffic noise	Road traffic noise is the main source of existing noise within the Concept corridor, with most stations and facilities located in urban areas within 100 metres of busy roads.
Suburban rail lines and stations	There are existing rail lines and stations near Westmead, Parramatta, Sydney Olympic Park and North Strathfield metro station sites and the Clyde stabling and maintenance facility.
Aircraft noise	Much of the Concept corridor is under flight paths and affected by aircraft noise. The noise levels vary depending on proximity to the airport, with areas such as the Inner West experiencing higher and more frequent aircraft noise.
Industrial areas	There are several industrial areas within and adjacent to the Concept corridor that generate noise, such as Clyde, Silverwater and The Bays.
Commercial areas	Noise is generated from commercial areas within and adjacent to the Concept corridor in areas such as Westmead, Parramatta, Silverwater, Five Dock, and Sydney CBD.
Occasional/sporting events	Noise is generated from occasional and sporting events at facilities such as at Western Sydney Stadium (Parramatta), Rosehill Gardens racecourse, Sydney Speedway (location on NSW Government owned land), Sydney Olympic Park, Concord Oval and Leichhardt Oval.

Potential noise and vibration sensitive receivers are within the Concept corridor and depending on location, they could include residential, 'other sensitive' (i.e. schools, childcare centres, places of worship, medical facilities and recreation areas), commercial and industrial uses. Types of sensitive receivers are discussed in Table 8-10.

Table 8-10: Ambient noise environment and types of sensitive receivers around the Concept corridor

Urban setting	Ambient noise environment and types of sensitive receivers
CBDs • Parramatta • Sydney CBD	The CBD areas are generally high noise environments, particularly during weekdays. The noise environment is dominated by traffic and transport noise, along with noise from other construction activities. The CBD areas are dominated by commercial and retail uses, with large numbers of receivers. There is a mix of residential receivers within the Parramatta CBD, with high density residential dwellings/buildings closer to the centre of the CBD, and low-medium density on the edges of the CBD area. There are multi-level high density residential dwellings/buildings within the Sydney CBD. Other types of receivers include schools, childcare centres, places of worship, medical facilities, recreation areas, hotels, restaurants/bars and cafes.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Noise in the suburban settings is dominated by traffic and transport noise, with some aircraft noise. The main receivers within the suburban areas are residential comprising a mix of low to medium density. Other types of receivers include schools, childcare centres, places of worship, medical facilities, restaurants/bars, cafes and recreation areas. There are numerous commercial receivers near: • The existing railway station at North Strathfield • Along the Parramatta Road corridor at Burwood North • Surrounding Great North Road at Five Dock.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The existing noise environments within the urban renewal precincts are reflective of the existing land uses, such as existing commercial enterprises and transport facilities at Westmead, large scale sporting and entertainment events at Sydney Olympic Park and industrial activities at The Bays. There are low to medium density residential areas near Westmead and The Bays, and multi-level high density residential also at Westmead and Sydney Olympic Park. Other types of receivers include schools, childcare centres, places of worship, medical facilities (including the Westmead health and education precinct), restaurants/bars, hotels, cafes and recreation areas. There are numerous commercial receivers near the existing railway stations at Westmead and Sydney Olympic Park. The Bays has some commercial/industrial receivers associated with White Bay, Glebe Island and Rozelle Bay.
Industrial and urban services areas • Clyde • Silverwater	The Clyde and Silverwater areas are dominated by industrial and commercial receivers. The noise environment is generally higher due to existing industrial activities.

8.5.4 Potential operational benefits and impacts

It is expected that the Concept can be designed to meet relevant operational noise and vibration guidelines including:

- The Rail Infrastructure Noise Guideline in relation to potential airborne noise, ground-borne noise and vibration impacts
- Assessing vibration: a technical guidelines (Department of Environment and Conservation, 2006) in relation to potential human comfort vibration impacts to vibration impacts to sensitive equipment
- The Noise Policy for Industry (EPA, 2017) in relation to potential noise from fixed facilities such as station and services facilities.

Where there is the potential for ground-borne noise and vibration impacts from operational rail lines in tunnels, the use of resilient track forms would be considered. There are several types of resilient track form that may be used, depending on the likely level of impact at locations along the Concept corridor. The need for resilient track forms would also depend on the extent of the predicted ground-borne noise and vibration impacts (to be determined during future stage assessments), which can be influenced by a range of operational factors including train speed, tunnel depth, tunnel design and position of track turnouts.

Permanent reconfigurations of existing roads may be required surrounding some of the proposed stations and facilities. This has the potential to affect receivers near to these altered roads. Any potential impacts would be assessed during later design stages and mitigated in line with the NSW Department of Planning, Industry and Environment's NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011a).

Following assessment in future stages, the need for appropriate noise attenuation measures at stations and services facilities would be determined, such as equipment selection, positioning of plant and ventilation discharges, in-duct attenuators, and acoustic enclosures.

In addition to these, the potential operational noise and vibration benefits and impacts associated with new infrastructure within each setting in the Concept are outlined in Table 8-11. Cumulative impacts are discussed in Section 8.21.

Table 8-11: Potential operational noise and vibration benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney CBD	The new station sites within the Parramatta and Sydney CBDs would mostly be underground, however aboveground elements such as ventilation systems and mechanical services have the potential to introduce new sources of airborne noise. Given the existing high noise environment of the CBD areas, any impacts are expected to be minimal and mitigated to comply with the Noise Policy for Industry (EPA, 2017). Standard engineering solutions would be designed and implemented to control operational impacts in order to comply with all relevant noise and vibration criteria. Solutions may include selection of low noise systems, enclosure of noisy items, or transmission path controls such as noise barriers.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock to The Bays	The new station sites within suburban settings would mostly be underground, however aboveground elements such as ventilation systems and mechanical services have the potential to introduce new sources of airborne noise. Potential impacts within suburban settings may be slightly higher than in the CBDs due to the lower ambient noise levels, however impacts are still expected to be minimal and able to be mitigated to comply with the Noise Policy for Industry (EPA, 2017). The services facility between Five Dock and The Bays would mostly be underground, however above ground elements have the potential to introduce new sources of airborne noise. Given this is an existing high noise area, any impacts are expected to be minimal and comply with the Noise Policy for Industry (EPA, 2017). Standard engineering solutions would be designed and implemented to control operational impacts in order to comply with all relevant noise and vibration criteria. Solutions may include selection of low noise systems, enclosure of noisy items, or transmission path controls such as noise barriers.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Within the urban renewal precincts, aboveground elements such as ventilation systems and mechanical services associated with new station sites have the potential to introduce new sources of airborne noise. Impacts are expected to be minimal and able to comply with the Noise Policy for Industry (EPA, 2017). With the implementation of standard engineering solutions, it is expected that any impacts would be minimal and comply with all relevant noise and vibration criteria. Solutions may include selection of low noise systems, enclosure of noisy items, or transmission path controls such as noise barriers.

Urban setting	Potential operational benefits and impacts
Industrial and urban services areas • Clyde • Silverwater	Operational noise from the proposed stabling and maintenance facility at Clyde, which includes maintenance areas that can generate high noise levels, has the potential to impact the surrounding receivers. The design of the site would consider options to minimise operational noise impacts such as positioning of noise generating facilities away from site boundaries and provision of noise barriers if required. It is anticipated the operational procedures for the stabling and maintenance facility would include noise management measures such as no horn testing as part of train departure. The facility is expected to operate 24 hours per day, 7 days per week but is in an area of high existing noise levels. Given this is an existing high noise area and located away from residential receivers, it is expected that any impacts would be minimal. The services facility at Silverwater would mostly be underground, however above ground elements have the potential to introduce new sources of airborne noise. Given this is an existing high noise area, any impacts are expected to be minimal and comply with the Noise Policy for Industry (EPA, 2017). With the implementation of appropriate engineering and management measures, it is expected both locations would comply with all relevant noise and vibration criteria. Solutions may include selection of low noise systems, enclosure of noisy items, or transmission path controls such as noise barriers.

8.5.5 Potential construction impacts

Potential construction noise and vibration impacts would be temporary and appropriately managed in accordance with the performance outcomes in Section 8.5.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The NSW Environment Protection Authority's Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) acknowledges that due to the nature of construction works, it is inevitable that there will be impacts where construction is near to sensitive receivers. The principal contractors appointed to construct each stage would be required to implement and adhere to the requirements of the Sydney Metro Construction Environmental Management Framework and Construction Noise and Vibration Standard which sets out the environmental, stakeholder and community management requirements for construction.

Where noise management level exceedances are predicted for works during the more sensitive out-of-hours periods or for works that would be conducted over a long period of time, all potentially feasible and reasonable mitigation measures would be considered to reduce predicted noise management level exceedances as far as possible. This would likely include the use of acoustic sheds or other acoustic measures at locations where construction works would regularly be undertaken 24 hours per day, 7 days per week.

Reduction of construction ground-borne noise and vibration impacts may require consideration of alternative construction methodologies such as the use of controlled blasting in lieu of continuous rock breaking.

The level of impact on sensitive receivers during construction would be dependent on a number of factors including distance of individual sensitive receivers to construction activities, the nature of the construction activities, and the time of day or night that the activities take place.

Excavation of the tunnels would be performed by tunnel boring machines on a 24 hours per day, 7 days per week basis. Ground-borne noise impacts are generally not expected for receivers where the tunnel is more than 50 metres deep. Where tunnel depth is less than 50 metres, ground-borne noise impacts from tunnelling during the daytime are predicted to generally be compliant with noise management levels or result in only 'minor' temporary impacts. There is potential for 'moderate' temporary ground-borne noise impacts near proposed construction sites as this is where tunnel depth would be shallowest. Given that night-time noise management levels are more stringent, there is potential to temporarily exceed the night-time ground-borne noise management level where tunnel depth is less than 25 metres. This exceedance would only be expected to occur in any one location for a few days, depending on the rate of progress of the tunnel boring machines.

Roadheaders and rockbreakers are likely to be used for the excavation of caverns, cross passages and the connecting tunnels to the stabling and maintenance facility. Depending on excavation method, geological conditions and depth, this has the potential to result in temporary ground-borne noise and vibration impacts.

While temporary exceedances of human comfort vibration management levels may occur above some tunnel sections, it is unlikely that there would be exceedances of cosmetic damage screening criteria.

In some circumstances, controlled blasting may be used to reduce the duration of potential noise impacts. Blasting would be managed to meet relevant criteria, including the limits stated in the Sydney Metro CNVS (refer to section 8.5.1).

There is potential for vibration sensitive medical and manufacturing equipment to be temporarily affected during the excavation of tunnels, cross passages, and caverns, however these impacts would be limited to the short time frame where tunnelling construction passes under the affected receiver or during short-term vibration intensive works.

Construction of new metro stations and services facilities would generally include the following activities:

- Site clearing and demolition of existing structures
- Excavation of shafts and station boxes including spoil handing
- Civil works and earthworks.

The use of highly noise and vibration intensive equipment, such as rockbreakers, would be required during certain periods, which has the potential to result in temporary impacts to nearby receivers. While most of these works would likely occur during standard daytime construction hours, some works may be required to be completed during out-of-hours construction periods.

Heavy vehicles would be required to transport spoil away from surface construction sites and for the delivery of construction materials. Deliveries and spoil haulage may be required during out-of-hours construction hours to minimise impacts on the local road network and allow for delivery of oversized plant, equipment and materials. There is potential for temporary impacts where haulage routes are along local roads and required during out-of-hours periods.

Permanent reconfigurations of existing roads may be required surrounding some of the proposed stations and facilities. This would likely require works during both standard daytime hours and out-of-hours works periods to minimise impacts on the surrounding road network. This has the potential to temporarily impact receivers near the proposed road work. Where high noise construction equipment is required to be used, there is the potential for wider noise management level exceedances.

Potential construction noise and vibration impacts by receiver type within each setting in the Concept are discussed in Table 8-12. Cumulative impacts are discussed in Section 8.21.

Table 8-12: Potential construction noise and vibration impacts

Urban setting	Potential impacts
CBDs • Parramatta • Sydney CBD	Noisy works, such as rock breaking and piling during excavation of shafts and station boxes, have the potential to generate temporary noise impacts that may exceed noise management levels during both standard and out-of-hours work. This may impact on commercial and other sensitive receivers adjacent to the proposed station sites. Impacts may be greater during out-of-hours works when the ambient noise environment is quieter, with the potential to affect residential receivers, along with late night/weekend commercial and retail operations, such as restaurants/bars and cafes, as well as recreation areas. Where possible, these activities would be undertaken during standard hours to minimise potential impacts. Tunnelling activities within the CBD areas also have the potential to generate temporary vibration impacts on sensitive receivers such as research and medical facilities, particularly near the proposed station sites where tunnel depths would be shallower. Noise management measures to reduce impacts at surrounding sensitive receivers would need to be considered for any long-term out-of-hours works.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Noisy works, such as rock breaking and piling during excavation of shafts and station boxes, have the potential to generate temporary high noise impacts during both standard and out-of-hours work. This may impact on commercial and other sensitive receivers adjacent to the proposed station sites. Other construction activities, such as demolition of existing structures, may also generate moderate noise impacts. Where possible, these activities would be undertaken during standard hours to minimise potential impacts. However, there may be the need to undertake activities out-of-hours for safety reasons or to minimise impacts on traffic or pedestrian movement. Noise management measures to reduce impacts at surrounding sensitive receivers would need to be considered for any long-term out-of-hours works. Tunnelling activities near the proposed stations and services facility site also have the potential to generate temporary ground-borne noise and vibration impacts on sensitive receivers, particularly where tunnel depths would be shallower.

Urban setting	Potential impacts
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Noisy works, such as rock breaking and piling during excavation of shafts and station boxes, have the potential to generate temporary high noise impacts during both standard and out-of-hours work. This may impact on commercial and other sensitive receivers adjacent to the proposed station sites. Other construction activities, such as demolition of existing structures, may also generate moderate noise impacts. Where possible, these activities would be undertaken during standard hours to minimise potential impacts. However, there may be the need to undertake activities out-of-hours for safety reasons or to minimise impacts on traffic or pedestrian movement. Noise management measures to reduce impacts at surrounding sensitive receivers, including acoustic sheds, would need to be considered for any long-term out-of-hours works. It is proposed to launch and support tunnel boring machines from both Westmead and The Bays. There is the potential for temporary noise impacts during times when the machines are working close to the surface. Measures such as acoustic sheds would be considered for these activities. Excavated spoil would need to be removed from these sites, and tunnel construction materials brought in. These activities have the potential to temporarily generate noise, particularly during out-of-hours work, as they would be carried out 24 hours a day, 7 days a week. Retrieval and dismantling of the tunnel boring machines would be carried at Sydney Olympic Park metro station construction site.
Industrial and urban services areas • Clyde • Silverwater	Construction of the stabling and maintenance facility would generally include: • Site clearing and demolition of existing structures • Ground excavation works • Civil works and earthworks. Demolition and excavation activities have the potential to generate temporary high noise levels. However, the site is in an area of high existing noise, so impacts are expected to be moderate. There may be the need to undertake activities out-of-hours for safety reasons or to minimise impacts on traffic movements. A temporary concrete segment facility would also be constructed at the Clyde stabling and maintenance facility construction site to provide concrete segments for the tunnel lining. This facility, along with transport of the concrete segments has the potential to generate noise. Given these activities are consistent with the existing industrial land use of the area, any impacts are expected to be minor.

8.5.6 Performance outcomes

Identified performance outcomes in relation to noise and vibration for operation and construction of the Concept are provided in Table 8-13.

Table 8-13: Noise and vibration performance outcomes

Operational performance outcomes	Construction performance outcomes
• Operational noise and vibration levels comply with the rail noise trigger levels in the Rail Infrastructure Noise Guidelines (Environment Protection Authority, 2013) and external noise criteria in the Noise Policy for Industry (Environment Protection Authority, 2017), where applicable.	• Construction noise and vibration impacts on local communities are minimised by controlling noise and vibration at the source, on the source to receiver path and at the receiver • Structural damage to buildings and heritage items from construction vibration is avoided • Local communities are engaged during construction, including on noise mitigation in areas predicted to be affected by high noise impacts.

8.5.7 Matters to be addressed in staged applications

Noise and vibration impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Noise and vibration assessments will include, as relevant to the stage:

- Description of the existing noise environment
- Explanation of the applicable standards, guidelines and environmental planning requirements
- Explanation of the construction methodology, design and operational procedures relevant to noise and vibration emissions
- Description of the methodology used to predict and assess the potential impacts
- Assessment of construction noise and vibration impacts
- Assessment of the potential cumulative impacts with other major projects
- Assessment of operational noise and vibration impacts
- Identification of feasible and reasonable construction and operational mitigation measures
- Further consultation with the NSW Environment Protection Authority.

An assessment of noise and vibration impacts for Stage 1 is provided in Chapter 11 (Noise and vibration impacts – Stage 1).

8.6 Non-Aboriginal heritage

8.6.1 Legislative and policy context

World and Commonwealth

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legislative framework for the protection and management of matters of national environmental significance. This includes heritage places of national and international importance which are protected through their inclusion on the World Heritage List, Commonwealth Heritage List or the National Heritage List.

New South Wales

The *NSW Heritage Act 1977* (Heritage Act) provides protection for items of 'environmental heritage' in NSW. 'Environmental heritage' includes places, buildings, works, relics, movable objects or precincts considered significant based on historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values. Items considered to be significant to the state are listed on the State Heritage Register.

Although the permits under the Heritage Act are not required for an approved State significant infrastructure project, the Heritage Act is relevant in that it guides assessment and defines statutory listed items. Certain sections of the Heritage Act are also still applicable to approved State significant infrastructure projects, such as Section 146 (notification of a relic).

Statutory registers provide legal recognition for heritage items. The State Heritage Register, government agency Heritage and Conservation Registers established under Section 170 of the Heritage Act, and the environmental heritage schedules of Local Environmental Plans (LEPs) are statutory listings.

Determining the significance of heritage items or a potential archaeological resource is undertaken by using a system of assessment centred on The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance, 2013 (Burra Charter) by the International Council on Monuments and Sites (ICOMOS). The principles of the Burra Charter are relevant to the assessment, conservation and management of sites and relics.

8.6.2 Assessment approach

The assessment involved:

- Identifying known heritage items and areas of potential archaeological remains within the Concept corridor that could be encountered during construction and operation of the Concept
- Considering the potential impacts of the Concept on the values, settings and integrity of heritage areas, items and archaeological resources, including items both above and underground and, where such potential exists, the likely significance of those impacts

- Consultation with the Sydney Metro Heritage Working Group and NSW Heritage Council to discuss the approach to the non-Aboriginal heritage assessment
- Identifying performance outcomes
- Identifying the proposed scope of non-Aboriginal heritage assessments for future stages.

8.6.3 Existing environment

The Concept corridor includes a range of historical values as outlined in Table 8-14.

Table 8-14: Non-Aboriginal heritage historical values

Historical setting	Description
Convict settlement	Convict settlements were developed shortly after the landing of the First Fleet in 1788. The settlement at Sydney Cove flourished and grew from the first days of settlement. At Westmead and Parramatta, the Government Domain of Government House was constructed primarily by convict labour; and the Government Farm was established, providing food resources to the greater colony. Convict settlements were also constructed along the route of Parramatta Road. At Burwood North, the Government's Longbottom Stockade and Farm was established providing an overnight gaol and accommodation for convict road gangs at the centre point between Sydney and Parramatta.
Agriculture and industry	A number of farms were established during the 1790s along the newly convict-built Parramatta Road. Government Farms were established at Parramatta and Westmead, and at the Government's Longbottom Stockade providing resources to the wider colony. Early land grants at Clyde, Silverwater, Sydney Olympic Park and The Bays provided the means to create centres for agriculture during early development. Industry flourished within these areas including oil refinery works at Clyde, slaughterhouses and saltworks at Silverwater, State Abattoirs at Sydney Olympic Park, and maritime industry and the White Bay Power Station at The Bays.
Residential development	Early land grants at Westmead, Parramatta, North Strathfield, Burwood, Five Dock and White Bay were in place before the rise of residential development. Grants within these areas changed hands a number of times before being subdivided from the mid-nineteenth century, although significant housing and a residential layout was not established in these areas until the 1890s and early twentieth century.
Maritime industry	Subdivision of White Bay occurred throughout the late 1820s with wealthy and prominent members of Sydney society establishing a number of industrial businesses which changed and developed over time, consolidating White Bay's maritime industry function. White Bay became synonymous with John Booth's Steam Saw Mills, the Australian Gas Light Company, the Glebe Island Abattoir and the Lever Brothers Factory. These businesses ultimately closed, with the area developing as residential throughout the twentieth century. The turn of the twentieth century was marked by the establishment of the White Bay Power Station, arguably the most prominent landmark at The Bays. The power station was decommissioned in 1983. Other maritime industries where also present along Parramatta River including transport services; and gas, coal and smelting industries which used water frontages, although these were largely closed during the latter half of the twentieth century for the preservation of the river.
Civic development and the railway	Sydney Cove was first settled in 1788, which quickly grew into a commercial and administrative centre of the colony of New South Wales. Temporary tents and convict huts quickly transitioned into substantial sandstone and brick residences. Well-known structures and precincts took form throughout the nineteenth century including Hyde Park, the Hyde Park Barracks, the Mint, St James Church, Customs House, Government House, and the Government Domain. The Sydney to Parramatta railway line was opened in 1855 and Central Station took its third and current form by the early twentieth century.

Heritage register searches were carried out across April and May 2019 including relevant State and Commonwealth statutory and non-statutory heritage registers. The Concept corridor extends beneath the curtilage of one World Heritage Site – Old Government House and Government Domain (Australian Convict Sites) (Ref. 1306); one Commonwealth Heritage listed site – Pyrmont Post Office (ID 105510); three items on the National Heritage List – Old Government House and the Government Domain (ID 105957), First Government House Site (ID 105761) and Hyde Park Barracks (ID 105935); and more than 70 State Heritage listed items.

The existing non-Aboriginal heritage context for the land use types within the Concept corridor are described in Table 8-15.

Table 8-15: Non-Aboriginal heritage and archaeological context

Urban setting	Existing heritage and archaeology
CBDs • Parramatta • Sydney	The Parramatta and Sydney CBDs contain representations of early convict settlement, civic development, and the development of transportation routes between the two centres, such as Parramatta Road and the railway. Local and State significant heritage items are present within both the Parramatta and Sydney CBDs, along with a number of National, Commonwealth and World heritage items including Old Government House and Government Domain (Australian Convict Sites) (Ref. 1306, ID 105957), Pyrmont Post Office (ID 105510), and Hyde Park Barracks (ID 105935). The CBDs are considered to have areas of State significant archaeological potential including low-moderate potential for archaeological remains relating to convict huts, yards and gardens, and early colonial residences and yards within Parramatta. State significant remains within the Sydney CBD are likely to relate to early European settlement, convict occupation and labour, early residential and commercial development, early infrastructure and the development of transport modes and routes. There are a number of State and World significant items with archaeological potential within the Parramatta CBD and the Sydney CBD investigation area including the Old Government House and Government Domain (Australian Convict Sites) (Parramatta CBD, Ref. 1306; ID 105957), Hyde Park (Sydney CBD investigation area, SHR 01871) and the Tank Stream (Sydney CBD investigation area, SHR 00636).
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	The suburban settings are representative of the transition from farming and agricultural areas established post convict settlement, to land subdivision and residential development in the early to mid-twentieth century. It is expected that any heritage items in these areas would mostly be of local heritage significance. North Strathfield and Five Dock are unlikely to have any archaeological potential due to previous ground disturbance following the transition from agricultural practices to suburban residential communities including the development of the railway. Burwood North has moderate archaeological potential associated with late 19th century development including potential archaeological remains associated with former residences. Between Five Dock and The Bays lies Callan Park which is listed on the National Trust of Australia register (Ref 6912), Register of the National Estate (Ref 1674) and State Heritage Register (SHR 00818). White Bay Power Station (SHR 01015) is located in Rozelle, close to The Bays.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The urban renewal precincts represent areas of more recent industrial and agricultural uses that are in current transition to other land uses. It is expected that heritage items present would mostly be of local heritage significance, with a number of State significant items, such as the State Abattoirs (SEPP (State Significant Precincts) 2005 Listing No. A; SREP No 24 – Homebush Bay Area Item No. 1) and White Bay Power Station (SHR 01015). There is low potential for archaeological remains within Westmead and Sydney Olympic Park associated with former land uses and the railway line, with these areas unlikely to contain archaeological remains which reach the threshold for local or State significance. The Bays contains varying potential (low-high) for locally significant archaeology related to former structures, reclamation fill and rail infrastructure.
Industrial areas • Clyde • Silverwater	The river frontage at Clyde and Silverwater has been used for industrial purposes since the late nineteenth century. These uses expanded in the mid-twentieth century and continue to the present day. It is expected that any heritage items present would be of local heritage significance. Potential archaeological remains are likely to be associated with post-1950 commercial/ industrial development and are unlikely reach the threshold for local or State significance.

8.6.4 Potential operational benefits and impacts

The operation and use of Sydney Metro West provides an opportunity to acknowledge and incorporate heritage values through heritage interpretation. Heritage interpretation would aim to partially offset the impact to heritage values that may occur due to the Concept.

It is unlikely there would be any direct impacts to heritage items during operation of the Concept, as activities with the potential to cause direct impacts, such as demolition and construction of facilities, would be confined to the construction stages.

Where heritage items are located close to metro stations or other infrastructure, the design would be sympathetic and reflect the heritage context and values of these heritage items. This would effectively manage the potential impacts associated with changes to the setting and views to and from heritage items.

The potential for vibration impacts during operation of the Concept would be assessed as part of the noise and vibration assessments for future stages. However, as the average tunnel depth is greater than 50 metres, any impacts are expected to be minimal and would be managed in accordance with relevant vibration guidelines and criteria, including the Rail Infrastructure Noise Guideline (Environment Protection Authority, 2019).

A discussion of likely impacts and benefits associated with the different settings within the Concept corridor is provided in Table 8-16.

Table 8-16: Potential operational non-Aboriginal benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney	Potential operational impacts within the CBDs relate to permanent changes to the streetscape, setting and views to and from heritage items near new metro stations or ancillary infrastructure. This may include State and National heritage items given the presence of both within the Parramatta and Sydney CBDs.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	It is expected that any impacts at sites within suburban settings would be related to permanent changes to streetscape, setting and views to and from heritage items near new metro stations or ancillary infrastructure. This may include State and local heritage items.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Within urban renewal precincts, there is the potential for permanent changes to streetscape, setting and views to and from local and State listed heritage items.
Industrial areas • Clyde • Silverwater	Potential impacts within industrial areas are expected to be minor and relate to impacts to streetscape, setting and views to and from local heritage items as a result of vegetation removal and ancillary infrastructure.

8.6.5 Potential construction impacts

Development of Sydney Metro West has generally avoided direct impacts to World, National and State heritage listed items. Where there are potential residual impacts to non-Aboriginal heritage items during construction, these would be appropriately managed in accordance with the performance outcomes in Section 8.6.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The potential for impacts on non-Aboriginal heritage would be dependent on the final locations and layout of construction sites across the Concept corridor. Construction of surface infrastructure such as stations and ancillary facility sites would likely require demolition and excavation activities, with the potential for direct impacts to heritage items.

While tunnel construction would mostly be deep enough to avoid areas of archaeological significance, there remains the potential for impacts to occur due to settlement or vibration caused by tunnelling and other construction activities. The potential for vibration impacts from construction activities would be considered as part of the noise and vibration assessments for each stage.

Potential construction impacts on non-Aboriginal heritage may include:

- Direct impact to heritage listed items including demolition, impacts within curtilages and potential impacts as a result of demolition of adjacent structures
- Indirect impacts to heritage items including visual impacts, impacts to setting and views
- Impacts to significant archaeological remains as a result of subsurface excavation at station sites, tunnel exits and entries and services facilities
- Impacts to heritage items relating to vibration and settlement as a result of tunnelling across the alignment.

A discussion of likely construction impacts associated with the different settings within the Concept corridor is provided in Table 8-17.

Table 8-17: Potential construction non-Aboriginal heritage impacts

Urban setting	Potential construction impacts
CBDs **Parramatta** **Sydney**	There is potential for direct impacts to local and State heritage items during construction of stations within both the Parramatta and Sydney CBDs. Local and State significant archaeological remains are likely to be present and demolition and ground excavation work may result in impacts to these remains. There is also the potential for temporary indirect impacts to local, State and National heritage items, including changes to views and settings during construction.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	There is potential for direct impacts to local and State heritage items during construction of stations and the proposed services facility. Impacts to State Heritage items would be avoided or minimised. Impacts would be associated with the demolition of existing structures, where required, and construction of new infrastructure. Significant archaeological remains are not expected at station locations and therefore impacts are unlikely. There is the potential for moderate indirect visual impacts where heritage items may be located directly adjacent to construction sites.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	There is potential for construction activities to impact both local and State heritage items within urban renewal precincts, particularly at Sydney Olympic Park and The Bays. While direct impacts to State Heritage Register listed items would be avoided where possible, indirect impacts are likely due to changed views and settings during construction. Impacts to significant archaeological resources may occur at The Bays Precinct during demolition and excavation works, however impacts are not expected at other locations.
Industrial and urban services • Clyde • Silverwater	Construction within the industrial and urban services settings has the potential to impact on local heritage items, however these are expected to be minor due to the limited number of listed items in the area. Significant archaeological remains have not been predicted at these locations and therefore impacts are not expected.

8.6.6 Performance outcomes

Identified performance outcomes in relation to non-Aboriginal heritage for operation and construction of the Concept are provided in Table 8-18.

Table 8-18: Non-Aboriginal heritage performance outcomes

Operational performance outcomes	Construction performance outcomes
Design is sympathetic to retained and adjacent heritage items Appropriately qualified and suitably experienced heritage architect and relevant stakeholders are consulted during design The design of stations include non-Aboriginal heritage interpretation.	Direct impacts on World Heritage and National Heritage List items are avoided Impacts on State Heritage Register items are avoided or minimised so that the overall heritage value of the item is maintained Impacts to non-Aboriginal heritage items and archaeology are avoided or minimised where feasible and reasonable Accidental impacts to heritage items are avoided.

8.6.7 Matters to be addressed in staged applications

Non-Aboriginal heritage impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Non-Aboriginal heritage assessments will include, as relevant to the stage:

- Identification of known heritage items or areas of archaeological potential that may be directly or indirectly impacted
- Identification of any requirements for further analysis, such as archival recording or sub-surface investigation
- Assessment of the likely level of impact and/or risk to heritage items and archaeological remains
- Identification of measures required to avoid or mitigate potential impacts to heritage items including significant archaeological remains
- Consultation with the Sydney Metro Heritage Working Group, NSW Heritage Council and local Councils.

An assessment of non-Aboriginal heritage impacts for Stage 1 is provided in Chapter 12 (Non-Aboriginal heritage – Stage 1).

8.7 Aboriginal heritage

8.7.1 Legislative and policy context

The main statutory protection of Aboriginal heritage is provided by the *National Parks and Wildlife Act 1974*. The following guidelines are relevant to the assessment of Aboriginal heritage:

- The Department of Planning, Industry and Environment's Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales 2010 (Department of Environment, Climate Change and Water, 2010a) outlines the requirements for archaeological investigations of Aboriginal objects in NSW
- The Department of Planning, Industry and Environment's Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (Office of Environment and Heritage, 2011) provides a process for the investigation and assessment of Aboriginal cultural heritage including identifying values of Aboriginal cultural heritage, and the assessment of potential harm of a proposed activity on Aboriginal objects and declared Aboriginal places
- The Department of Planning, Industry and Environment's Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (Department of Environment, Climate Change and Water, 2010b) outlines the requirements for proponents to consult with Aboriginal stakeholders during heritage assessment and/or applications for Aboriginal Heritage Impact Permit
- The Burra Charter 2013 (Australia ICOMOS, 2013) provides guidance for the conservation and management of places of cultural significance (cultural heritage places). The Charter sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians. The Burra Charter provides several significance criteria that attempt to define why a site is important. Such assessment recognises that sites may be important for different reasons to different people, and even at different times.

8.7.2 Assessment approach

The assessment involved:

- Identifying known Aboriginal heritage sites and areas of potential archaeological sensitivity within the Concept corridor that could be encountered during construction and operation of the Concept
- Considering the potential impacts on Aboriginal sites recorded on the Aboriginal Heritage Information Management System (AHIMS) and listed Aboriginal places of significance on the relevant local environment plans
- Consultation with Sydney Metro Heritage Working Group to discuss the approach to the Aboriginal heritage assessment
- Identifying performance outcomes
- Identifying the proposed scope of Aboriginal heritage assessments for future stages.

8.7.3 Existing environment

Aboriginal ethnohistory

Prior to the appropriation of their land by Europeans, Aboriginal people lived in small family or clan groups that were associated with particular territories or places. It seems that territorial boundaries were fairly fluid, although details are not known. The language group spoken across Sydney was known as Darug (Dharruk – alternate spelling). This term was used for the first time in 1900, as before the 1800s language groups or dialects were not discussed in the literature (Matthews and Everitt,1900) (Attenbrow, 2010). The Darug language group is thought to have been spoken in the area south of Port Jackson, north of Botany Bay, and west to Parramatta. Clan groups identified near the Concept corridor included the Cadigal, Wangal and Barramatagal (Attenbrow, 2010).

Aboriginal people were a highly mobile society utilising different landscapes and resource strategies across the Concept corridor. Land use often included complex land management strategies including the use of fire-stick farming to facilitate effective hunting and promote fresh growth across the environment. In addition, different resources may have been available seasonally, necessitating movement or trade across the landscape (Attenbrow, 2010).

The limited historical references to Aboriginal people identify a focus of longer term land use on valley bottoms and along existing shorelines (Attenbrow, 2010). The Parramatta River and its surrounds in particular would have provided access to a number of marine resources including fish, eel and shellfish species. Other aspects of the landscape would have formed travel routes with current roads such as Parramatta Road reportedly following traditional Aboriginal walking tracks.

With the establishment of European settlement at Sydney Cove, Aboriginal people were rapidly alienated from land and resources. A smallpox epidemic which broke out in 1789 had a devastating effect on the Aboriginal population of Sydney which compounded the dislocation and destruction of the lifeways of Aboriginal people.

Archaeological context

The existing archaeological record comprises a variety of features reflecting the diversity of land uses used by Aboriginal people. Some site types such as scarred trees are particularly susceptible to destruction by historic land use, while other sites types are able to withstand degradation and decay. As a result, the most common type of Aboriginal objects remaining in the archaeological record are stone artefacts, followed by bone and shell.

A search of AHIMS sites within and near the Concept corridor identifies a prevalence of sites along foreshore contexts as well as within the Parramatta CBD.

Sites within the Parramatta and Sydney CBD are largely comprised of subsurface artefact sites and areas of archaeological potential (see further discussion below). Additionally, the early colonisation of Parramatta suggests the potential for Aboriginal objects to be associated with European contact.

Sites along the foreshore environments are dominated by shell midden sites reflecting the use of marine resources along the Parramatta River. Areas of pigment art and grinding grooves are also focused around foreshore areas likely associated with less developed portions of the Concept corridor as well as locations of exposed sandstone outcrops and shelters.

Archaeologically sensitive environmental features

Most of the Concept corridor is underlain by a shale geology which is the predominant geological feature of the Cumberland Plain, an area that approximately extends from inner western Sydney to the Nepean River. This landscape is characterised by generally gently undulating terrain incised by freshwater tributaries of the Parramatta River, the Nepean River and the Hawkesbury River. Shale geology is often associated with overlying residual soils which are susceptible to a high degree of impact from construction activities, such as residential and commercial development (Herbert, 1983). Areas within these landscape features which have been subject to previous development are likely to have low archaeological sensitivity.

The foreshore areas of Sydney Harbour and the Parramatta River by comparison are generally characterised by Quaternary period sediments and outcropping Triassic period Hawkesbury Sandstone (Clark and Jones, 1991). Hawkesbury Sandstone outcrops in foreshore areas are associated with elevated and steep terrain bordering the foreshore contexts. Quaternary period sediments underlie tidally influenced flats and the margins of numerous tributaries that flow into Sydney Harbour and Parramatta River. Foreshore areas exhibit archaeological sensitivity associated with presence of Hawkesbury Sandstone outcrops and the presence subsistence resources such shellfish within the intertidal zones.

Foreshore areas within the Concept corridor include Clyde, The Bays and Sydney CBD. In several cases the pre-European foreshore in these areas have been modified through reclamation programs. In these areas, it is considered that archaeologically sensitive foreshore contexts may exist below layers of reclamation fills.

Portions of the Parramatta CBD are underlain by a significant geological feature, the Parramatta Sand Body. The Parramatta Sand Body is an important archaeological resource with evidence of Aboriginal activities dating from the Holocene and Pleistocene epochs. The sand body is also relatively deep, increasing the possibility of portions of the sand body surviving beneath phases of historical development.

The major watercourse associated with the Concept corridor is the Parramatta River. The Parramatta River extends eastwards from North Parramatta to the confluence with Lane Cove River between Balmain and Greenwich. In the Sydney CBD, a major watercourse known as the Tank Stream flowed north from a swampy area between current day Market and Park Street to Sydney Harbour. A number of first and second order watercourses flow into Parramatta River and Sydney Harbour within the Concept corridor. Due to the tidally influenced nature of Parramatta River and Sydney Harbour, the mouth of each watercourse generally consists of tidally influenced flats that were likely to have been extensive areas of mangrove. Many of these watercourses have been modified and the tidal flats in-filled as areas of reclamation. Areas within 200 metres of watercourses are considered to contain archaeological sensitivity (Department of Environment Climate Change and Water, 2010a).

Known Aboriginal sites and areas of archaeological sensitivity

There are 27 recorded AHIMS sites within the Concept corridor. This includes 15 sites within the Parramatta CBD, two within Pyrmont and ten within the Sydney CBD investigation area. Most of the sites within the corridor are areas of potential archaeological deposit and subsurface artefact sites. Five of these sites have been classified as destroyed or 'not a site'. There are around 40 additional AHIMS sites recorded within 500 metres of the Concept.

Several additional sites within the Parramatta CBD are located near the Concept corridor. Further investigation of these sites during future assessment stages may identify that their site extent continues into land covered by the Concept corridor.

Several environmental features have been identified as containing Aboriginal archaeological sensitivity including areas within 200 metres of water sources, foreshore areas, and areas containing outcropping Hawkesbury Sandstone. Portions of the Concept corridor within Clyde, Lilyfield, The Bays and the Sydney CBD contain one or more of these landscape features.

No areas of Aboriginal heritage significance as listed on the relevant local environmental plans were identified within the Concept corridor.

Cultural heritage significance

Areas within the Concept corridor may also contain cultural significance associated with the spiritual, traditional, historic or contemporary associations and attachments the place or area has for Aboriginal people.

Aboriginal cultural knowledge was traditionally passed on through oral traditions from generation to generation. Within Aboriginal communities there was a time of dislocation and upheaval associated with the arrival of colonial settlers. This widespread disruption resulted in much of the detailed knowledge and understanding of many of the elements of the cultural landscape being lost from the Aboriginal community. Nonetheless, many Aboriginal people maintain a strong connection to the land of their ancestors and collectively possess a wealth of knowledge passed down through the generations.

Consultation undertaken with Aboriginal stakeholders during future staged assessments may identify cultural heritage values or areas of cultural heritage significance within or in the immediate vicinity of the Concept corridor.

Predictive model

Based on the existing environment, archaeological context and known features, the following predictive statements have been developed:

- The survivability of Aboriginal objects would be largely dependent on the extent and nature of subsequent phases of historical construction activities
- Sub-surface artefact sites tend to consist of lower density isolated occurrences in areas away from major watercourses such as freshwater, marine and estuarine areas
- More frequent and higher concentrations of sub-surface artefact sites are likely to occur near major watercourses such as freshwater, marine and estuarine areas
- Shell midden sites are more likely to be identified in close proximity to marine and estuarine areas. Due to land reclamation in many areas, former marine and estuarine areas may be set-back from contemporary shoreline areas
- Sandstone shelters suitable for archaeological deposit and outcrops suitable for engravings may be preserved in ridge crest and ridge slope landform contexts
- Surviving portions of deeper soil profiles, such as the Parramatta Sand Body, may provide stratified evidence of occupation.

8.7.4 Potential operational benefits and impacts

Impacts to Aboriginal sites or areas of Aboriginal archaeological potential during operation of the Concept are not expected.

The operation and use of Sydney Metro West provides opportunity to acknowledge and incorporate Aboriginal heritage values through heritage interpretation. The key aim of heritage interpretation would be to connect the contemporary experience of the commuters and staff with the Aboriginal cultural and heritage values associated with the Concept corridor. Heritage interpretation elements may include:

- Engaging Aboriginal artists to develop designs/artworks that could be incorporated into the built form of the stations
- Incorporating local Aboriginal language words into naming conventions
- Incorporating native plant species into landscaping elements
- Providing interpretive information regarding the Aboriginal history of the site(s) developed in consultation with Aboriginal stakeholders.

Heritage interpretation would aim to partially offset any potential impact to Aboriginal heritage that may occur as part of construction. Further detail in relation to Aboriginal cultural design is provided in Chapter 7 (Placemaking).

8.7.5 Potential construction impacts

Development of Sydney Metro West has aimed to avoid and minimise interface with known Aboriginal sites and areas of high Aboriginal archaeological potential. Potential impacts to Aboriginal heritage items and archaeology would be appropriately managed in accordance with the performance outcomes in Section 8.7.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The Concept would require substantial earthworks, primarily related to demolition and excavation within proposed station and services facilities sites. Likely impacts during construction include:

- Potential for direct impact to registered AHIMS sites and sensitive landforms with the potential to contain Aboriginal objects within the surface construction sites
- Potential impacts to AHIMS listed sites related to vibration and settlement as a result of tunnelling across the alignment, although given average tunnel depth is greater than 50 metres, the risk is expected to be very low
- Potential impacts to areas of cultural significance
- Cumulative impacts on the archaeological record through the continued reduction of intact archaeological contexts which may contain Aboriginal objects.

There is a high likelihood of direct construction impacts to identified AHIMS sites at Parramatta due to the concentration of sites at this location. Interaction with the Parramatta Sand Body is possible, with potential for archaeological deposit(s) with high archaeological significance to be uncovered.

As several AHIMS sites are located in the Sydney CBD investigation area, the Concept may also impact identified AHIMS sites within the Sydney CBD.

Intact landforms or significant geological features at other sites may also be associated with the presence of Aboriginal objects. In particular, there is potential for impacts to areas of archaeological sensitivity associated with foreshore areas within the Concept. Detailed investigations and consultation with Aboriginal stakeholders would be carried out as part of the assessment of each stage.

Following consultation with Aboriginal stakeholders, impacts to areas of cultural heritage significance or cultural heritage values may also be identified.

8.7.6 Performance outcomes

Identified performance outcomes in relation to Aboriginal heritage for operation and construction of the Concept are provided in Table 8-19.

Table 8-19: Aboriginal heritage performance outcomes

Operational performance outcomes	Construction performance outcomes
The design of stations include Aboriginal heritage interpretation in consultation with registered Aboriginal parties.	Impacts on areas of moderate or higher archaeological potential and significance are avoided or minimised, where feasible and reasonable Accidental impacts to heritage items are avoided.

8.7.7 Matters to be addressed in staged application

Aboriginal heritage impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Aboriginal heritage assessments will include, as relevant to the stage:

- Identification of the potential to disturb Aboriginal heritage (sites, objects, remains, values, features or places)
- Determination, in consultation with relevant stakeholders, of the significance of the heritage resources
- Determination of the extent and significance of impacts to those resources
- Identification of the potential for in situ conservation of items and/or areas and the need for further archaeological testing and/or excavations
- Identification of appropriate measures to avoid, minimise and/or mitigate potential impacts
- Consultation with Sydney Metro Heritage Working Group, local Councils and registered Aboriginal parties.

An assessment of Aboriginal heritage impacts for Stage 1 is provided in Chapter 13 (Aboriginal heritage – Stage 1).

8.8 Property and land use

8.8.1 Legislative and policy context

Strategic planning context

Strategic direction for land use planning across the Concept corridor is provided in several plans and strategies. Further discussion of planning strategies relevant to the Concept is provided in Chapter 2 (Strategic need and justification) and Chapter 7 (Placemaking). An overview is provided below.

The Greater Sydney Region Plan: A Metropolis of Three Cities (Greater Sydney Commission, 2018a) sets the 40-year vision and 20-year implementation plan for Sydney to develop as three unique and connected cities. Of these cities, the Concept corridor is located within the Central River City and Eastern Harbour City. The Central City District Plan (Greater Sydney Commission, 2018b) and the Eastern City District Plan (Greater Sydney Commission, 2018c) provide direction for the growth of the Central River City and Eastern Harbour City respectively.

Between Westmead and Sydney Olympic Park, the Concept is located within the Greater Parramatta and the Olympic Peninsula economic corridor. The NSW Department of Planning, Industry and Environment's Greater Parramatta Interim Land Use and Infrastructure Implementation Plan (Department of Planning and Environment, 2017) sets out the future envisaged growth in the Greater Parramatta and the Olympic Peninsula economic corridor.

Land to the east of the existing North Strathfield Station and around Burwood North is also included in the Parramatta Road Corridor Urban Transformation Strategy (2016). This strategy identifies the Parramatta Road urban renewal corridor as a focus for increased housing, economic activity and social infrastructure over a thirty year period.

Local planning context

Local Government Areas within the Concept have local plans and strategies relevant to the local conditions and growth strategies. Details of the plans and strategies relevant to each site are provided in Chapter 7 (Placemaking). The plans and strategies relevant to property and land use include:

- Cumberland 2030: Our Local Strategic Planning Statement (Cumberland City Council, 2019)
- City of Parramatta Local Strategic Planning Statement (City of Parramatta Council, 2020)
- Sydney Olympic Park Master Plan 2030 (Sydney Olympic Park Authority, 2018)
- Canada Bay Local Strategic Planning Statement (City of Canada Bay Council, 2020)
- Draft Burwood 2030 Local Strategic Planning Statement (Burwood Council, 2019)
- Our Place Inner West: Inner West Council Local Strategic Planning Statement (Inner West Council, 2019)
- City Plan 2036 Draft Local Strategic Planning Statement (City of Sydney, 2019).

8.8.2 Assessment approach

This assessment involved:

- Describing the key strategic land use context of the Concept, including identification of the strategic role of each centre based on a review of aerial photography, strategic policy and land use zones specified by applicable local environmental plans
- Reviewing strategic land use policy documentation relevant to the Concept, in order to identify planned future land use priorities and developments
- Identifying potential impacts of the Concept on strategic land use roles at centres along the Concept corridor
- Consultation with the Department of Planning, Industry and Environment and local Councils in regard to local and regional plans and proposed developments
- Identifying performance outcomes
- Identifying the proposed scope of property and land use assessments for future stages.

8.8.3 Existing environment

The Concept traverses through a highly urbanised area connecting a range of existing and future centres with a diverse range of land uses along the Concept corridor. The land use context of the different settings within the Concept corridor are described in Table 8-20, including key land uses.

Table 8-20: Land use context within the Concept

Urban setting	Land use context
CBDs • Parramatta • Sydney	The Parramatta and Sydney CBDs include highly developed commercial cores, with a wide range of commercial, retail, health, government administration and community based uses, and high density residential developments located towards the edge of the CBD areas. A number of key administrative uses are located in or around the Parramatta and Sydney CBDs, including educational facilities, historic structures, law courts, public gathering places and places of worship. Significant areas of open space, such as Parramatta Park, the Botanical Gardens, the Domain and Hyde Park are also located within or near the CBD areas. The Sydney CBD is also the hub of the Sydney's existing public transport network which services the city centre, including the suburban rail network and the under-construction Sydney Metro City & Southwest, as well as light rail, bus and ferry networks.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	The suburban areas feature low scale commercial uses, shops, business premises and restaurants, surrounded by low and medium density residential uses. North Strathfield has an existing railway station with small scale retail and office spaces directly opposite the entrance of the existing North Strathfield Station. There are a number of educational facilities nearby, with low and medium density residential beyond these facilities. The Burwood North locality is located along the Parramatta Road corridor between Burwood and Concord. The Parramatta Road corridor contains a wide range of commercial and urban services facilities, including business premises, shops, and pubs/hotels. Moving away from the Parramatta Road corridor to the north and south, the land use changes to residential, with a mix of densities. Surrounding residential areas are generally of low to medium density, however newer residential development has started to introduce higher densities, especially closer to Parramatta Road. There are also several educational, medical and recreational facilities in the surrounding neighbourhood. Five Dock comprises a range of retail and commercial uses, with some local education and health services, apartments and community facilities. The middle of the town centre is located around Fred Kelly Place on the western side of Great North Road, and a small area of open space located opposite on the eastern side of Great North Road, adjacent to the Post Office. To the west and east of Great North Road are low to medium density residential areas, including a mix of low rise (generally up to two storeys) residential flat buildings, medium density dwelling types and detached dwelling houses. The area between Five Dock and The Bays consists mostly of low density residential neighbourhoods with some retail and commercial uses in Lilyfield and Rozelle. There are also several educational, medical and recreational facilities within and surrounding these neighbourhoods.

Urban setting	Land use context
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The urban renewal precincts generally contain a mix of uses, including specialised health, education and recreation areas. The Westmead health and education precinct includes over 400,000 square metres of specialised health related developments, which includes four hospitals, three medical research institutes and two university campuses (Health NSW, 2019). Significant education and health facilities in this precinct include Western Sydney University's Westmead campus, Westmead Hospital and The Children's Hospital at Westmead. Westmead has an existing railway station which is surrounded by a range of different business uses including commercial, medical and retail services. South of the railway station is generally low and medium density residential. Sydney Olympic Park comprises a mix of sports and entertainment facilities, with a growing mixed use commercial and residential core immediately to the south and east of the existing Olympic Park Station. Major sporting and entertainment facilities at Sydney Olympic Park include the ANZ Stadium, the Sydney Olympic Park Tennis and Hockey centres, the Sydney Olympic Park Aquatic and Athletic Centres, and the Showgrounds. The precinct also benefits from high quality public open space, located to the north and east, including Brickpit Ring Walk, Wentworth Common and Bicentennial Park. The Bays Precinct currently features a mix of maritime and port related employment uses around White Bay and Glebe Island ports. Key facilities within the White Bay and Glebe Island ports include the White Bay Cruise Terminal and the Glebe Island Silos, which are currently operated partly by Cement Australia and partly by Sugar Australia, as well as the disused White Bay Power Station. White Bay and Glebe Island also contain a number of multi-user berths for general port activities, including the import of bulk materials. North of White Bay are the largely low and medium density residential suburbs of Rozelle and Balmain, however a small industrial precinct is located immediately opposite the port along Robert Street. To the east are Jones and Johnstons Bays, and then the high density residential suburb of Pyrmont. To the south of Glebe Island is the City West Link and Anzac Bridge, and beyond is a maritime precinct along the northern foreshore of Rozelle Bay. To the west are Victoria Road, and the future Westconnex (Stage 3) Rozelle Interchange.
Industrial and urban services areas • Clyde • Silverwater	The industrial centres of Clyde and Silverwater are dominated by a range of industrial and urban services. Clyde is an industrial precinct dominated by major transport infrastructure including the Western Motorway, Parramatta Road, James Ruse Drive, the T1 Western Line, which forms the southern boundary of the precinct, and the now closed T6 Carlingford Line, which forms the western boundary of the precinct. To the north and east is the Rosehill industrial estate, which contains the Viva Energy Parramatta and Clyde Terminals and the Rosehill Gardens racecourse. Silverwater contains warehousing, industrial and urban services uses. The residential area of Silverwater is located to the south and south-east with Newington to the east.

8.8.4 Potential operational benefits and impacts

The Concept would support planned growth and improve transport accessibility between Greater Parramatta and the Sydney CBD, providing services which connects residents, workers and visitors. The broader land use benefits of the Concept have been described in Chapter 2 (Strategic need and justification).

In most cases, the permanent operational footprint of the Concept would be located within the construction sites. However, in some instances there may be residual land at the completion of construction that is not required for operational infrastructure. Opportunities may arise in relation to the use of residual land to support the strategic land use objectives for precincts around new metro stations. Future land use adjustments for the concept are detailed in Chapter 7 (Placemaking) however, would be assessed at a later stage. Strategies to assist in the realisation of strategic land use benefits from the Concept would be further developed in consultation with relevant authorities including the Department of Planning, Industry and Environment, the Greater Sydney Commission, and local councils as well as with local communities.

The Concept corridor is not anticipated to impact on any Commonwealth owned land. However, there may be Commonwealth leased land within the footprint of some sites. This is likely to comprise offices and other facilities for Commonwealth Government departments. These facilities are likely to re-establish in another location nearby and the impact would be negligible.

The potential land use opportunities and impacts within each setting have been identified in Table 8-21. Discussion of how the Concept integrates with relevant local strategic plans and strategies is provided in Chapter 7 (Placemaking).

Table 8-21: Potential operational property land use benefits and impacts

Urban setting	Potential land use benefits and impacts
CBDs • Parramatta • Sydney	The proposed metro stations provide opportunities to create high quality integrated station precincts which are well connected with existing rail and bus networks, and integrated with the surrounding built form. Further detail is provided in Chapter 7 (Placemaking). At CBD sites there would be a change from mixed use (commercial / retail) to transport infrastructure, although this change in land use would be negligible when considering the scale of commercial and retail in the surrounding area.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	The proposed metro stations would provide opportunities to create high quality integrated station precincts that result in improved public domain outcomes, while supporting the delivery of a range of new housing and commercial buildings as transit-oriented development. Further detail is provided in Chapter 7 (Placemaking). At suburban station sites there would be a change from mixed use (commercial / retail) and residential areas to transport infrastructure. It is envisaged that development would retain the current low-medium density residential character of the suburban settings, while enhancing the character of the town centres. The services facility between Five Dock and The Bays may have a minor impact on surrounding land uses by changing a small area of the land use to transport infrastructure. The design of the facility would consider surrounding land use.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The proposed metro stations and improved accessibility would support the continued growth and development of these areas where revitalisation is underway or planned. There is also opportunity for the Concept to support increased housing supply through transit-oriented development at each location. Further detail is provided in Chapter 7 (Placemaking). At urban renewal settings there would be a change from mixed use (commercial/ retail), residential and/or industrial areas to transport infrastructure.
Industrial and urban services areas • Clyde • Silverwater	There would be minimal change to land use within the industrial and urban services areas as services facilities would be within existing industrial uses. Due to the nature of these facilities there are limited land use integration opportunities. Sydney Metro would liaise with relevant Councils to identify potential opportunities to integrate the facilities with any strategic plans for the area.

8.8.5 Potential construction impacts

Potential property and land use impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.8.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

During construction, the main land use and property impacts would relate to property acquisition. Private properties directly affected by the Concept would be acquired. All property acquisition would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms announced by the NSW Government which can be viewed online at https://www.propertyacquisition.nsw.gov.au/property-acquisition-process. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process.

The social impacts and business impacts of relocation are discussed in Section 8.11 (Social impacts - Concept) and Section 8.10 (Business impacts - Concept) respectively.

Where a property is over the future tunnel then it is generally only necessary to acquire the underground envelope containing the tunnel and any associated structures. This is referred to as substratum acquisition and is undertaken in accordance with the *Transport Administration Act 1988*. The steps for substratum acquisition are also managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, however compensation is generally not payable except in specific circumstances.

Construction of the Concept would result in a land use change from its current land use (such as residential, commercial or industrial) to a construction site. Impacts would be minimised where possible by developing and planning construction sites to limit the amount of land required for construction outside of the permanent infrastructure footprint. This would also minimise the amount of residual land at the completion of construction.

Potential amenity impacts to surrounding land uses would be appropriately managed through the performance outcomes identified in Section 8.4 (Transport and traffic - Concept), Section 8.5 (Noise and vibration - Concept), 8.9 (Landscape character and visual amenity - Concept), and Section 8.17 (Air quality - Concept). The social and business impacts as a result of these amenity effects are assessed in Section 8.11 (Social impacts - Concept) and Section 8.10 (Business impacts - Concept).

8.8.6 Performance outcomes

Identified performance outcomes in relation to property and land use for operation and construction of the Concept are provided in Table 8-22.

Table 8-22: Property and land use performance outcomes

Operational performance outcomes	Construction performance outcomes
• Future land use opportunities within metro station precincts are developed in cooperation with (as relevant) the Department of Planning, Industry and Environment, the Greater Sydney Commission, and local councils • Transport infrastructure is effectively integrated with land use planning.	• Acquisition of privately owned land is minimised by limiting the extent of construction sites and using existing Government owned land where possible • Residual land at the completion of construction is minimised • The need for partial acquisitions is minimised.

8.8.7 Matters to be addressed in staged applications

Property and land use impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Property and land use assessments will include, as relevant to the stage:

- Description of land use and planning context for each site along the corridor relevant to the stage
- Identification of planning controls analysis for each site along the corridor relevant to the stage
- Identification of the potential acquisition, including processes and procedures for acquisition
- Identification of potential land use impacts and opportunities
- Identification of mitigation measures to address the property and land use impacts
- Further consultation with the Department of Planning, Industry and Environment and local Councils.

A property and land use assessment for Stage 1 is provided in Chapter 14 (Property and land use – Stage 1).

8.9 Landscape character and visual amenity

8.9.1 Legislative and policy context

The following guidelines, policies and standards are applicable to landscape character and visual impact assessment:

- Guidance note EIA-N04 Guidelines for Landscape Character and Visual Impact Assessment, (Transport for NSW, 2018)
- Guidance for Landscape and Visual Impact Assessment (Landscape Institute and Institute of Environmental Management & Assessment, 2013)
- Guidance Note for Landscape and Visual Assessment (Australian Institute of Landscape Architects, 2018).

Chapter 7 (Placemaking) provides detail on the Design Quality Framework, design principles and objectives, and design guidelines that are applicable to Sydney Metro West.

8.9.2 Assessment approach

The assessment involved:

- Describing the existing landscape character and visual sensitivity around the Concept and the potential receivers which could be impacted
- Categorising the different levels of landscape and visual sensitivity that could apply across the corridor
- Assessing the types of potential landscape character and visual amenity impacts of constructing and operating the Concept, by describing the types of changes that may be experienced in typical landscapes and views along the Concept corridor, and their compatibility with the existing setting
- Categorising the potential impact of the Concept as either likely to cause an adverse, negligible or beneficial effect on the landscape character and visual amenity
- Consultation with local Councils in regard to urban design considerations
- Identifying performance outcomes
- Identifying the proposed scope of landscape character and visual amenity assessments for future stages.

Landscape character impact assessment

Landscape sensitivity refers to the value placed on a landscape element or place and the level of service it provides to the community. For the Concept, the degree of sensitivity of each landscape element to change was identified as either neighbourhood, local, regional, State or national and described in Table 8-23.

Table 8-23: Landscape and visual sensitivity levels

Sensitivity	Description
National	• Landscape feature protected under national legislation or international policy • Heavily experienced view to a national icon.
State	• Landscape feature that is heavily used and/or is iconic to the State • Heavily experienced view to a feature or landscape that is iconic to the State.
Regional	• Landscape feature that is heavily used and valued by residents of a major portion of a city or a non-metropolitan region • Heavily experienced view to a feature or landscape that is iconic to a major portion of a city or a non-metropolitan region, or an important view from an area of regional open space.
Local	• Landscape feature valued and experienced by concentrations of residents and/or local recreational users • High quality view experienced by concentrations of residents and/or local recreational users, local commercial areas and/or large numbers of road or rail users.
Neighbourhood	• Landscape feature valued and appreciated primarily by a small number of residents (e.g. street trees in a local street) • Views where visual amenity may be appreciated by a small number of residents or local road users but is not particularly valued by the wider community.

Landscape and visual modification levels

To assess the changes to the landscape, proposed changes are assigned a magnitude of change level. The magnitude of change can result in adverse or beneficial effects and is defined for the Concept in Table 8-24.

Table 8-24: Landscape and visual magnitude of change levels

Landscape magnitude of change	Description
Reduction	• Changes could reduce the quality or quantity of valued landscape features. This may include changes to vegetation cover, the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm • Changes could reduce the quality or availability of views. The Concept would contrast with the surrounding landscape.
No-perceived change	• Either the view is unchanged or if it is, the changes would be generally unlikely to be perceived by viewers. The Concept is not likely to contrast with the surrounding landscape • Either the landscape quality is unchanged or if it is, it is largely mitigated by proposed public realm improvements. Would not alter or not noticeably alter the vegetation cover, the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm.
Improvement	• Changes could improve the quality or quantity of valued landscape features. This may include changes to vegetation cover, the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm • Changes could improve the quality or availability of views.

Landscape and visual impact magnitude

To assess the potential landscape character impact of the Concept, the sensitivity of the landscape and the likely landscape magnitude of change are combined to form likely impact levels (see Table 8-25).

Table 8-25: Landscape and visual impact levels

Modification	Sensitivity				
	National	State	Regional	Local	Neighbourhood
Reduction	Higher adverse effect		Adverse effect		
No change	Negligible				
Improvement	Higher beneficial effect		Beneficial effect		

8.9.3 Existing environment

The landform of the Concept corridor is generally undulating due to being part of the historical large river valley of Parramatta River, and the creeks, coves and bays of Sydney Harbour including Iron Cove and White Bay.

Within the Concept corridor there are a number of different receiver environments, including suburban, urban and industrial. These are described in the context of the existing landscape character and visual environment in Table 8-26.

Table 8-26: Existing landscape character and visual environment

Urban setting	Existing landscape character and visual environment
CBDs • Parramatta • Sydney	The CBD areas form regional focal points for commerce, trade, employment, retail and recreation. They generally consist of medium to high density commercial, retail and residential, with a mix of contemporary urban and historic character built form. Heritage features reflect colonial settlement and historical development; and are important visual features. The CBD areas also contain recreational and open space features which are often of national significance, such as Parramatta Park, Hyde Park and the Royal Botanic Gardens. Landscape elements and views within the CBDs range from local to national level sensitivity.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Suburban areas are characterised by a mix of low to medium rise retail, commercial, light industrial and residential uses, along with recreational and open space uses. These uses are generally the focal point of the local neighbourhood. Views from existing heritage structures and street planting/landscaping may be considered sensitive, along with views from nearby residential receivers. Landscape elements and views within suburban areas generally range from neighbourhood to local sensitivity.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Urban renewal precincts are areas of local redevelopment and/or transformation. They are generally mixed use precincts which are in the process of going through change to be redeveloped into new commercial, residential and recreational land uses. Urban renewal precincts include Westmead, Sydney Olympic Park and The Bays Precinct. Landscape elements and views within urban renewal precincts range from regional to local sensitivity.
Industrial and urban services areas • Clyde • Silverwater	Industrial areas are centres of local industry and employment. They include a mix of general and heavy industrial uses, with industrial built form often including large warehouses, heavy vehicle access roads and loading docks. Clyde is located near Duck Creek and A'Becketts Creek which contain mature stands of native vegetation of visual sensitivity to local workers and passing road users. Land uses with high visual impact include the Sydney Speedway at Clyde and the Sydney Helicopters helipad, both located on Government owned land. Landscape elements and views within industrial areas generally range from neighbourhood to local sensitivity.

8.9.5 Potential operational benefits and impacts

The introduction of new metro stations would provide improved local visual amenity and landscape character through:

- High quality architecture and urban design that reflects the Sydney Metro Design Objectives and the place and design principles
- Upgrades to public realm areas and streetscapes providing and improved pedestrian environment and accessibility
- Integration of the station with future development and reflecting the existing or desired future scale and character of local areas
- Tree plantings and landscaping to ensure no net loss of tree numbers and tree canopy.

The potential landscape character and visual amenity benefits and impacts associated with the operation of the Concept are outlined in Table 8-27.

Table 8-27: Operational landscape character and visual benefits and impacts

Urban setting	Potential operational benefits and impacts	Impact
CBDs • Parramatta • Sydney	The architecture of the new metro station entries would have a civic quality that provides a visual feature improving sense of place.	Beneficial landscape impacts
	Upgrades to adjacent public realm areas and streetscapes would improve pedestrian accessibility and amenity.	Beneficial landscape impacts
	The station entry architecture would be integrated into future development and would have a scale and character which would be in keeping with the surrounding built form.	Beneficial visual impacts
	Refreshed and upgraded public realm areas and streetscapes would improve the amenity of short range views from adjacent heavily used city streets and buildings.	Beneficial visual impacts
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Local amenity would be restored and improved by the public realm design of the new Metro station entries, including improvements to adjacent streetscapes and access to open space where possible	Beneficial landscape impacts
	The architecture of the new stations would provide a sense of place and precinct identity. Reconfigured street layouts and intersection upgrades if required, could improve local precinct accessibility, and provide improved pedestrian connectivity to stations and interchange facilities which would enhance permeability and accessibility for public transport customers.	Beneficial landscape impacts
	The station entry architecture would have a scale and character which would be in keeping with the surrounding built form and have a civic quality that provides a local feature within views.	Beneficial visual impacts
	Public realm areas would be refreshed and upgraded, including new trees, improving the amenity of short-range views from adjacent streets and residential areas.	Beneficial visual impacts
	The built form of the services facility would be architecturally designed considering its setting. The services facility would have a function driven scale and include service vehicle areas.	Adverse visual impacts
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The architecture of the new metro station entries would have a civic quality that provides a visual feature and improves the sense of place within the emerging future urban form of urban renewal precincts.	Beneficial landscape impacts
	New public realm areas would be created, increasing public accessibility, amenity and passive recreation opportunities. At Sydney Olympic Park these areas would build upon the predominantly leafy character of the avenues.	Beneficial landscape impacts
	The station entry architecture would consider future development and would have a scale and character which would be in keeping with the future character of surrounding built form.	Beneficial visual impacts
	Built form would be designed to respond to the setting of any nearby heritage places and important streetscapes and plaza areas which have higher visual sensitivity.	Beneficial visual impacts
Industrial and urban services areas • Clyde • Silverwater	Views of the stabling and maintenance facility from residential and commercial areas, including the visibility of large structures such as the dive structure, retaining walls and bridge structures would be screened where practicable. Opportunities for the incorporation of vegetation into the services facility and stabling and maintenance facility for screening and amenity would be considered.	Neutral landscape and visual impacts

8.9.4 Potential construction impacts

Potential landscape character and visual amenity impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.9.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The potential landscape character and visual amenity impacts associated with the construction of the Concept are outlined in Table 8-28.

Table 8-28: Potential construction landscape character and visual amenity impacts

Urban setting	Potential construction impacts	Magnitude
CBDs • Parramatta • Sydney	Removal of street trees reducing the amenity of streetscapes.	Adverse landscape impacts
	Temporary alterations to footpaths and diversion of inter-block pedestrian connections reducing local accessibility or legibility.	Adverse landscape impacts
	Potential impacts on the higher sensitivity public domain and parks within the Sydney CBD which are typically used intensively by the community during events, and the high density population share access to these recreational resources.	Higher adverse landscape impacts
	Temporary introduction of construction works and temporary site structures into a dense commercial precinct.	Adverse visual impacts
	Potential impact on the visual setting of heritage buildings.	Adverse visual impacts
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Removal of vegetation within the proposed construction site (if present) and on adjacent streets if required, reducing the temporary amenity of streetscapes.	Adverse landscape impacts
	Temporary alterations to footpaths and street reconfigurations reducing local accessibility or legibility.	Adverse landscape impacts
	Temporarily altered pedestrian movements and precinct arrangements during construction near existing stations, particularly North Strathfield Station which could reduce wayfinding and legibility.	Adverse landscape impacts
	Potentially direct impacts on recreational areas and parks if construction sites are located nearby.	Adverse landscape impacts
	Temporary introduction of construction works, and temporary site structures to residential, commercial or recreational areas which would contrast in scale and character.	Adverse visual impacts
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Potential impacts on the public domain of Sydney Olympic Park as these spaces are typically used intensively by the community during events.	Higher adverse landscape impacts
	Removal of vegetation within the construction sites and on adjacent streets (where required) reducing the amenity of streetscapes.	Adverse landscape impacts
	Temporary introduction of construction works, and temporary site structures into a dense urban setting with heritage places, residential and commercial uses.	Adverse visual impacts
Industrial and urban services areas • Clyde • Silverwater	Removal of vegetation within the proposed construction site and on adjacent streets reducing the amenity of streetscapes.	Adverse landscape impacts
	Potential visual amenity impacts associated with the construction of the stabling and maintenance facility as seen from surrounding roads, residential and commercial areas.	Adverse visual impact
	Potential changed landscape character as a result of bulk earthworks and the construction of structures such as retaining walls and bridges.	Adverse visual impact

8.9.6 Performance outcomes

Identified performance outcomes in relation to landscape character and visual amenity for operation and construction of the Concept are:

- The design reflects the Sydney Metro Design Objectives and the place and design principles
- The Sydney Metro Design Quality Framework is implemented
- Metro stations contribute positively to the surrounding urban environment and provide a sense of place
- No net loss of tree numbers and tree canopy.

8.9.7 Matters to be addressed in staged applications

Landscape character and visual amenity impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Landscape character and visual amenity assessments will include, as relevant to the stage:

- Description of the existing landscape character and visual sensitivity and the receivers which could be impacted
- Assessment of the landscape character impacts (including all ancillary infrastructure) on:
  - Key sites and buildings
  - Areas of open space and impacts on trees impacts
  - Streetscapes
  - Vegetation within the construction footprints.
- Assessment of the visual amenity impacts (including all ancillary infrastructure) on:
  - Key views and vistas
  - Streetscapes, recreation and open space areas
  - Heritage items including Aboriginal places and environmental heritage
  - The local community.
  - Identification of mitigation measures to address the landscape character and visual amenity impacts
  - Further Consultation with local Councils.

An assessment of landscape character and visual amenity impacts for Stage 1 is provided in Chapter 15 (Landscape character and visual amenity – Stage 1).

8.10 Business impacts

8.10.1 Legislative and policy context

The *Environmental Planning and Assessment Act 1979 establish*es the framework for social and economic impacts to be considered and assessed as part of the environmental planning assessment process.

Business impacts would be assessed using the significance categories and likelihood ratings established in the Australian Transport Assessment and Planning Guidelines (Australian Transport Council, 2016).

8.10.2 Assessment approach

This assessment involved:

- Describing the existing business environment within the Concept corridor
- Identifying the types of business impacts that could occur during construction or operation of the Concept
- Consultation with local Councils, business and industry groups
- Identifying performance outcomes
- Identifying the proposed scope of business impact assessments for future stages.

8.10.3 Existing environment

The existing regional business context across the Concept corridor is described in Table 8-29.

Table 8-29: Business context within the Concept

Urban setting	Business context
CBDs • Parramatta • Sydney CBD	Parramatta CBD is an established business district, recognised as Sydney's second CBD, with a substantial number and range of businesses. Businesses include commercial, retail, government administration, education, entertainment and events and other population serving businesses. The Sydney CBD is Sydney's primary business district, with important commercial, financial, retail and government centres. Businesses range from domestic to large international companies. There are a wide range of businesses in the Sydney CBD including retail, commercial, entertainment and events, education, cafes and restaurants.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Commercial and retail locations of varying size exist throughout the Concept corridor within suburban settings, from local village types to slightly larger suburban town centres. These locations provide easy access to goods and services, with some businesses having developed their own unique identity which reflects the local cultural diversity and needs of the community. North Strathfield is a small but growing suburban centre, which has three distinct business precincts: along Concord Road, along Queen Street and the Bakehouse Quarter and associated businesses along George Street. Businesses range from commercial, retail, education, cafes and restaurants which serve commercial customers and local communities in the suburb and from adjoining localities. Burwood North has a range of established businesses which serve the local population. Many of the businesses are located along main transport corridors such as the Parramatta Road corridor and Burwood Road. Businesses within the area include commercial, retail, educational and health uses. Businesses located within the Parramatta Road corridor are mainly focussed on the auto services industry (including car washes, repairs and maintenance and sales showrooms) but also include retail, commercial and local services. Businesses such as small retail shops and cafes, are generally located along the shopping strip of Burwood Road. Five Dock is an established local centre with a wide range of businesses serving the local population. The local centre also provides a key destination for the local community to connect and engage with others while accessing local goods and services. Businesses within the area include a wide range of retail, restaurants and cafes, commercial services, educational and health services. Between Five Dock and The Bays, there are local retail, commercial and services , mostly centred around Balmain Road/Darling Street in Lilyfield and Victoria Road in Rozelle.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Westmead is a growing town centre located adjacent to the Westmead health and education precinct. Businesses include those serving local populations such as local retail, services and cafes, as well as businesses that service or contribute to the health, education and research activities in the broader area. Sydney Olympic Park is Sydney's premier entertainment, sports and recreation precinct, attracting 10 million visitors a year. Businesses within the area range from commercial, education, short term accommodation, retail, cafes and restaurants. Some of these businesses are reliant on events within the area to attract customers. The Bays is a former industrial precinct adjoining Sydney Harbour. Significant urban renewal is planned for the area over the next 20-30 years, including new retail, commercial and residential areas. Existing businesses operating near The Bays are mainly industrial with heavy presence of automotive related or related to the operation of the White Bay Cruise Terminal. Businesses in the nearby suburbs of Balmain and Rozelle include retail and commercial.
Industrial and urban services areas • Clyde • Silverwater	Clyde is a heavy industrial precinct, as well as home to Rosehill Gardens racecourse. Businesses within Clyde range from commercial, industrial, manufacturing, warehousing and logistics. Silverwater is an industrial and urban services precinct with a large number of businesses specialising in manufacturing, urban services, and other industrial uses.

8.10.4 Potential operational benefits and impacts

The broader economic benefits of Sydney Metro West are detailed in Chapter 2 (Strategic need and justification).

The types of potential benefits and impacts to businesses during the operation of Sydney Metro West include:

- Improved accessibility and connectivity of business precincts around the Concept to the rest of Sydney. The benefits include increasing business access to local and regional labour markets and increasing customer access to businesses
- Increased visual amenity through placemaking initiatives at new metro stations – refer to Chapter 7 (Placemaking)
- Increased urban renewal and development around new metro stations adding to local placemaking – refer to Chapter 7 (Placemaking)
- Increase in passing trade for some existing businesses near new metro stations, depending on the type of business and their location. For example, retail businesses that serve customers such as convenience stores or cafes could experience an increase in trade from pedestrian flows to and from the metro station
- Potential adverse impacts associated with operational noise and vibration although these are likely to be negligible and mitigated through appropriate design of elements such as track form, mechanical and ventilation systems.

Potential local business impacts and benefits for different settings are described in Table 8-30.

Table 8-30: Potential business benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney CBD	New metro stations in the Parramatta and Sydney CBDs would improve connectivity between Sydney's two core business districts further enhancing and reinforcing their regional and national importance. Sydney Metro West would effectively double rail capacity from Parramatta to the Sydney CBD. The Concept would also improve travel time between the Parramatta CBD and Sydney CBD to a target of about 20 minutes. It is expected these two metro stations would support further business investment and growth within the Parramatta and Sydney CBDs by providing greater connections between businesses, labour markets, customers and clients located within and near to the Concept corridor.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Sydney Metro West would increase the reach and use of Sydney's public transport network by providing new stations at Burwood North and Five Dock, which are not serviced by the existing suburban rail network. Locating metro stations in suburban centres would improve access to major employment centres and education facilities within the Concept corridor. At North Strathfield, a metro station would provide additional interchange capability and reduce crowding on existing rail services. This would provide greater access to employment and education opportunities for local workers, customers and communities. It is expected business investment would be attracted to suburban centres serviced by metro because they would become more accessible, improving access to labour markets and customers. As identified in Chapter 2 (Strategic need and justification), public transport accessibility and amenity are critical to supporting employment and supporting economic growth. There are not expected to be operational business impacts from the services facility proposed to be located between Five Dock and The Bays as it would only require periodic access for maintenance purposes.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	New metro stations in urban renewal areas would support opportunities for business investment, along with improving access and connectivity to labour markets, customers and visitors. The metro station at Westmead would contribute to and support the health, education and research precinct by increasing its accessibility for patients, customers and employees supporting the precinct in expanding its role, function and ability to serve the community. A new metro station at Sydney Olympic Park is expected to further enhance the area's role as Sydney's premier entertainment, sports and recreation precinct by providing direct connections from both the Parramatta and Sydney CBDs and other catchments within the Concept corridor. The presence of a metro station would provide more public transport options for members of the public travelling to events utilising supporting businesses and services. A new metro station at The Bays is a vital component of The Bays Precinct Masterplan and would provide access to an area not currently serviced by the existing suburban rail network. Increased accessibility would support revitalisation of the area and encourage further business investment which otherwise may not be realised. It would also improve connectivity to existing commercial centres, such as Parramatta CBD and Sydney CBD, providing greater opportunities for employment and economic growth within the precinct and across the corridor due to increased public transport access for workers and customers to the area.
Industrial and urban services areas • Clyde • Silverwater	A stabling and maintenance facility at Clyde is expected to provide a limited range of positive business impacts. Local retail, cafes and restaurants are expected to benefit most from the presence of the operational workforce. The services facility at Silverwater would have only minor impacts as it would be in keeping with surrounding industrial land uses.

8.10.5 Potential construction impacts

Potential business impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.10.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Some businesses around construction sites could experience an increase in passing trade due to nearby construction workers. Construction impacts are expected to vary depending on a number of factors, including the type of business, its location relative to a construction site and the potential type of business impact. The main types of potential impacts that could affect businesses during the construction phase include:

- Direct impacts to businesses where they are located within the properties being acquired. This process is managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and Sydney Metro assists businesses through this process
- Potential temporary changes to employee and customer access if traffic congestion due to vehicle movements from the construction site leading to increased travel times
- Potential loss of parking near construction areas which could affect access to businesses for both employees and customers
- Potential temporary reduced local amenity (due to noise, vibration dust and visual impacts) which could affect certain types of businesses (e.g. cafés)
- Potential for temporary reduction in passing customers due to changes in access or business visibility.

Potential local business impacts for different settings are described in Table 8-31.

Table 8-31: Potential construction business impacts

Urban setting	Potential construction impacts
CBDs • Parramatta • Sydney CBD	Construction activities at the Parramatta and Sydney CBDs that reduce local amenity (from visual impacts, increased noise or dust levels) could temporarily impact businesses such as cafes and restaurants, which are more susceptible to these impacts. Impacts are expected to be slightly greater in CBD areas compared to other areas due to the comparatively larger number of businesses within Parramatta and Sydney CBDs. However, these areas are diverse and dynamic, with a high capacity to absorb and adapt to construction impacts.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Visual impacts, increased noise levels, dust and construction traffic could temporarily impact certain local businesses. Businesses that are located on busier roads like Parramatta Road and Burwood Road may be less susceptible to amenity impacts due to the existing lower amenity from high traffic volumes compared to quieter local roads. If traffic congestion occurs due to truck movements from the construction sites, or parking losses are significant, this could temporarily affect the attractiveness for customers to visit certain suburban centres to access products and services from local businesses.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Construction activities in or around urban renewal precincts could temporarily impact on local business through amenity related issues (e.g. visual, or increased noise and dust levels) and construction traffic from vehicle movements to and from construction sites. A large number of businesses within these precincts form the main attraction to the area and are expected to be less susceptible to amenity related impacts. This includes businesses associated with the health, education and research activities at Westmead and sporting and entertainment venues in Sydney Olympic Park. Businesses which occupy commercial offices may also be less susceptible to amenity impacts but may be impacted by traffic congestion caused by construction traffic. Businesses within The Bays Precinct are less likely to experience amenity related impacts owing to the existing industrial nature of the area. However, the area is highly car dependent and businesses are relatively more sensitive to temporary disruptions or congestion on the local road network.
Industrial and urban services areas • Clyde • Silverwater	Businesses within industrial areas may be less susceptible to amenity related impacts. The areas are highly car dependent and businesses are relatively more sensitive to temporary disruptions to the local road network.

8.10.6 Performance outcomes

Identified performance outcomes in relation to business impacts for operation and construction of the Concept are provided in Table 8-32.

Table 8-32: Business performance outcomes

Operational performance outcomes	Construction performance outcomes
• Potential impacts to businesses are minimised • Connectivity is improved to, from and between businesses in Greater Parramatta, the Sydney CBD and other centres.	• Potential impacts to businesses are minimised • Affected businesses are communicated with in a clear and timely manner to reduce disruption and address concerns • Access to businesses for employees and customers is maintained • Assistance is provided to businesses that are adversely impacted.

8.10.7 Matters to be addressed in staged applications

Business impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Business impact assessments will include, as relevant to the stage:

- Identification of businesses that may be directly or indirectly impacted
- Assessment of the potential impacts on local businesses
- Identification of measures to avoid or mitigate the potential impacts
- Further consultation with local government, business and industry groups.

An assessment of business impacts for Stage 1 is provided in Chapter 16 (Business impacts – Stage 1).

8.11 Social impacts

8.11.1 Policy and legislative setting

The *Environmental Planning and Assessment Act 1979* establishes the framework for assessing all types of development in New South Wales. In particular, the objects of the *Environmental Planning and Assessment Act 1979* include the need to promote the social and economic welfare of the community and to include social considerations in decision-making about environmental planning and assessment.

Guidelines relevant to the assessment of social impacts include:

- International Principles for Social Impact Assessment (Vanclay, 2003)
- Social impact assessment: NSW Department of Planning, Industry and Environment's Draft guidelines for State significant mining, petroleum production and extractive industry development (Department of Planning and Environment, 2017).

8.11.2 Assessment approach

This assessment involved:

- Describing the existing social environment where surface sites for construction and/or operation could be located along the Concept corridor
- Assessing the potential social impacts of operating and constructing the Concept
- Consultation with local Councils, the potentially impacted and broader community
- Identifying performance outcomes
- Identifying the proposed scope of social impact assessments for future stages.

8.11.3 Existing environment

Community profile

For Census purposes, the Australian Bureau of Statistics breaks regions down into statistical areas. Statistical Area Level 2 is the second smallest unit, often based on officially gazetted State suburbs and localities (Australian Bureau of Statistics, 2013). There are 15 Statistical Area Level 2 units relevant to the Concept corridor. As at the 2016 Census, the combined population within these areas was 306,563. Other demographic trends include:

- The largest overall household type is 'couple households with children', which tended to be higher in the western extent of the Concept. Lone person households tended to be higher in the eastern extent. There were also larger household sizes in the western areas
- The level of household income across the Concept was comparable to Greater Sydney. Households with higher incomes tend to be concentrated in the east, whereas the level of income tends to decline further west, particularly between Westmead and Clyde
- There are high levels of cultural and linguistic diversity including:
  - Large numbers of residents identifying as Indian in the western extent of the Concept
  - Large numbers of residents identifying as Chinese in the areas around Sydney Olympic Park to Burwood
  - A noticeable grouping of residents identifying as Italian around the Burwood to Lilyfield area
- The proportion of English-speaking households was higher in the east but tended to be lower along the western extent. Newly arrived migrants tended to live in the western part of the Concept corridor
- Areas in the west have a relatively higher level of disadvantage across all 'socio-economic indexes for areas', whereas areas to the east, and around Sydney Olympic Park, have relatively higher levels of advantage

- Within the Concept corridor, most jobs are within the Sydney CBD followed by Parramatta CBD. The share of jobs across the other station catchments is quite low, with most of these jobs being 'population serving' jobs that services the local population
- Most of the station catchments within the Concept corridor support a large number of dwellings and are important population centres - the exception being Sydney Olympic Park. The low share of dwellings in this area is due to its historic role and function being an entertainment centre rather than a population centre.

Social infrastructure

The Concept corridor contains a wide range of regional, district and local social infrastructure serving a broad catchment across greater Sydney.

There are a number of significant regional social infrastructure assets within the Concept, including hospitals, regional open space and recreation facilities, heritage assets and cultural and creative facilities.

Local and district social infrastructure within the Concept includes schools, childcare centres, open spaces, medical facilities, aged care facilities, community facilities, creative and cultural facilities and recreation facilities.

Within predominantly industrial and commercial settings, such as Silverwater and Clyde, there tends to be very limited social infrastructure given the lack of residential population in these areas. Similarly, Sydney Olympic Park is a mainly recreation and entertainment destination with limited other social infrastructure.

Community values

Key community values within the Concept include:

- Economic activity and regional infrastructure is concentrated within key centres (including Parramatta CBD and Sydney CBD). Residents are seeking opportunities to reduce travel times and congestion and to be able to access social infrastructure, employment opportunities and housing close to where they live
  - Concentrations of employment, educational opportunities and high-value knowledge sector jobs occur within and around the CBDs, particularly the Sydney CBD. This contributes to a Greater Sydney that is divided by economic opportunity, health and social outcomes
  - Increasing pressures and community concerns related to housing affordability near places of employment, local shopping centres and leisure precincts
  - A number of neighbourhoods have maintained a low scale, walkable, neighbourhood character that is valued by the local community. Other neighbourhoods have higher densities, more employment opportunities and activation opportunities throughout the day and night, such as Parramatta and Sydney CBD
- Many of the residential precincts are tightly formed residential neighbourhoods, reliant on local social infrastructure, community facilities and services for their day-to-day community health and wellbeing
  - A wide range of infrastructure and urban renewal projects within and near the Concept are transforming communities and potentially affecting connection to place, which has resulted in community concern in relation to some projects.

An overview of the community profile and social infrastructure of the different settings within the Concept are described in Table 8-33.

Table 8-33: Social context within the Concept

Urban setting	Social context
CBDs • Parramatta • Sydney	**Community profile(s)** There are increasing residential populations within the Parramatta and Sydney CBDs, where residents tend to be relatively young and culturally and linguistically diverse. There are large housing development areas within 30 minutes of the Parramatta CBD, which is increasing demand for jobs and services away from the traditional Sydney CBD centre. Within the Concept, more than 70 per cent of jobs are based in either the Parramatta or Sydney CBDs, with more than 50 per cent of jobs based in the Sydney CBD. **Social infrastructure** The CBD areas contain numerous items of key social infrastructure, often the focus of large regional events, recreation and tourism. They include Parramatta Park, Hyde Park and the Domain and Western Sydney Stadium.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	**Community profile(s)** The suburban areas are made up of mostly residential areas, with a mix of low to medium density housing. There are a smaller number of jobs located within the suburban areas compared to other settings within the Concept, which are generally limited to jobs that service the local population. **Social infrastructure** Social infrastructure within the suburban setting tends to cater for local community events and recreation, including sporting grounds such as Concord Oval, along with local parks and community facilities.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	**Community profile(s)** Community profiles vary between the urban renewal precincts. Sydney Olympic Park contains relatively few residents, compared to Westmead and The Bays areas that are surrounded by large residential neighbourhoods. Job opportunities within the urban renewal precincts tend to be focused around specialty areas such as medical, education, sporting and industrial, reflecting the existing infrastructure within each of the precincts. **Social infrastructure** The Westmead and Sydney Olympic Park areas in particular contain a number of items of key social infrastructure, including Westmead Hospital, Westmead Children's Hospital, Western Sydney University (Westmead Campus), Parramatta Park, ANZ Stadium and Sydney Olympic Park Aquatic Centre.
Industrial and urban services areas • Clyde • Silverwater	**Community profile(s)** The Clyde and Silverwater areas are dominated by heavy industry, with some residential areas nearby. Job opportunities are linked to the existing industrial operations and support services. **Social infrastructure** Key social infrastructure within the industrial and urban services areas include Sydney Speedway (located on government owned land and currently leased from the government).

8.11.4 Potential operational benefits and impacts

The Concept has the potential to provide opportunities and impacts on a number of social factors including way of life, community composition and character, access to infrastructure, services and facilities, culture, health and wellbeing.

Potential social opportunities may include:

- Increased economic development opportunities due to greater access to public transport and urban renewal
- Improvements to accessibility due to new public transport opportunities in areas which are currently disconnected from high speed and high capacity public transport
- Increased use of public transport due to increased connections and faster travel times compared to existing transport options
- Improved equity, particularly for groups that currently experience transport or mobility difficulties such as older people, youth, people experiencing disability, non-drivers or people without access to a private vehicle
- Increased opportunities for healthy active lifestyles and reduced car trips as users walk and cycle to stations on improved pedestrian and cycle facilities
- Increased access to jobs, universities, and social infrastructure across the Concept and greater Sydney, which helps to improve social cohesion and reduce social health related issues.

Potential social impacts may result from the following:

- Changes to community character and composition due to loss of established businesses, changes to streetscape and urban fabric
- Changes in access to community facilities, businesses or services due to relocation
- Reduced visual amenity associated with new structures or impaired view to heritage items or familiar local landmarks
- New facilities may conflict with existing community values and character for some members of the community.

Additional potential social benefits and impacts within each setting associated with operation of the Concept are identified in Table 8-34. Cumulative impacts are discussed in Section 8.21.

Table 8-34: Potential operational social benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney	**Benefits** Improved accessibility to employment precincts in the Parramatta CBD and Sydney CBD. **Impacts** Changes to sense of place associated with potential impacts to heritage items, loss of established businesses, changes to streetscape and urban fabric Changes to how the community functions, through changes to accessibility of services, recreation facilities and open space.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	**Benefits** Increased community pride associated with renewal and activation of areas surrounding the metro stations Increased employment opportunities associated with new business growth close to the proposed metro stations and increased productivity of local businesses due to increased foot traffic from customers accessing the metro Potential for increased property values for housing and commercial premises within walking distance to public transport opportunities Positive changes to localised community character and sense of place associated with placemaking opportunities, potential for activation and viability of local centres. **Impacts** Perceived and potential safety impacts associated with increased numbers of people using metro stations, resulting in an influx of unfamiliar visitors to some areas, including low density neighbourhoods Perception of changes to community values and connections due to potential shifts in community composition, associated with potential new development and changes in employment distribution Changes to how the community functions, through changes to accessibility of services, loss of community meeting spaces, recreation facilities and open space.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	**Benefits** • Increased economic development opportunities as a result of precinct development and improved accessibility to employment precincts in Sydney Olympic Park and Westmead • Increased community pride and excitement associated with renewal and activation of areas surrounding proposed metro stations • Increased employment opportunities associated with new business growth close to metro stations and increased productivity of local businesses due to increased foot traffic from customers accessing the metro • Potential for increased property values for housing and commercial premises within walking distance to public transport opportunities • Positive changes to localised community character and sense of place associated with placemaking opportunities, potential for activation and viability of local centres.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	**Impacts** • Changes to community character and values due to urban renewal and development • Perceived and potential safety impacts associated with increased numbers of people using metro stations, resulting in an influx of unfamiliar visitors to some areas, including low density neighbourhoods • Perception of changes to how the community functions, through changes to accessibility of services, loss of community meeting spaces, recreation facilities and open space.
Industrial and urban services areas • Clyde • Silverwater	**Benefits** • Increased economic development opportunities within the industrial and urban services areas as a result of new maintenance and service facilities. **Impacts** • Changes to the composition of employment opportunities.

8.11.5 Potential construction impacts

Potential social impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.11.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage. Mitigation measures and performance outcomes associated with amenity related issues (such as noise, traffic, visual and air quality) would also manage potential special impacts.

Within the Concept as a whole, potential social impacts during construction may include:

- Potential for temporary noise and vibration impacts to communities above tunnelling activities between construction sites, with associated impacts relating to concerns about property damage
- Potential to temporarily impact traffic conditions for road users on existing road networks, potentially affecting people's daily routines and access to services
- Potential for temporary reductions in amenity due to construction noise and vibration particularly near construction sites
- Potential for temporary changes to working and living environments for residents, workers and visitors in around construction precincts
- Potential for temporary impacts to health and wellbeing associated with construction noise and vibration (e.g. sleep disturbance and stress). These impacts would affect communities near construction sites, along with those living or working above the tunnels
- Potential impacts to wellbeing associated with compulsory property acquisition, and uncertainty for affected businesses and residents
- Potential for cumulative negative wellbeing impacts, such as fatigue, frustration and stress, associated with ongoing construction associated with major infrastructure projects of a long duration, including Westconnex, Parramatta Light Rail and Sydney CBD and South East Light Rail.

Potential construction social impacts associated with each setting are described inTable 8-35. Cumulative impacts are discussed in Section 8.21.

Table 8-35: Potential social impacts within each Concept setting during construction

Urban setting	Potential construction impacts
CBDs • Parramatta • Sydney	• Temporary disruption to pedestrian and vehicle movements, changes to road and public transport routes and access patterns, resulting in potential disruption to daily routines • Temporary changes to access to local retail and community facilities and recreation facilities.

Urban setting	Potential construction impacts
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	• Temporary disruption to pedestrian and vehicle movements, changes to road and public transport routes and access patterns, changed wayfinding and pedestrian accessibility, resulting in potential disruption to daily routines. Changes are likely to be more challenging for people living with disabilities, older people and children and their carers • Perceived safety impacts associated with changed sightlines, changes to wayfinding, and the reduced (or increased) activation of construction precincts at night, which may affect residents' decisions to access particular community facilities or localities • Reduced car parking available to communities, resulting in increased inconvenience and disruption • Temporary changes to access to local retail and community facilities and recreation facilities • Perceived changes to sense of community associated with acquisition and introduction of construction sites, particularly within the Five Dock town centre • Perceived safety impacts associated with the influx of unfamiliar construction workers to neighbourhoods, particularly when construction sites are located close to sensitive receivers (e.g. schools, childcare centres, nursing homes).
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	• Temporary changes to community connections to place and local place narratives associated with the transformation of the area, e.g. the transition of areas from industrial or suburban residential contexts to more activated, mixed-use precincts • Temporary disruption to pedestrian and vehicle movements, changes to road and public transport routes and access patterns, changed wayfinding and pedestrian accessibility • Perceived safety impacts associated with changed sightlines, changes to wayfinding, and the reduced (or increased) activation of construction precincts at night, which may affect residents' decisions to access particular community facilities or localities • Reduced car parking available to communities, resulting in increased inconvenience and disruption • Temporary changes to access to local retail and community facilities and recreation facilities • Perceived safety impacts associated with the influx of unfamiliar construction workers to neighbourhoods, particularly when construction sites are located close to sensitive receivers (e.g. schools, childcare centres, nursing homes).
Industrial and urban services areas • Clyde • Silverwater	• Temporary disruption to vehicle movements, changes to road and public transport routes and access patterns.

8.11.6 Performance outcomes

Identified performance outcomes in relation to social impacts for operation and construction of the Concept are provided in Table 8-36.

Table 8-36: Social performance outcomes

Operational performance outcomes	Construction performance outcomes
• Negative impacts on customers and the community (including transport services, amenity, noise and vibration, water management and air quality) are minimised • Impacts on the availability and quality of public open space and social infrastructure are avoided • Access to local facilities, services and destinations is improved, supporting opportunities for community interaction and improving social connections and connection to place • Placemaking at stations provides a focal point for the community improving social cohesion • Legacy projects are delivered to benefit local communities.	• Negative impacts on customers and the community (including transport services, amenity, noise and vibration, water management and air quality) are minimised • Affected communities are communicated with in a clear and timely manner to enhance community benefits, reduce disruption and address community concerns.

8.11.7 Matters to be addressed in staged applications

Social impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Social impact assessments will include, as relevant to the stage:

- Identification of the existing social environment and any impacts to social conditions, communities and community values
- Review of community characteristics, including identification of significant community infrastructure
- Assessment of the social impact on the directly affected community and its facilities and/or services
- Identification of any community facilities that would be lost, and if alternative facilities are available or if the facilities can be replaced in the local area
- Identification of community facilities adjacent to construction sites that may be impacted by reduced amenity or access
- Identification of mitigation and management measures for the potential impacts
- Further consultation with the impacted and broader community.

An assessment of social impacts for Stage 1 is provided in Chapter 17 (Social impacts – Stage 1).

8.12 Groundwater and ground movement

8.12.1 Legislative and policy context

The policy context for the assessment of potential groundwater impacts includes:

- National Water Quality Management Strategy which is the adopted national approach to protecting and improving water quality in Australia. The strategy includes the Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013), which sets out a high-level risk-based approach to protecting or improving groundwater quality for a range of groundwater beneficial uses (called 'environmental values')
- The NSW Department of Planning, Industry and Environment's NSW Aquifer Interference Policy (NSW Office of Water, 2012) which defines the regime for protecting and managing impacts of aquifer interference activities on NSW water resources. The policy requires that an aquifer interference activity (such as excavation which intercepts the aquifer) meets defined minimal impact considerations and that any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity
- The NSW Department of Planning, Industry and Environment's NSW State Groundwater Dependent Ecosystems Policy (Department of Land and Water Conservation, 2002) provides guidance on the protection and management of Groundwater Dependent Ecosystems.

Under the *Water Management Act 2000*, water sharing plans provide the basis for equitable sharing of surface water and groundwater between water users, including the environment. For groundwater, Stage 1 lies within the area covered by the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The Water Sharing Plan contains provisions for allocation of water to construction projects through a volume of 'unassigned water' or through the ability to purchase an entitlement where groundwater is available under the long-term average annual extraction limit.

8.12.2 Assessment approach

This assessment involved both a desktop review of the existing groundwater data for areas near the Concept, and a review of data obtained from field investigations for Sydney Metro West. The assessment included:

- Reviewing relevant legislation, guidelines and policies
- Reviewing data from relevant databases, including the WaterNSW groundwater bore database, the Water Register and the Bureau of Meteorology Groundwater Dependent Ecosystems Atlas
- Identifying the primary groundwater risks during construction and operation
- Assessing the potential groundwater impacts based on the risks and level of sensitivity identified
- Identifying performance outcomes
- Identifying the proposed scope of groundwater and ground movement assessments for future stages.

8.12.3 Existing environment

Geology

The geology of the Concept corridor is dominated by Triassic-Age Ashfield Shale of the Wianamatta Group. The alignment is crossed by Triassic-Age Hawkesbury Sandstone of the Wianamatta Group; Quaternary Age alluvial/fluvial sediments comprising sand, silt and clay; and fill.

Information obtained as part of site investigations, and desktop review of the NSW Government's 1:100,000 Geological Sheet 9030 for Parramatta (Herbert and Smith, 1991) and the 1:100,000 Geological Sheet 9130 for Sydney (Herbert, 1983), indicate the geological units in the region of the Concept include, in order of shallowest to deepest:

- Fill – typically comprising waste, emplaced material and engineered fill. Reclaimed land areas are generally located next to the harbour and include parkland, residential, industrial, and open space areas
- Quaternary deposits – alluvial and marine sediments associated with gullies, valleys, and former drainage channels
- Ashfield Shale – comprising claystone, mudstone, siltstone, laminites, and fine-grained lithic sandstone of four variably thick sub-units
- Mittagong Formation – comprising interbedded dark siltstone and fine-grained sandstone beds and laminae of varying thickness
- Hawkesbury Sandstone – typically medium- to coarse-grained quartz sandstone. It generally has a shallow weathering profile, but possesses increased defects in zones of faulting, shear and valley stress relief.

A number of structural features, including faults, dykes and joint swarms, have also been identified and inferred. The regional geological context within the Concept is shown in Figure 8-3.

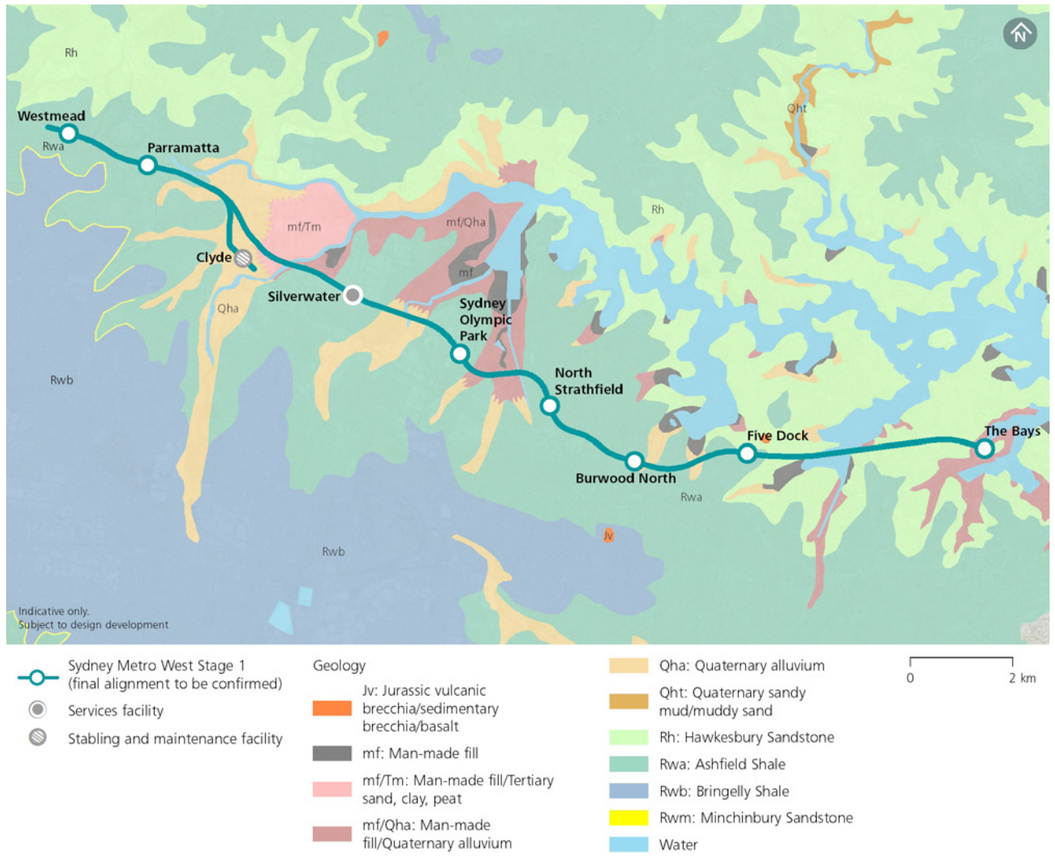

Figure 8-3: Regional geological context

Aquifers

Aquifers are permeable rocks or soil that transmit groundwater and are related to the geological units. Aquifers near the Concept corridor include porous and fractured rock aquifers. Porous aquifers in alluvial soils are continuous (unconfined) over an area. Porous aquifers in the residual soils are often ephemeral and result from water building on bed rock, where there is perched groundwater and are localised and discontinuous and are reflective of water moving down the soil profile into the underlying bedrock.

Fractured rock aquifers occur where groundwater is transmitted through fractures or joints and bedding planes, such as in the shales and Hawkesbury Sandstone.

The permeability of the shale, siltstone and sandstone is generally low to very low, with most of the groundwater flow transmitted through joints and fractures. The alluvial/residual soils are of variable permeability but generally expected to be relatively low.

Groundwater levels

The groundwater level along most of the Concept corridor is between five and 30 metres below ground level. Local shallow groundwater within residual soils is anticipated to be between two and five metres below ground level.

Groundwater data from along the Concept corridor indicates that there is generally hydraulic connection between the soil and rock aquifers. At some locations a perched water table may be present within the soils.

Soils are recharged by rainfall, localised irrigation and incidental runoff from impervious surfaces. Recharge to the rock groundwater systems is by downward filtration through soils. Where rock is exposed at the surface, it is anticipated that there is direct recharge of the rock groundwater system. Groundwater discharge is expected to occur to drainage lines and water bodies.

Groundwater quality

Groundwater quality is influenced by both the underlying geology and potential contaminants that may leach into the groundwater system. Groundwater quality is typically fresh to brackish, with near-neutral pH and shows concentrations of numerous heavy metals above the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger levels for protection of aquatic ecosystems (ANZECC, 2019). This is not uncommon for groundwater encountered in the Sydney basin.

The expected groundwater quality based on key geological units within the Concept corridor is shown in Table 8-37.

Table 8-37: Expected groundwater quality in key geological units

Geological unit	Expected salinity	Expected pH	Other expected characteristics
Quaternary deposits	Fresh to saline 300 milligrams per litre to 20,000 milligrams per litre	Neutral to slightly acidic (4-8)	Nil
Ashfield Shale	Brackish to saline 2,000 milligrams per litre to 20,000 milligrams per litre	Neutral to slightly acidic (4-8)	Nil
Hawkesbury Sandstone	Fresh to brackish 300 milligrams per litre to 1,400 milligrams per litre	Neutral to slightly acidic (4.5 to 8)	Elevated iron Elevated manganese
Mittagong Formation	Fresh to brackish 250 milligrams per litre to 350 milligrams per litre	Neutral to slightly acidic (4.5 to 8)	Elevated iron Elevated manganese

There is potential for contaminants to have leached into the groundwater due to the highly disturbed nature of much of the Concept corridor and former industrial uses at locations such as Clyde, Sydney Olympic Park and The Bays. These contaminants may include heavy metals, total recoverable hydrocarbons, benzene, toluene, ethyl benzene and xylene, polycyclic aromatic hydrocarbons, nutrients, hexavalent chromium, total and speciated phenols, per- and polyfluoroalkyl substances, volatile organic compounds, organochlorine and organophosphate pesticides, and tributyltins. Areas of fill or reclaimed land may have a higher potential risk of groundwater contaminants, these risks are discussed further in Section 8.14 (Contamination – Concept).

Groundwater users

A review of the WaterNSW Groundwater Bore Database (WaterNSW, 2019) and the Register of Water Approvals (WaterNSW, 2019) identified 333 registered groundwater bores within about one kilometre of the Concept corridor. Of the 333 registered bores, five are supply bores, one is for dewatering and one is for commercial/industrial purposes. All others are recorded as monitoring bores or for unknown/exploration purposes.

Of the five supply bores, three bores are listed as functional (GW108611 – located near Westmead; GW024667 – located near Parramatta; GW106471 - located near the Sydney CBD). The status of the other two supply bores is unknown (GW305646 - located near Burwood North; GW200690 – located near the Sydney CBD). The status of the bore for commercial/industrial purposes (GW108378 - located near Westmead) is also unknown.

The NSW Water Register provides information on water licencing. Based on this, only one bore of those listed above (GW106471, located near the Sydney CBD) is listed as active. This suggests that only this bore is licenced to actually extract groundwater. The status of groundwater licences would be investigated further during assessment of each stage.

Groundwater dependent ecosystems

A search of relevant online tools and review of the biodiversity assessment for the Concept identified groundwater dependent ecosystems within 500 metres of the Concept corridor near the Westmead metro station and Clyde stabling and maintenance facility (refer to Section 8.16 Biodiversity - Concept).

Protected wetlands

The Bicentennial Park Wetlands and the Newington Wetlands, both at Sydney Olympic Park, are listed as Nationally Important Wetlands. Online search tools did not identify any Ramsar Wetlands near the Concept corridor.

8.12.4 Potential operational benefits and impacts

To limit potential groundwater inflows and groundwater drawdown, the metro tunnels would be tanked (designed to prevent the inflow of groundwater, typically using concrete lining and waterproofing membrane). Similarly, the cross passages and some of the station caverns would be tanked. As a result, limited change is expected to groundwater levels.

When operational, Sydney Metro West could cause interaction between groundwater and surface water along the alignment which would likely be limited to:

- Likely surface water infiltration that percolates through the soil and/or rock and contributes to groundwater
- Discharge from groundwater to surface watercourses and waterbodies
- Leakage from surface watercourses to groundwater.

The main impacts from operation could occur where untanked stations are proposed (i.e. groundwater could flow into the station excavation across both soil and rock) and could include:

- Ongoing groundwater drawdown, that is, lowering of the water table due to station excavations, until a steady state is reached
- Impacts on groundwater users (if present) due to reduced groundwater yields in existing bores as a result of groundwater drawdown
- Potential for ground settlement at sites where alluvial/fluvial soils are present below the groundwater table in the vicinity of drained structures.

8.12.5 Potential construction impacts

Potential groundwater and ground movement impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.12.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

For the running tunnels, the tunnel boring machines would install a pre-cast segmental tunnel lining as excavation progresses. Therefore, the tunnels would be tanked almost immediately following the tunnel boring, preventing groundwater from entering the tunnels. As such, tunnel construction is anticipated to possibly cause only short-term disruption to groundwater levels.

Some of the station excavations would similarly be tanked (sealed), which would prevent groundwater from the surrounding rock and soil flowing into the excavation. Other excavations for stations or services facilities would be untanked.

Tunnelling activities and underground excavations have the potential to impact on groundwater and ground movement during and immediately following construction. Potential impacts include:

- Where excavations are untanked and occur below the water table, groundwater would flow into the excavation through the aquifers (porous aquifers or the fractures and joints). This groundwater inflow would be pumped out of the excavation (dewatering) which could result in lowering the water table near the excavation, causing groundwater drawdown
- Groundwater drawdown may reduce existing groundwater baseflow and modify local groundwater flow regimes. This has the potential to impact on groundwater dependent ecosystems – refer to Section 8.16 (Biodiversity – Concept)
- Possible reduction of surface water baseflow in surface water bodies (such as creeks and wetlands) if the underlying groundwater contributes to stream baseflow and is impacted by groundwater drawdown
- Potential mobilisation of groundwater contaminants (where present) due to groundwater drawdown
- Potential ground movement and settlement due to the removal of soil and/or rock through tunnelling or excavation activities and from the possible effects of groundwater drawdown
- Potential impacts on groundwater users due to reduced groundwater yields, reduced groundwater quality and/or direct impacts and damage to existing groundwater bores. Potential to reduce available groundwater supply at one bore located near Sydney CBD (GW106471) has been identified
- Potential reduction in infiltration of rainfall or surface water into the groundwater system due to the structures extending below the groundwater table (such as piled walls) and the increase in impervious areas.

There is also the potential to temporarily impact on surface water quality due to the discharge of treated groundwater (from construction activities) into the stormwater system. Temporary water treatment plants would treat collected groundwater so that the discharge requirements meet any relevant environment protection licence or the requirements of the *Protection of the Environment Operations Act 1997*.

Where station excavations are not tanked, the potential groundwater drawdown during construction would depend on site-specific conditions, and the interaction of recharge sources and drainage measures. The generally low hydraulic conductivity of the Mittagong Formation, Hawkesbury Sandstone and Ashfield Shale geological units indicates the extent of groundwater drawdown may be limited by relatively low discharge rates compared to recharge sources. Rock near water-bearing geological features such as faults, dykes and joint swarms does have the potential for relatively high hydraulic conductivity, potentially increasing the pathways of groundwater flow to those excavations.

8.12.6 Performance outcomes

Identified performance outcomes in relation to groundwater and ground movement for operation and construction of the Concept are:

- Groundwater supply for licenced groundwater users is not significantly affected by groundwater drawdown
- The groundwater accessible to groundwater dependent ecosystems is not significantly reduced
- Structural damage to buildings from ground movement associated with excavation, tunnelling or groundwater drawdown is avoided.

8.12.7 Matters to be addressed in staged applications

Groundwater and ground movement impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Groundwater and ground movement assessments will include, as relevant to the stage:

- Characterisation of the existing environment including climate, topography, geology, groundwater occurrence, quality and use, existing groundwater users and groundwater dependent ecosystems which would include desktop studies and site investigations
- Modelling of groundwater flow to assess the potential groundwater inflows to proposed excavations and associated groundwater drawdown during construction and to untanked structures/elements during operation

- Assessment of potential groundwater-related impacts due to estimated groundwater level drawdown associated with construction, operation and cumulative impacts, based on modelling results. Consideration of potential impacts including those related to groundwater dependent ecosystems, acid sulfate soils, groundwater contamination, groundwater quality and ground settlement (including associated potential damage to infrastructure/sensitive assets)
- Assessment of the requirements for treatment of collected groundwater at each excavation during construction and drained structures/elements during operation
- Identification of mitigation measures for the potential impacts.

An assessment of groundwater and ground movement impacts for Stage 1 is provided in Chapter 18 (Groundwater and ground movement – Stage 1).

8.13 Soils and surface water quality

8.13.1 Legislative and policy context

The Australian Government Department of Agriculture's National Water Quality Management Strategy (Australian Department of Agriculture and Water Resources, 2018) is the adopted national approach to protecting and improving water quality in Australia. The National Water Quality Management Strategy contains guidelines for setting water quality objectives to sustain current or likely future environmental values for water resources.

Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) have developed water quality guidelines to provide a set of tools for assessing and managing ambient water quality in natural and semi-natural water resources. The ANZECC/ARMCANZ Water Quality Guidelines, 2000 (ANZECC/ARMCANZ (2000) guidelines) provide a framework for conserving ambient water quality in rivers, lakes, estuaries and marine waters and list a range of environmental values assigned to that waterbody. The guidelines provide recommended trigger values which have been considered when describing the existing water quality and key indicators of concern.

The NSW Government has developed NSW Water Quality and River Flow Objectives (Department of Environment, Climate Change and Water, 2006) that are consistent with the National Water Quality Management Strategy (Australian Department of Agriculture and Water Resources, 2018). The water quality objectives are the agreed environmental values and long-term goals for NSW surface water. The water quality objectives provide environmental values for NSW waters and the ANZECC/ARMCANZ (2000) guidelines provide technical guidance to assess the water quality needed to protect these values.

8.13.2 Assessment approach

This assessment involved:

- Reviewing desktop information to describe the existing soil types, catchments and sensitive receiving environments within the Concept
- Identifying the types of potential soil and surface water quality impacts which may occur during construction and operation of the Concept
- Consultation with the NSW Environment Protection Authority to discuss assessment approach
- Identifying performance outcomes
- Identifying the proposed scope of soils and surface water quality assessments for future stages.

8.13.3 Existing environment

Soil types

The geology of the Concept corridor is dominated by Quaternary Age alluvial/fluvial sediments and fill, along with Wianamatta Group Ashfield Shale and Hawkesbury Sandstone, as discussed in Section 8.12 (Groundwater and ground movement – Concept). The Soil Landscapes of Sydney 1:100,000 Sheet (Tille et al., 2009) and Penrith 1:100,000 Sheet (Hazelton et al., 2010) identify a number of soil types within the Concept corridor derived from the underlying geological units. The soil units and their characteristics are described in Table 8-38 and shown in Figure 8-4.

Table 8-38: Soil units underlying the Concept

Soil unit	Description
Birrong	• Landscape: found on level to gently undulating alluvial floodplain draining Wianamatta Group shale, with slopes less than three per cent. Broad valley flats and extensively cleared tall open forest and woodland • Soils: deep soils (less than 250 centimetres) on older alluvial terraces and current floodplain • Limitations: localised flooding, high soil erosion hazard, saline subsoils, seasonal waterlogging, and very low soil fertility.
Blacktown	• Landscape: found on gently undulating rises on Wianamatta Group shales, with slopes of less than five per cent and local reliefs of up to 30 metres • Soils: strongly acidic and hard setting soils • Limitations: low fertility, high aluminium toxicity, localised salinity and sodicity, low wet strength, low permeability, and low available water holding capacity.
Disturbed terrain	• Landscape: found on a variety of landscapes ranging from level plain to hummocky terrain that has been extensively disturbed by human activity. Slopes are typically less than five per cent and local reliefs of less than 10 metres • Soils: the original soil has been completely disturbed, removed or buried. Landfill may include soil, rock, building and waste material with a cap of sandy loam. Soil may by strongly acidic to strongly alkaline • Limitations: low fertility, low wet strength, low availability water capability, high permeability, localised toxicity/acidity and/or alkalinity, potential mass movement hazard.
Glenorie	• Landscape: found on undulating to rolling low hills on Wianamatta Group shales, with slopes typically between five per cent and 20 per cent • Soils: shallow to moderately deep on crests (less than 100 centimetres) moderately deep on upper slopes (70 to 150 centimetres) and deep on lower slopes (greater than 200 centimetres) • Limitations: high soil erosion hazard, localised impermeable soil and moderate soil reactivity.
Gymea	• Landscape: found on undulating to rolling rises and low hills on Hawkesbury Sandstone, with slopes between 10 per cent and 25 per cent and local relief up to 80 metres • Soils: shallow to moderately deep (30 to 100 centimetres) • Limitations: localised steep slopes, high soil erosion hazards, shallow highly permeable soil and very low soil fertility.
Lucas Heights	• Landscape: found on gently undulating crests and ridges on plateau surfaces of the Mittagong Formation, with local reliefs up to 30 metres and slopes less than 10 per cent • Soils: moderately deep (50 to 150 centimetres) soils on the outer edges of crests • Limitations: stony soil, low soil fertility, and low waterholding capacity.
Hawkesbury	• Landscape: found on rugged, rolling to very steep hills on Hawkesbury Sandstone, with slopes greater than 25 per cent and local reliefs up to 200 metres • Soils: Shallow (less than 50 centimetres) discontinuous lithosols/siliceous sands associated with rock outcrops, with earthy sands and some yellow podzolic soils on the inside of benches and along rock joints and fractures • Limitations: extreme soil erosion hazard, mass movement hazard, steep slopes, high permeability soil and low soil fertility.

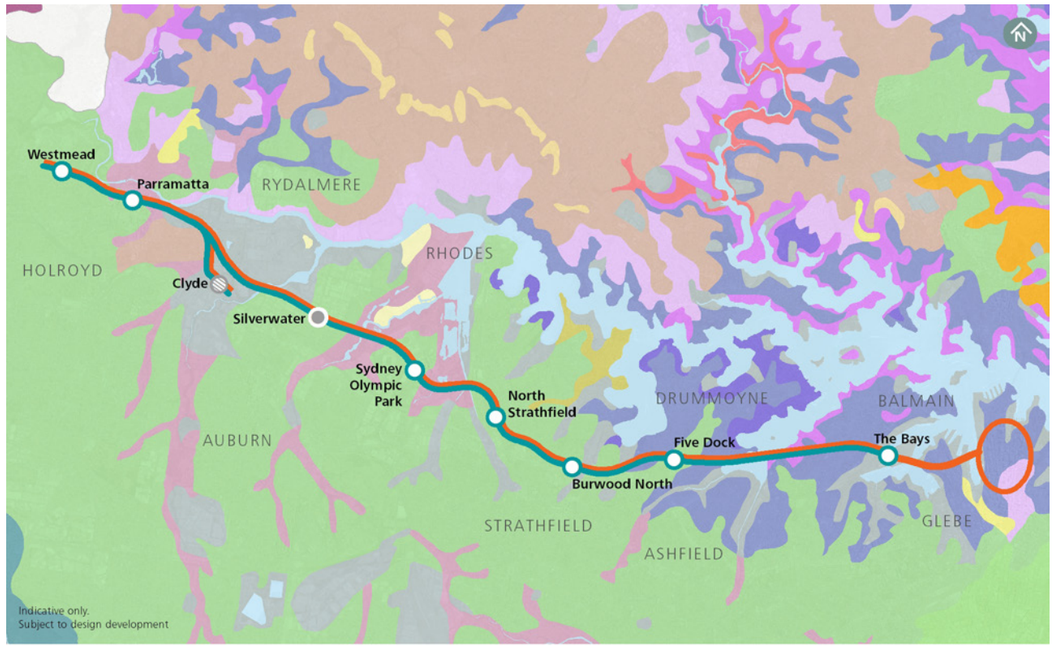

Figure 8-4: Soil landscapes within the Concept

Soil salinity

Soil salinity refers to the movement and concentration of salt in soils as a result of weathering rock materials, historic inland seas and deposition of salt from the ocean onto land by wind or rain. Saline soils can degrade ecosystems and habitats and reduce the productive agricultural capacity of land (Agriculture Victoria, 2017). The NSW Soil and Land Information System and the Salinity Hazard Report for Catchment Action Plan upgrade – Sydney Metropolitan Catchment Management Authority (Winkler et al, 2012) were reviewed to identify the probability for saline soils to be present within the Concept.

Based on this information, there would be a high probability for saline soils to be present within the Concept between Westmead and Parramatta, and a very high probability between Parramatta and Burwood North. There would be a high to very high probability of saline soils between Burwood North and the Sydney CBD in elevated areas, and a very low probability in areas of low elevation.

Acid sulfate soils

Acid sulfate soils are the common name given to naturally occurring sediments and soils containing iron sulfides. Excavation, drainage or groundwater drawdown of this soil type can result in exposure of the sulfides within these soils to oxygen which can generate sulphuric acid.

Acid sulfate soil risk maps were reviewed to assess the probability of acid sulfate soils being present across the Concept. Most of the Concept passes through areas having 'no known occurrence' of acid sulfate soils (NSW Office of Environment and Heritage, 2019). These areas are typically on elevated ground at distance from shorelines and drainage lines. Areas around the Parramatta River, Rosehill, Silverwater, Sydney Olympic Park, Lilyfield/Rozelle, White Bay, Pyrmont Bay/Darling Harbour and Sydney CBD are identified as 'disturbed terrain'. These areas are often located on reclaimed land or land subject to dredging or mining, with the potential presence of acid sulfate soils. These areas are associated with fill and/or alluvium that extends from harbour shores up local drainage lines.

Catchments and watercourses

The Concept is located within the Sydney Metropolitan catchment (Port Jackson) which includes the Parramatta River and Sydney Harbour. The catchment is highly urbanised and altered from its natural state, with pockets of open spaces and parkland. Many of the watercourses within the catchment have been extensively modified, with creek systems channelised or edged with concrete. Most of the catchment is estuarine, up to the tidal limit of Parramatta River at Charles Street weir in Parramatta. Freshwater watercourses occur in the upper catchments of the tributaries of Parramatta River. The catchment lies over the Cumberland Plain and is relatively flat, with elevation ranging from 140 metres Australian Height Datum in the north-west of the catchment to sea level in the east.

Water quality

The NSW Department of Planning, Industry and Environment's Water Quality and River Flow Objectives (Department of Environment, Climate Change and Water, 2006) provide a number of environmental values for the Sydney Harbour and Parramatta River regional catchment:

- Aquatic ecosystems and visual amenity which applies to all waterways within the Concept
- Secondary contact recreation applies to the estuarine waterways
- Primary contact recreation applies to the Parramatta River and The Bays area.

While commercial fishing has been banned in the harbour, some recreational fishing occurs along the foreshore where consumption of fish is likely.

The water quality of watercourses relevant to the Concept is influenced by several factors including:

- Current and historical polluting land uses within the catchments
- Stormwater and sewage overflows and leachate from contaminated and/or reclaimed land
- Urbanisation of the catchments and subsequent reduction in permeable area, increasing run-off and pollutant loads entering watercourses
- Illegal dumping.

A review of available existing water quality data indicates that the watercourses relevant to the Concept are generally in poor condition and are representative of a heavily urbanised system.

Water quality objectives that provide guideline levels to help manage water quality have been developed for each catchment in NSW (Department of Environment and Conservation, 2006). These objectives include community-based values, long term goals, and their associated national criteria drawn from ANZECC/ ARMCANZ (2000) guidelines. The objectives aim to improve poor water quality and maintain existing good water quality (Department of Environment and Conservation, 2006). The water quality objectives, trigger values and/or criteria for the Sydney Harbour and Parramatta River catchments are shown in Table 8-39. The applicability of the criteria in Table 8-39 would be determined during assessments of relevant future stages.

Table 8-39: Water quality objectives for catchments within the Concept

Water quality objective	Indicators	Associated trigger values or criteria
Aquatic ecosystems		
Maintain or improve the ecological condition of waterbodies and their riparian zones over the long term.	**Total phosphorus**	• Upland rivers: 20 µg/L • Lowland rivers: 25 µg/L for rivers flowing to the coast • Lakes and reservoirs: 10 µg/L • Estuaries: 30 µg/L
	Total nitrogen	• Upland rivers: 250 µg/L • Lowland rivers: 350 µg/L for rivers flowing to the coast • Lakes and reservoirs: 350 µg/L • Estuaries: 300 µg/L
	Chlorophyll-a	• Upland rivers: not applicable • Lowland rivers: 5 µg/L • Lakes and reservoirs: 5 µg/L • Estuaries: 4 µg/L
	Turbidity	• Upland rivers: 2–25 NTU • Lowland rivers: 6–50 NTU • Lakes and reservoirs: 1–20 NTU • Estuaries: 0.5–10 NTU
	Salinity (electrical conductivity)	• Upland rivers: 30–350 µS/cm • Lowland rivers: 125–2200 µS/cm
	Dissolved oxygen	• Upland rivers: 90–110% • Lowland rivers: 85–110% • Freshwater lakes and reservoirs: 90–110% • Estuaries: 80–110%
	pH	• Upland rivers: 6.5–8.0 • Lowland rivers: 6.5–8.5 • Freshwater lakes and reservoirs: 6.5–8.0 • Estuaries: 7.0–8.5
Visual amenity		
Maintain the aesthetic qualities of waterways.	**Visual clarity and colour**	Natural visual clarity should not be reduced by more than 20%. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.
Secondary contact recreation		
Maintain or improve water quality for activities such as boating and wading, where there is a low probability of water being swallowed.	**Faecal coliforms**	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL).
	Algae & bluegreen algae	< 15 000 cells/mL
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation.

Water quality objective	Indicators	Associated trigger values or criteria
Primary contact recreation		
Maintain or improve water quality for activities such as swimming, where there is a high probability of water being swallowed.	**Turbidity**	A 200 mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6 m (approximately 6 NTU).
	Faecal coliforms	Beachwatch considers waters are unsuitable for swimming if: • The median faecal coliform density exceeds 150 colony forming units per 100 millilitres (cfu/100mL) for five samples taken at regular intervals not exceeding one month, or • The second highest sample contains equal to or greater than 600 cfu/100mL (faecal coliforms) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend: • Median over bathing season of < 150 faecal coliforms per 100 mL, with 4 out of 5 samples < 600/100 ML (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Beachwatch considers waters are unsuitable for swimming if: • The median enterococci density exceeds 35 cfu/100mL for five samples taken at regular intervals not exceeding one month, or • The second highest sample contains equal to or greater than 100 cfu/100mL (enterococci) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend: • Median over bathing season of < 35 enterococci per 100 mL (maximum number in any one sample: 60-100 organisms/100 mL).
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water. (Note: it is not necessary to analyse water for these pathogens unless temperature is greater than 24 degrees Celsius).
	Algae & bluegreen algae	< 15 000 cells/mL
	Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	pH	5.0-9.0
	Temperature	15°-35°C for prolonged exposure
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation.
Aquatic foods		
Protect water quality so it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	**Algae & bluegreen algae**	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms.
	Faecal coliforms	Guideline in water for shellfish: The median faecal coliform concentration should not exceed 14 MPN/100mL; with no more than 10% of the samples exceeding 43 MPN/100 mL. Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli/g of flesh with a standard plate count of 100,000 organisms/g.
	Toxicants (as applied to aquaculture activities)	Metals: • Copper: less than 5 μgm/L • Mercury: less than 1 μgm/L • Zinc: less than 5 μgm/L Organochlorin==es: • Chlordane: less than 0.004 μgm/L (saltwater production) • PCB's: less than 2 μgm/L
	Physicochemical indicators (as applied to aquaculture activities)	• Suspended solids: less than 40 micrograms per litre (freshwater) • Temperature: less than 2 degrees Celsius change over one hour

Sensitive receiving environments

A number of watercourses relevant to the Concept have been identified as sensitive receiving environments due to their proximity to State Environmental Planning Policy Coastal Wetlands and their mapping as Key Fish Habitat (Department of Primary Industry, 2019). These watercourses have a high conservation or community value or supports ecosystems or human uses of water that are particularly sensitive to pollution or degradation of water quality. These watercourses are shown in Figure 8-5 and include:

- Parramatta River/Sydney Harbour
- Duck River
- Duck Creek
- Haslams Creek
- Powells Creek
- Dobroyd Canal/Iron Cove Creek.

Figure 8-5: Key watercourses crossing the Concept

8.13.4 Potential operational benefits and impacts

Potential impacts to soils and water quality during operation of the Concept are anticipated to be limited and mainly associated with activities at the stabling and maintenance facility at Clyde.

Soils

The presence of acid sulfate soils near drained structures and facilities has the potential to impact on groundwater quality and therefore surface water quality during operation. The highest potential risk of this is at Clyde, Silverwater, Burwood North and near Lilyfield. Where required, any captured groundwater would be appropriately treated prior to discharge to the surface water systems to avoid impacts to the receiving environment.

Water quality

The Concept would be designed to achieve a maximum water discharge quality equivalent to the 90 per cent protection level specified for freshwater ecosystems in accordance with ANZECC/ARMCANZ (2000) guidelines. The discharge water quality level would be determined in consultation with the NSW Environment Protection Authority, taking into consideration the current water quality of the receiving watercourses. It is unlikely that the sensitive receiving environments identified in Section 8.13.3 would be impacted by discharge from the water treatment plant during operation.

There would be a minor increase in hard standing areas which would result in increased runoff and therefore generation of additional pollutants and litter being transported to downstream watercourses via local stormwater systems. The operation of a stabling and maintenance facility at Clyde has the potential to result in sediments, fuels/oil and other pollutants entering the surrounding stormwater system.

Operation of the Concept would require the ongoing capture and management of surface water runoff into the tunnels and groundwater inflows into any drained station structures or ancillary facilities. Groundwater inflows and surface water runoff have the potential to be contaminated with sediments, fuel/oils and/or other pollutants (such as litter), which could have the potential to enter the surrounding stormwater system. Water would be captured and pumped to the operational wastewater treatment plant located at Clyde. Treated water would either be reused or discharged into the local stormwater system which in turn discharges to A'Becketts Creek and Duck Creek.

8.13.5 Potential construction impacts

Potential soils and water quality impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.13.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Soils

A summary of potential impacts to soils during construction of the Concept is provided in Table 8-40.

Table 8-40: Summary of potential construction impacts on soils

Type of impact	Description of impact
Soil erosion	Potential temporary increase in soil erosion from the temporary exposure of soil to water runoff and wind through the removal of vegetation, overlying structures (such as buildings and footpaths) and excavation of construction footprints for stations, structures and foundations. This would be adequately managed with the implementation of standard erosion and sediment controls.
Disturbance of saline soils	Construction of the tunnel and station excavations may cause salinity impacts where there is disturbance of saline soils, often associated with changes to the groundwater system. Salinity impacts may include locally severe salt scalding across landscape elements, damage to buildings and infrastructure, fluvial and sheet erosion, high in-stream salinity, localised waterlogging, flood hazard, and a potential decline in water quality. Any potential salinity impacts would be managed in accordance with Book 4 Dryland Salinity: Productive Use of Saline Land and Water (NSW DECC 2008).
Disturbance of acid sulfate soils	The exposure of acid sulfate soils during excavation could result in the release of acid sulfates, which could pollute downstream watercourses. Any potential acid sulfate soil impacts would be managed in accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998)

Water quality

Performance outcomes relating to meeting discharge water quality requirements and implementing erosion and sediment controls would adequately manage potential water quality impacts during construction of the Concept. A summary of potential impacts to water quality during construction of the Concept is provided in Table 8-41.

Table 8-41: Summary of potential construction impacts on surface water quality

Construction activities	Potential impacts
Surface activities	
Demolition works	Demolition works, including the removal of existing buildings and structures, have the potential to disturb and/or spread sources of pollutants that could affect water quality. These pollutants, once mobilised, could have the potential to enter stormwater runoff and be distributed downstream receiving watercourses via the drainage network.
Earthworks	Exposure of soils during earthworks could potentially result in temporary soil erosion and off-site movement of eroded sediments by wind and/or stormwater into receiving watercourses. If sediments were to enter watercourses, they could impact the aquatic environment by increasing turbidity, reducing dissolved oxygen levels, and increasing the concentration of nutrients and heavy metals.
Removal of vegetation	The removal of vegetation for construction has the potential to temporarily increase the risk of erosion and sedimentation. This could result in the mobilisation of soils into stormwater runoff and nearby watercourses.
Accidental spills from the operation of construction plant and equipment	Accidental spills or leaks could potentially occur from the maintenance or re-fuelling of construction plant and equipment machinery at construction sites, or from vehicle/truck incidents travelling to and from construction sites. This could result in contaminants being transported downstream to receiving waters via drainage infrastructure.
Disturbance of contaminated land	Disturbance of contaminated land, groundwater, or acid sulfate soils construction could potentially result in the mobilisation of contamination or acid sulfate soils by stormwater runoff and subsequent transportation to downstream watercourses, potentially increasing contaminant concentrations in the receiving environment.
Tunnelling and underground excavation activities	
Generation and discharge of wastewater from tunnelling and underground excavation works	Tunnelling and underground excavation works would result in large volumes of wastewater being generated from the following sources: • Groundwater ingress • Rainfall runoff into tunnel portals • Machinery wash down runoff • Dust suppression water. Captured water would be appropriately treated to meet discharge water quality requirements and avoid potential impacts on the water quality of downstream watercourses and the nominated environmental values.

8.13.6 Performance outcomes

Identified performance outcomes in relation to soil and water quality impacts for operation and construction of the Concept are provided in Table 8-42.

Table 8-42: Soil and water quality performance outcomes

Operational performance outcomes	Construction performance outcomes
The water quality criteria for water discharge, determined in consultation with NSW Environment Protection Authority, is met.	• The discharge water quality requirements outlined in applicable environment protection licence(s) are met • Existing water quality of receiving surface watercourses is maintained • Impacts on aquatic environments from the disturbance of acid sulfate soils are avoided • Pollution of surface water is minimised through the implementation of appropriate erosion and sediment controls.

8.13.7 Matters to be addressed in staged applications

Soil and surface water quality impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Soil and surface water quality assessments will include, as relevant to the stage:

- Consideration of the relevant regulatory framework and guidelines, and publicly available data
- Identification of the existing soil landscapes, surface catchments and watercourses
- Identification of the potential environmental impacts to soils and surface water quality including acid sulfate soils, erosion and sedimentation, and an indicative water balance
- Identification of mitigation measures to address the potential impacts
- Further consultation with the NSW Environment Protection Authority.

A soils and surface water quality assessment for Stage 1 is provided in Chapter 19 (Soils and surface water quality – Stage 1).

8.14 Contamination

8.14.1 Legislative and policy context

The *Contaminated Land Management Act 1997* provides the statutory framework for managing contaminated land in NSW.

The following guidelines are applicable to the assessment of contamination for the Concept:

- The NSW Department of Planning, Industry and Environment's Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land (Department of Urban Affairs and Planning and Environment Protection Authority, 1998)
- The NSW Environment Protection Authority's Guidelines for Consultants Reporting on Contaminated Sites (Office of Environment and Heritage, 2000)
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (as revised 2013).

8.14.2 Assessment approach

The assessment involved:

- Desktop review of relevant information sources and site observations of the Concept corridor to understand the existing environment and potential risk for contamination
- Identification of areas of contamination potential
- Assessment of the potential for contamination to be exposed during construction and the management of existing/residual contamination during operation
- Consultation with the NSW Environment Protection Authority to discuss the approach to contamination assessment
- Identifying performance outcomes
- Identifying the proposed scope of contamination assessments for future stages.

8.14.3 Existing environment

The existing contamination potential for each setting within the Concept is described in Table 8-43.

Table 8-43: Potential sources of contamination

Urban setting	Potential sources of contamination
CBDs **Parramatta** **Sydney**	Historical activities undertaken within the proposed corridor include maritime and industrial land uses (including former gasworks) and commercial land use (potential underground storage tanks). There is the possibility of leaks from underground storage tanks related to commercial or industrial buildings and the possible inappropriate management (during demolition) and/or degradation of hazardous building materials within current and former on-site structures. There is potential for contamination from existing and former railway activities within both the Parramatta and Sydney CBDs.

Urban setting	Potential sources of contamination
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Current and historical activities undertaken in the area include possible leaks/spills from underground petroleum storage infrastructure, automotive repair/maintenance, possible inappropriate management (during demolition) and/or degradation of hazardous building materials within current and former on-site structures. Between Five Dock and The Bays current and historical activities include industrial land use and historical land reclamation adjacent to waterways. There is also potential contamination from existing railway activities at North Strathfield.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Current and historical activities undertaken in the locality include adjacent industrial land uses, historical land reclamation adjacent to waterways, mechanical workshop activities (including associated leaks/spills from underground petroleum storage infrastructure), dumping of construction wastes and the possible inappropriate management (during demolition) and/or degradation of hazardous building materials within current and former on-site structures. There is potential for contamination from existing railway activities at Westmead and Sydney Olympic Park, and former railway activities in the vicinity of The Bays. There is also a risk at Sydney Olympic Park associated with historical landfilling with areas of waste and groundwater contamination, and degradation of organics within former waste landfills.
Industrial and urban services • Clyde • Silverwater	Current and historical activities undertaken on the site in the area include industrial land uses, industrial land uses on adjoining sites, vehicle maintenance, historical land reclamation around on-site waterways, known soil and groundwater contamination (James Hardie and former Clyde Refinery). There is also asbestos waste remaining at the former James Hardie site.

8.14.4 Potential operational benefits and impacts

As the tunnels would be lined and most stations would be tanked, the potential for contamination groundwater, vapour and gas ingress is low. However, there could be an ongoing requirement to ensure that where existing contamination may pose risks, whether in soil, groundwater or vapour, it is appropriately managed to protect human and ecological receivers during the life of the Concept.

Operation of the Concept would also require maintenance activities to be undertaken which could give rise to the potential for soils and/or groundwater contamination to occur due to spills and leaks of fuel, oils and other hazardous materials from trains, maintenance vehicles and other infrastructure.

8.14.5 Potential construction impacts

Potential contamination impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.14.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

During construction, contamination is likely to be encountered at several locations in the Concept corridor due to current and historical activities. A desktop review of available data and previous reports identified potential contaminants that could be encountered during excavation, other ground disturbing activities or associated with groundwater ingress are described in Table 8-44.

Table 8-44 Potential contaminants that may be encountered during construction

Urban setting	Potential contaminants of concern
CBDs • Parramatta • Sydney	• Hydrocarbons, heavy metals and metalloids, solvents, phenolics, per- and polyfluoroalkyl substances, pesticides, and asbestos in soil associated with former and current industrial land uses • Hydrocarbons and heavy metals associated with leaks and spills from fuel storage infrastructure • Metals, hydrocarbons, pesticides, nutrients, phenols, carbamates, pesticides, herbicides and asbestos in soils associated with existing railways.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	• Hydrocarbons and heavy metals associated with leaks and spills from fuel storage infrastructure • Hydrocarbons, heavy metals and metalloids, solvents, phenolics, per- and polyfluoroalkyl substances, pesticides, and asbestos in soil associated with former and current industrial land uses • Metals, hydrocarbons, pesticides, nutrients, phenols, carbamates, pesticides, herbicides and asbestos in soils associated with existing railway activities at North Strathfield.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	• Hydrocarbons and heavy metals associated with leaks and spills from fuel storage infrastructure • Hydrocarbons, heavy metals and metalloids, solvents, phenolics, per- and polyfluoroalkyl substances, pesticides, and asbestos in soil associated with former and current industrial land uses • Metals, hydrocarbons, pesticides, nutrients, phenols, carbamates, pesticides, herbicides and asbestos in soils associated with existing railways • Landfill leachate and/or hazardous ground gases including methane, hydrogen sulphide, and carbon monoxide associated with former landfill sites.
Industrial and urban services • Clyde • Silverwater	• Hydrocarbons, heavy metals and metalloids, solvents, phenolics, per- and polyfluoroalkyl substances, pesticides, and asbestos in soil associated with former and current industrial land uses • Contaminated groundwater associated with the above soil contamination.

8.14.6 Performance outcomes

Identified performance outcomes in relation to contamination impacts for operation and construction of the Concept are provided in Table 8-45.

Table 8-45: Contamination performance outcomes

Operational performance outcomes	Construction performance outcomes
• Residual contamination does not pose a risk to Sydney Metro customers or staff.	• Contamination risks to human health and ecological receivers are minimised through effective management of existing contaminated land • Contaminated land is remediated to be suitable for the intended future land use.

8.14.7 Matters to be addressed in staged applications

Contamination impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Contamination assessments will include, as relevant to the stage:

- Desktop review of relevant information sources and observations from site inspections to gain an understanding of the existing environment and potential risk for contamination
- Identification of the potential contamination risk based on the potential for contamination to be present, the potential for works to interface with contamination and the potential for pathways to human or ecological receivers
- Identification of mitigation measures and management strategies to address the potential impacts
- Identification of any further investigations that are required to better inform management or remediation in accordance with current guidelines
- Further consultation with the NSW Environment Protection Authority.

An assessment of contamination impacts for Stage 1 is provided in Chapter 20 (Contamination – Stage 1).

8.15 Hydrology and flooding

8.15.1 Legislative and policy context

The Department of Planning, Industry and Environment's Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources, 2005) guides the assessment of potential hydrology and flooding impacts in New South Wales. The Floodplain Development Manual incorporates the NSW Government's Flood Prone Land Policy. The key objectives of this policy are to identify potential hazards and risks associated with flooding, reduce the impact of flooding and flood liability on owners and occupiers of flood prone property, and to reduce public and private losses resulting from floods. This policy also recognises the benefits of the use, occupation and development of flood prone land.

8.15.2 This assessment involved:

- Describing the existing flood behaviours within the Concept footprint
- Identifying the types of potential hydrology and flooding impacts which may occur during construction and operation of the Concept
- Consultation with Department of Planning, Industry and Environment (Environment, Energy and Science Group) to discuss the approach to hydrology and flooding assessment
- Identifying performance outcomes
- Identifying the proposed scope of hydrology and flooding assessments for future stages.

8.15.3 Existing environment

Surface hydrology and drainage infrastructure

The Concept corridor is within the Parramatta River and Sydney Harbour catchment, with Parramatta River being one of the main tributaries of Sydney Harbour. Surface water within the Concept corridor west of The Bays drains towards watercourses which are sub-catchments of the Parramatta River. Surface water near The Bays and Sydney CBD drains directly to Sydney Harbour. Many of the watercourses within the Concept corridor have been greatly modified, with creek systems extensively made into channels or hard-edged with concrete.

Drainage catchments across the Concept corridor are highly urbanised, with large impervious surfaces created by roads, footpaths and buildings. These impervious surfaces are interspersed with pervious surfaces within parkland areas and other unsealed surfaces (such as vacant land and landscaped areas). Surface water is generally collected by developed stormwater networks, which consist of road kerb and guttering, lined and unlined drainage channels, and sub-surface pit and pipe networks.

Flooding

Due to the highly urbanised and modified environment, the Concept corridor is mainly affected by local runoff and overland flooding. These impacts may be caused by intense rainfall events resulting in a rapid rise in flood flows. When local catchment runoff exceeds the capacity of existing drainage systems, excess flows are conveyed in overland flow paths and can cause ponding at low points.

There are a limited number of locations where the Concept corridor is affected by mainstream, or riverine, flooding. Mainstream flooding may be caused by prolonged heavy rainfall providing some warning time for rising floodwaters, particularly for the large catchment of the Parramatta River.

Mainstream flooding occurs within the Parramatta River and its major tributaries, including Duck River, Duck Creek and A'becketts Creek. Parramatta River has a catchment area of 108 square kilometres upstream of Charles Street weir at Parramatta. Duck River, Duck Creek and A'becketts Creek have a combined catchment area of about 28 square kilometres.

Low-lying areas within the Concept corridor are also subject to coastal inundation. Elevated ocean levels caused by storm surges or high tides raise water levels within the Parramatta River and tributaries, affecting low-lying areas. Coastal inundation events can also coincide with catchment and mainstream flooding, making impacts worse by raising flood levels in and around the waterways.

8.15.4 Potential operational benefits and impacts

Surface hydrology and drainage infrastructure

Aboveground infrastructure within the Concept corridor would be generally located in areas of existing development and is expected to have a negligible impact on the existing surface hydrology. At most sites, the runoff volume and flow rate would likely be similar to existing conditions with minimal impact to the capacity of the existing downstream stormwater infrastructure.

The Concept has the potential to alter localised stormwater catchment flows and the operation of existing stormwater drainage networks due to:

- The introduction of additional drainage infrastructure or rerouting of existing drainage infrastructure (drainage infrastructure may need to be relocated and/or augmented to accommodate elements of the project such as station infrastructure)
- Increases to local drainage catchment areas
- Interruption to existing surface flows due to new or modified infrastructure
- Increases to impervious surface areas.

There are existing large areas of mostly unpaved surfaces near Clyde. The siting of surface infrastructure would likely require paving of at least part of these areas. An increase in impervious surface areas brings the potential for increased runoff volumes, flow rates and resultant increases in downstream flooding without the implementation of appropriate mitigation measures. New drainage infrastructure would be constructed as part of both aboveground facilities and tunnel dive structures and connected to existing stormwater systems.

Flooding

Aboveground stations and ancillary infrastructure are expected have a negligible impact on existing flood behaviour because the infrastructure would be generally located within the footprint of existing structures. Infrastructure would be designed to be compatible with the existing flood hazard and hydraulic function of the sites and to have minimal impact to the community and emergency management response requirements.

Based on known flooding patterns within Parramatta River and its tributaries, areas around Parramatta, Clyde, Silverwater and The Bays are at risk of flooding during operation. Flooding risk would be taken into account during design development so that station entries and aboveground rail system facilities sit above the Probable Maximum Flood level and at least 0.5 metres above the one per cent annual exceedance probability flood level, where feasible and reasonable. Where it is not feasible and reasonable to meet these design criteria, design would consider the need for sumps and pumps to manage any potential inflows. Design development for the stabling and maintenance facility at Clyde would include quantitative flood modelling which would take into account a climate change scenario for future projected sea level rise.

Low-lying sites including The Bays may be exposed to coastal inundation, as a result of high tides combined with storm surge. Their exposure may increase due to future climate change and resulting sea level rise.

The construction of filled embankments has the potential for flooding impacts due to loss of floodplain storage and obstruction of flood flow routes, particularly for sites with a higher flood risk and flood affectation.

8.15.5 Potential construction impacts

Potential hydrology and flooding impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.15.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Construction of the Concept has the potential to impact existing flooding behaviour through disruption of existing conditions (such as drainage systems and/or overland flow paths). In addition, flooding events during construction could impact areas within and near construction sites, including the potential inundation of construction sites.

Potential flood-related impacts during construction may include:

- Temporary interruption of overland flow paths by installation of temporary construction site infrastructure (i.e. noise barriers, temporary structures, retaining walls) and/or modifications to landforms (i.e. placement of fill materials, stockpiles)
- Loss of floodplain storage resulting from construction of permanent filled embankments
- An increase in runoff volumes following rainfall events due to an increase in impervious surfaces at construction sites
- Temporary interruption or diversion of existing flood routes away from the location of bunding or spoil within construction sites, resulting in a re-distribution of flood flows and an increased flood risk to adjacent areas
- Temporary blocking of drainage networks through increased sedimentation of receiving waters
- Flow of water into station excavations, services facility shafts and tunnel portals.

Key risk areas for potential flooding during construction include Parramatta, Clyde, Silverwater and The Bays. Construction flooding risk is expected to be minor to negligible at all other locations within the Concept corridor. Flooding risk at each construction site, along with potential risk mitigation measures, would be considered as part of assessment and construction planning in future stages.

8.15.6 Performance outcomes

Identified performance outcomes in relation to hydrology and flooding impacts for operation and construction of the Concept are provided in Table 8-46.

Table 8-46: Hydrology and flooding performance outcomes

Operational performance outcomes	Construction performance outcomes
• Increases in flood levels are minimised, particularly within private properties, during events up to and including the one per cent annual exceedance probability • No additional private properties are affected by flood events up to and including the 1% annual exceedance probability • The potential for soil erosion and scouring is minimised for events up to and including a 1% annual exceedance probability event • Dedicated evacuation routes are not impacted in flood events up to and including the probable maximum flood • The performance of the downstream drainage network is maintained • Metro tunnels and other critical infrastructure would be protected from the probable maximum flood, or be 0.5 metres above the one per cent Annual Exceedance Probability flood level (whichever is greater).	• Dedicated evacuation routes are not impacted in flood events up to and including the probable maximum flood.

8.15.7 Matters to be addressed in staged applications

Hydrology and flooding impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Hydrology and flooding assessments will include, as relevant to the stage:

- Consideration of the relevant regulatory framework and guidelines, and publicly available data
- Identification of the existing hydrology and flooding conditions
- Identification of the potential environmental impacts to hydrology and flooding, including qualitative and quantitative assessment as required
- Identification of mitigation measures to address the potential impacts
- Further consultation with Department of Planning, Industry and Environment (Environment, Energy and Science Group).

A hydrology and flooding assessment for Stage 1 is provided in Chapter 21 (Hydrology and flooding – Stage 1).

8.16 Biodiversity

8.16.1 Legislative and policy context

The following key biodiversity legislation and policy is applicable to the Concept:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* provides a framework for protection of the Australian environment, including its biodiversity and its natural and culturally significant places
- *Biodiversity Conservation Act 2016* and the Biodiversity Conservation Regulation 2017 sets out the framework for assessing and reporting on biodiversity impacts from development and requires proponents to avoid, minimise and offset biodiversity impacts from development through the Biodiversity Offset Scheme
- *Biosecurity Act 2015* provides a framework for the prevention, elimination, minimisation and management of biosecurity risks
- *Fisheries Management Act 1994* identifies threatened fish and marine vegetation in NSW along with providing a framework for their protection
- NSW Biodiversity Assessment Method (Office of Environment and Heritage, 2017).

8.16.2 Assessment approach

The assessment involved:

- Reviewing existing databases, reports, and mapping for the area within 10 kilometres of the Concept corridor (referred to as the search area) and a more comprehensive review of the existing environment within a 500 metre buffer area from the centreline of the Concept corridor (referred to as the biodiversity study area). The review considered mapping of vegetation, geology and soils, wetlands, groundwater dependent ecosystems and key fish habitat
- Conducting a Protected Matters Search using the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* tool
- Preparing a list of potential plant community types
- Preparing a list of threatened animal species, populations and communities
- Identifying important habitats for migratory species with a likelihood of occurrence in the survey area and Concept
- Identifying any areas of outstanding biodiversity value
- Reviewing the preliminary and provisional determinations to list species and ecological communities as threatened under the *Biodiversity Conservation Act 2016* and the annual Final Priority Assessment List of nominated species and ecological communities that have been approved for assessment by the Minister responsible for the *Environment Protection and Biodiversity Conservation Act 1999* (Australian Government Department of the Environment and Energy 2019)
- Assessing potential impacts to biodiversity including native vegetation, threatened ecological communities, habitat, threatened species, ground dependent ecosystems and key threatening processes
- Consultation with Department of Planning, Industry and Environment (Environment, Energy and Science Group) to discuss the approach to biodiversity assessment
- Identifying performance outcomes
- Identifying the proposed scope of biodiversity assessments for future stages.

8.16.3 Existing environment

A summary of the existing biodiversity environment is provided in Table 8-47 and shown on Figure 8-6, Figure 8-7 and Figure 8-8.

Table 8-47: Existing biodiversity environment

Aspect	Existing biodiversity environment
Bioregion	Sydney Basin Bioregion, Cumberland subregion and Pittwater subregion.
Landscape	Sydney Metro catchment (Port Jackson) within the Ashfield Plains and the Port Jackson Basin landscape.
Rivers, streams, estuaries	The tunnel alignment would pass at depth beneath Domain Creek, Clay Cliff Creek, Duck River, Haslams Creek, Saleyards Creek, Powells Creek and Iron Cove. Other waterways near the Concept include Coopers Creek, Toongabbie Creek, Finlaysons Creek, Darling Mills Creek, Hunts Creek, A'Becketts Creek, Duck Creek, Vineyard Creek, Subiaco Creek, Saltwater Creek, Iron Cove Creek, Hawthorne Canal, Whites Creek, Johnstons Creek and a number of unnamed tributaries and canals. The Concept is also located in proximity to the upper reaches of the Parramatta River estuary, Homebush Bay, Exile Bay, Canada Bay, Kings Bay, Iron Cove and White Bay.
Wetlands	The biodiversity study area contains several wetlands, some of which are known to be regularly used by migratory bird species and threatened species. Of these wetlands, Mason Park wetlands adjacent to Powells Creek, Bicentennial Park wetlands, Newington Nature Reserve wetlands, the Brickpit at Sydney Olympic Park, Haslams Creek, and wetlands associated with Duck River including the Clyde Wetland are the most important. Mapped areas of wetland listed under State Environmental Planning Policy (Coastal Management) 2018 are present and include vegetation along the Parramatta River, Duck River, Haslams Creek, Bicentennial Park, Powells Creek, and Mason Park wetlands.

Aspect	Existing biodiversity environment
Key fish habitat	Within the biodiversity study area Key Fish Habitat is mapped in the following areas (NSW Government Department of Primary Industries 2019): • Parramatta River • Toongabbie Creek • Darling Mills Creek • Subiaco Creek • Duck River • Duck Creek • Pond on Rosehill Racecourse • Haslams Creek • Lake Belvedere in Bicentennial Park • Powells Creek • Kings Bay • Iron Cove Creek • Hawthorne Canal • Sydney Harbour including Iron Cove, Rozelle Bay, White Bay, Johnstons Bay, Blackwattle Bay Cockle Bay, Elizabeth Macarthur Bay, Pyrmont Bay, Darling Harbour.
Habitat connectivity	The habitats within the biodiversity study area have a low degree of connectivity due to the impacts of urbanisation. Habitat within the biodiversity study area is generally present as small isolated fragments within an urban land use context of residential, commercial and industrial development. There are discontinuous corridors of habitat along riparian areas specifically the Parramatta River, Duck River, Haslams Creek, and Powells Creek. Remnant patches of vegetation in Parramatta Park, Five Dock and Concord are connected by planted trees and gardens which provide some functional connectivity for mobile species such as the Grey-headed Flying-fox and birds that can use the resources available in urban areas.
Areas of outstanding biodiversity values	The Concept would not impact any areas of outstanding biodiversity value.
Native vegetation	The biodiversity study area contains native vegetation from the following plant community types as identified in the BioNet Vegetation Classification database and mapped in The Native Vegetation of the Sydney Metropolitan Area – Version 3.1 (State Government of NSW and Office of Environment and Heritage 2016): • Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 835) • Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 849) • Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 920) • Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 1126) • Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 1234) • Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion (Plant Community Type 1281) • Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Plant Community Type 1800) • Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline (Plant Community Type 1808) • Seagrass meadows of the estuaries and lagoons of the New South Wales coast (Plant Community Type 1913).
Marine vegetation	Mangroves, saltmarsh and seagrass are classed as marine vegetation protected under the *Fisheries Management Act 1994* (FM Act). Marine vegetation is present in the biodiversity study area along Parramatta River, Duck River, Duck Creek, A'Becketts Creek, Haslams Creek, Bicentennial Park Wetlands, Powells Creek, Mason Park Wetlands, Iron Cove, Blackwattle Bay and Johnstons Bay.

Aspect	Existing biodiversity environment
Threatened ecological communities (*Biodiversity Conservation Act*)	The following threatened ecological communities listed under the *Biodiversity Conservation Act, 2016* are found within the biodiversity study area: • Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Cumberland Plain Woodland in the Sydney Basin Bioregion • River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Sydney Turpentine-Ironbark Forest.
Threatened ecological communities (*Environment Protection and Biodiversity Conservation Act*)	The following threatened ecological communities listed under the *Environment Protection and Biodiversity Conservation Act, 1999* are found within the biodiversity study area: • Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest • Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion • Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community • Coastal Upland Swamps in the Sydney Basin Bioregion • Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion • Shale Sandstone Transition Forest of the Sydney Basin Bioregion • Subtropical and Temperate Coastal Saltmarsh • Western Sydney Dry Rainforest and Moist Woodland on Shale.
Groundwater dependent ecosystems	There are no aquatic groundwater dependent ecosystems mapped within the biodiversity study area (Bureau of Meteorology 2017). However, there are several terrestrial ecosystems that could be high to moderate potential groundwater dependent ecosystems including: • Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 849) in Parramatta Park • Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 835) along Domain Creek in Parramatta Park and the Parramatta River • Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Plant Community Type 1800) along Parramatta River • Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 920) along the Parramatta River, Duck River, Duck Creek, A'Becketts Creek, Haslams Creek, Powells Creek, Mason Park Wetlands, Iron Cove, Blackwattle Bay and Johnstons Bay • Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion PCT (PCT 781) along the Duck River at Auburn • Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 1126) along Duck River, Haslams Creek, Bicentennial Park wetlands, and the Mason Park Wetlands • Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 1234) along Parramatta River, Duck River, Duck Creek, Bicentennial Park wetlands, Powells Creek and Mason Park Wetlands • Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion (Plant Community Type 1281) in Queen Elizabeth Park and Five Dock Park • Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline (Plant Community Type 1808) in Bicentennial Park.

Aspect	Existing biodiversity environment
Threatened species	The BioNet database searches (NSW Government Department of Planning, Industry and Environment 2019) returned 37,219 individual threatened plant records and 63,240 individual threatened animal records. There are 111 threatened plant species, 81 threatened bird species, 30 threatened mammal species, eight threatened frog species, eight threatened reptile species, three threatened invertebrate species, three threatened fish species, and two threatened elasmobranchs (sharks and rays) known from the search area. Nineteen endangered populations listed under the *Biodiversity Conservation Act 2016* are known from the search area. The Protected Matters Search Tool (Australian Government Department of the Environment and Energy 2019) returned 78 *Environment Protection and Biodiversity Conservation Act 1999* listed threatened species from the search area. This includes 17 threatened plants and 61 threatened animals.
Migratory species	The Protected Matters Search Tool (Australian Government Department of the Environment and Energy 2019) returned 69 *Environment Protection and Biodiversity Conservation Act 1999* listed migratory species from the search area. While some migratory species of bird are likely to use the biodiversity study area, there are no habitats that may be impacted by the Concept that would be classed as an 'important habitat' (Department of Environment 2013; Department of the Environment 2015). The habitats of the biodiversity study area are not large enough or of high enough quality to support a nationally significant proportion of the population of any migratory species.
Threatened fish and marine species	The desktop searches returned 16 species including two threatened fish, five elasmobranchs (sharks and rays), four marine mammals, and five marine reptiles that may be found within the biodiversity study area.

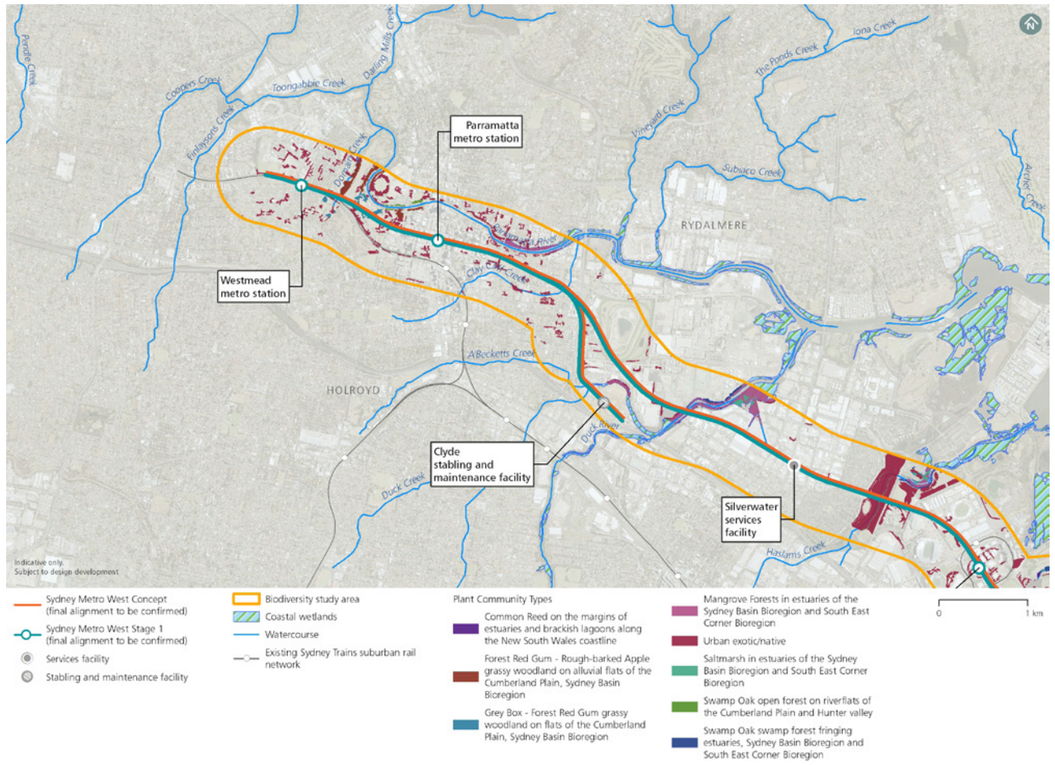

Figure 8-6: Biodiversity environment for the Concept – Map 1

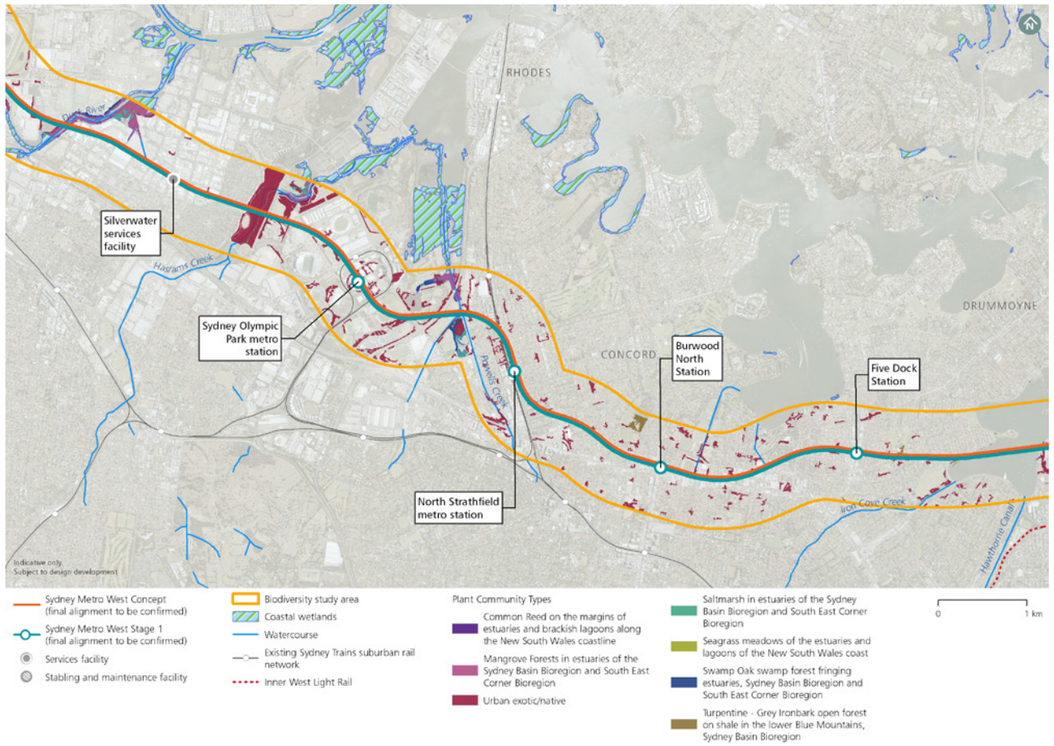

Figure 8-7: Biodiversity environment for the Concept – Map 2

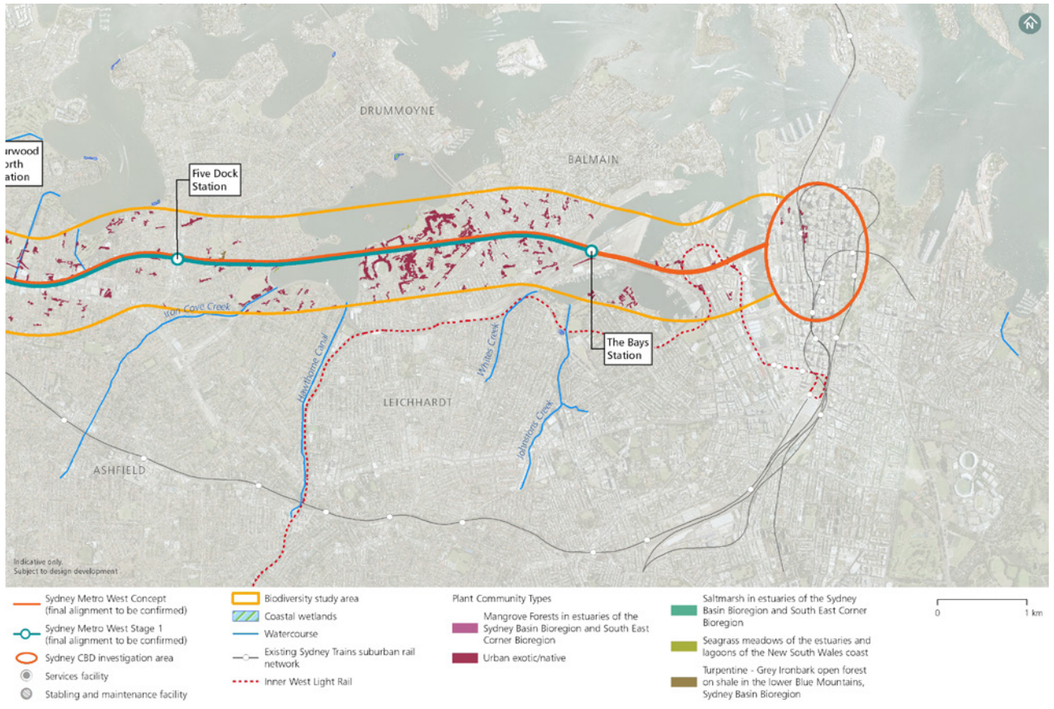

Figure 8-8: Biodiversity environment for the Concept – Map 3

8.16.4 Potential operational benefits and impacts

The potential operational impacts of the Concept on biodiversity are expected to be negligible considering the highly urbanised landscape where the Concept is situated and given that most of the Concept is underground. However, in areas where aboveground disturbance would occur such as at the Clyde stabling and maintenance facility construction site there are likely to be some potential ongoing biodiversity impacts during operation including weed invasion, runoff and sedimentation, and the introduction and spread of pathogens. The implementation of standard mitigation measures is expected to control potential weed invasion, runoff and sedimentation and the introduction and spread of pathogens.

The vegetation adjacent to the Clyde stabling and maintenance facility construction site is a thin band of vegetation along Duck Creek and is currently heavily impacted by edge effects, so further loss of vegetation integrity is not expected in the adjacent vegetation during operation.

8.16.5 Potential construction impacts

Potential biodiversity impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.16.6. This would include offsetting any residual impacts in accordance with the *Biodiversity Conservation Act 2016*. Specific mitigation measures and offset requirements would be developed as part of assessment of each subsequent stage.

The Concept is mainly located in built up areas and has substantially avoided or minimised direct biodiversity impacts. Most of the biodiversity impacts associated with the Concept would occur during construction due to vegetation and habitat removal.

Impacts to native vegetation

As most works would be underground and surface disturbance limited to discreet areas in built up urban and industrial sites, there is likely to be minimal disturbance to native vegetation and threatened ecological communities. There may however be some limited impact to small unmapped areas of threatened ecological communities.

The biodiversity study area contains a mix of plant community types including threatened ecological communities, planted native vegetation (street trees, gardens) and weed growth typical of the Sydney area. Vegetation clearing may occur, but the magnitude of this impact is likely to be low given the majority of works would be underground and surface disturbance is limited to discreet areas in built up urban and industrial sites. The Concept is located within a highly urbanised area that does not possess large expanses of intact native vegetation. Where vegetation removal and disturbance cannot be avoided, the vegetation is likely to be of poor to moderate quality and/or to provide limited habitat for threatened species.

Plant community types within the biodiversity study area are generally in poor to moderate condition due to human disturbance and weed invasion. The integrity of existing vegetation, including composition, structure and function, is likely to be low. Therefore, minimal impacts are expected.

Impacts to habitat

The Concept is located in a highly urbanised and industrialised part of Sydney and the natural habitats have largely been cleared or have been extensively modified. The habitat suitability for most threatened species in large parts of the study area is marginal.

The habitats that do remain in the biodiversity study area are fragmented and isolated. Vegetated riparian zones (e.g. the Parramatta River, Duck River, Haslams Creek and Powells Creek) provide the most obvious semi-intact movement corridors that may be impacted. Additionally, the isolated vegetation remnants, planted urban vegetation, and to a lesser extent, weed growth within the biodiversity study area also play a less obvious role in facilitating the movement of threatened species across the landscape.

Functional connectivity still exists for many species, particularly birds and bats and, to a more limited extent, amphibians, mammals and reptiles. Flying animals such as birds and bats use the airspace to move between habitats and may use fragmented vegetation as cover to escape from predators. The biodiversity study area is likely to be used as a foraging or perching resource by flying animals as part of daily movements. For example, a portion of the Grey-headed Flying-fox population leaves the nationally important Parramatta camp of an evening and likely passes through the biodiversity study area as the bats fly to foraging grounds. The threatened Swift Parrot is likely to pass through the biodiversity study area during seasonal movements. Threatened species known from the Concept corridor including the Grey-headed Flying-fox, Swift Parrot and threatened micro bats are powerful flyers capable of covering large distances between habitat patches. The landscape of the Concept corridor in its current form is accessible to these species. Habitat connectivity for these species, and threatened species movement, is unlikely to be detrimentally affected and the bioregional persistence of these species would not be influenced by the Concept.

There are no karst, caves, crevices, cliffs and other geological features of significance that are likely to be impacted by the Concept. There are no areas likely to be impacted that contain significant rock features that may be used by threatened species as habitat. Human made structures, notably buildings, would be impacted by the Concept.

Impacts on threatened species

Potential impacts to threatened species habitat would be avoided where possible through detailed design and siting of the Concept components on land already disturbed from current or previous urban development.

Direct impacts to threatened species within the biodiversity study area are unlikely. There is, however, potential for impacts to threatened species habitat, although this is likely to be minimal given the small area of habitat that would require removal. Based on the threatened species returned from the database searches, the following threatened species may have habitat impacted by the Concept:

- Plants including *Acacia pubescens*, *Cynanchum elegans*, *Dillwynia tenuifolia*, *Grevillea juniperina subsp. juniperina*, *Haloragis exalata subsp. exalata*, *Marsdenia viridiflora* endangered population, *Pultenaea pedunculata*, and *Wilsonia backhousei*
- Birds including Dusky Woodswallow, Australasian Bittern, Curlew Sandpiper (foraging habitat only), Little Lorikeet, White-bellied Sea-Eagle (foraging habitat only), Swift Parrot (foraging habitat only), Broad-billed Sandpiper (foraging habitat only), Black-tailed Godwit (foraging habitat only), Eastern Osprey (foraging habitat only), Red Knot (foraging habitat only), Great Knot (foraging habitat only), Lesser Sand-plover (foraging habitat only), and Eastern Curlew (foraging habitat only)
- Bats including Little Bentwing-bat (foraging habitat only), Eastern Bentwing-bat (foraging habitat only), Eastern Freetail-bat, Southern Myotis, and Grey-headed Flying-fox (foraging)
- Green and Golden Bell Frog.

The high number of threatened species records returned from the searches reflects the intense biodiversity survey effort that has occurred in the Sydney area.

The tunnel alignment potentially passes beneath Domain Creek, Duck River, Haslams Creek and Powells Creek. These areas contain threatened ecological communities listed under the *Biodiversity Conservation Act 2016* that are at least somewhat dependent on groundwater, surface water flows, and/or tidal flushing. While there is a risk that groundwater drawdown could detrimentally impact these areas and associated ecosystems and species, tunnel construction is anticipated to cause only short-term disruption to groundwater levels as tunnels would be lined almost immediately after excavation to prevent significant volumes of groundwater inflow. Therefore, the risk to threatened species and groundwater dependent ecosystems from groundwater drawdown during tunnelling is expected to be minimal.

These areas also contain habitat for the Green and Golden Bell Frog and threatened and migratory bird species listed under the *Biodiversity Conservation Act 2016* and *Environment Protection and Biodiversity Conservation Act 1999*. There is potential to disturb habitat for these listed species during excavation at construction sites located within the vicinity of the above waterways.

The risk of increased vehicle strike from construction of the Concept is low and would generally be limited to vehicle movements to and from construction sites, which would typically be on existing busy roads. Vehicle strike is considered unlikely to detrimentally affect any threatened species of animals or animals that are part of a threatened ecological community.

There would be no components of the Concept that would affect species movement or interfere with the current flight paths of any protected species. The movement of migratory, nomadic or local species is likely to continue unaltered as no new obstacles would be placed in the flight path of any species. Importantly, no important habitats along the flight path of any species (e.g. wetlands) are likely to be directly affected and the Concept is unlikely to result in an increased collision risk to flying species.

Impacts to aquatic ecosystems and groundwater dependent ecosystems

Construction and operation of permanent waterway crossings (such as bridges and culverts) is unlikely to impact fish species given the existing quality of the habitat and the implementation of mitigation measures to prevent detrimental changes to water quality. Construction activity around watercourses has the potential to result in temporary changes to flow and loss of aquatic habitat associated with the removal of woody snags, changes to instream substrate and loss of aquatic plants (macrophytes). Tunnels would likely pass at depth beneath Domain Creek, Duck River, Haslams Creek, Saleyards Creek, Powells Creek and Iron Cove. Work may be required within Duck Creek and A'Becketts Creek as part of works at the Clyde stabling and maintenance facility. These creeks are mapped as key fish habitat and mitigation measures would be implemented so that fish passage is not blocked in these areas as much as practicable.

The only threatened fish that may be impacted is the Black Rockcod, but the likelihood of an impact to this species is considered low given no direct impacts to the habitat are likely to occur.

As stated above, tunnel construction is anticipated to cause only short-term disruption to groundwater levels. Therefore, risk to threatened species groundwater dependent ecosystems from groundwater drawdown during tunnelling is expected to be minimal.

There are no aquatic groundwater dependent ecosystems mapped within the biodiversity study area. The following threatened ecological communities within the biodiversity study area are considered likely to be terrestrial groundwater dependent ecosystems:

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Cumberland Plain Woodland in the Sydney Basin Bioregion
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Sydney Turpentine-Ironbark Forest.

Most of the threatened ecological communities listed above are not obligate groundwater dependent ecosystems (i.e. they are not entirely dependent on groundwater). Cumberland Plain Woodland in the Sydney Basin Bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, and Sydney Turpentine-Grey Ironbark Forest are not restricted to locations of groundwater discharge and are not located within aquifers. These three threatened ecological communities are likely to be opportunistic facultative groundwater dependent ecosystems that depend on the subsurface presence of groundwater (often accessed via the capillary fringe – subsurface water just above the water table) in some locations but not in others, particularly where an alternative source of water (i.e. rainfall) cannot be continuously accessed to maintain ecological function. The plants within these threatened ecological communities would mainly use shallow soil water but would also make use of deeper soil water or groundwater where available. The trees may rely on groundwater from the capillary fringe during dry years or in extended drought.

Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions and Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions are tidal wetland threatened ecological communities which may depend on groundwater or a combination of surface and groundwater. Mangroves and seagrass beds also fall into this category.

Contribution to Key Threatening Processes

A key threatening process is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. The Concept may directly or indirectly contribute to the following key threatening processes:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams
- Clearing of native vegetation and land clearance
- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis and infection of amphibians with chytrid fungus resulting in chytridiomycosis
- Infection of native plants by *Phytophthora cinnamomi* and dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae
- Invasion and establishment of exotic vines and scramblers
- Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif.
- Invasion of native plant communities by *Chrysanthemoides monilifera*
- Invasion of native plant communities by exotic perennial grasses
- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)
- Degradation of native riparian vegetation along New South Wales water courses.

8.16.6 Performance outcomes

Identified performance outcomes in relation to biodiversity are:

- Impacts on biodiversity are avoided (where possible) and minimised, including the clearing of native vegetation
- Significant impacts to flow regimes in receiving waterways are avoided
- Design of waterway modifications and crossings incorporates best practice principles
- The Concept does not contribute to key threatening processes associated with weeds and pathogens
- Biodiversity impacts are offset in accordance with the *Biodiversity Conservation Act 2016.*

8.16.7 Matters to be addressed in staged applications

Biodiversity assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Biodiversity assessments will include, as relevant to the stage:

- Identification and description of flora and fauna species, habitat, populations and ecological communities that occur, or are considered likely to occur
- Assessment of potential impacts in accordance with the Biodiversity Conservation Act and the Biodiversity Assessment Method
- Identification of mitigation measures using the principles of 'avoid, minimise, mitigate'
- Consideration and assessment of required biodiversity offsets in line with the Biodiversity Offsets Scheme
- Further consultation with Department of Planning, Industry and Environment (Environment, Energy and Science Group).

A biodiversity assessment for Stage 1 is provided in Chapter 22 (Biodiversity – Stage 1).

8.17 Air quality

8.17.1 Legislative and policy context

The *Protection of the Environment Operations Act 1997* provides the statutory framework for managing pollution in NSW. It includes procedures to regulate the potential for pollution, including the issue of environment protection licences for activities identified in Schedule 1 of the Act. Air quality requirements (including criteria) are typically included in environment protection licences.

Air quality impact assessment is guided by the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Environment Protection Authority, 2016). The Approved Methods generally apply to stationary sources of air pollution but include air quality impact assessment criteria.

The National Environment Protection (Ambient Air Quality) Measure sets national air quality standards for particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}), and for particulate matter with an aerodynamic diameter of less than 2.5 microns ($PM_{2.5}$).

8.17.2 Assessment approach

Potential air quality impacts were assessed qualitatively by:

- Identifying potential environmental sensitivity around the Concept corridor considering existing land uses and sources of emissions to air, climate and meteorological conditions, and background air quality information
- Identifying the primary potential air quality risks during construction and operation
- Determining the potential air quality impacts based on the risks and level of sensitivity
- Consultation with the NSW Environment Protection Authority to discuss the approach to air quality assessment
- Identifying performance outcomes
- Identifying the proposed scope of air quality assessments for future stages.

8.17.3 Existing environment

Climate and meteorology

Climate and meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. Typical climate conditions for different locations across the Concept corridor were determined by reviewing long-term climate records from automatic weather stations operated by the Bureau of Meteorology. These included Parramatta North (Station number 066124) which was used to characterise prevailing conditions at areas towards the western end of the Concept and Sydney Observatory Hill (Station number 066062) for eastern areas of the Concept.

The data measured at the Parramatta North weather station indicates the area around this location generally experiences warm, wet summers, with average maximum temperatures of around 28 degrees Celsius. Months through winter are generally the coldest, with average mean daily maximum temperatures of around 18 degrees Celsius. Months through winter were also measured to be the driest, with the lowest average monthly rainfall recorded in July (45 millimetres).

At Sydney Observatory Hill, data indicates that average maximum summer temperatures are around two degrees Celsius lower (26 degrees Celsius). Summers are also wet, although June has the highest average mean rainfall (133 millimetres) of all months. July is the coldest month and September has the lowest mean monthly rainfall (68 millimetres).

At both stations, unfavourable weather conditions most associated with dust dispersion (i.e. above average temperature conditions and average or below average rainfall) were measured in spring.

Long-term records of wind speed and direction measurements from Parramatta North and Sydney Observatory Hill automatic weather stations were reviewed to understand prevailing meteorological conditions. In the mornings (9am), winds blowing from the north-west and west are most common at Parramatta North, and winds from the east and south-east are prevalent at Sydney Observatory Hill. In the afternoons (3pm), winds from the west are most common at Parramatta North, with easterly winds blowing most frequently at Sydney Observatory Hill.

Existing emissions sources

The air quality in the Greater Sydney region is influenced by a variety of different man-made and natural sources. The Air Emissions Inventory for the Greater Metropolitan Region in New South Wales (Environment Protection Authority, 2012) recorded the relative contribution of air pollutants in the Sydney region from different human sources. These included on-road mobile (i.e. road traffic), off-road mobile (e.g. boats and construction plant), domestic, commercial and industrial sources. The following key pollutants were reported:

- Fine particulate matter, comprising PM_{10} and $PM_{2.5}$
- Oxides of nitrogen
- Carbon monoxide
- Volatile organic compounds.

Air quality criteria

Air quality impact assessment criteria are provided in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Environment Protection Authority, 2016), and are summarised in Table 8-48 for key pollutants. The air quality impact assessment criteria reflect the environmental outcomes adopted by the Environment Protection Authority for the cumulative ground level concentration of air pollutants as a result of all emissions sources and are not individual emissions source criteria.

Table 8-48: Air quality impact assessment criteria for key pollutants

Pollutant	Units	Averaging period	Criteria
PM_{10}	$\mu g/m^3$	24-hour	**50**
		Annual	**30**
$PM_{2.5}$	$\mu g/m^3$	24-hour	**25**
		Annual	**8**
Carbon monoxide	mg/m^3	1-hour	**30**
Nitrogen dioxide	$\mu g/m^3$	1-hour	**246**
		Annual	**62**
Sulfur dioxide	$\mu g/m^3$	1-hour	**570**
		Annual	**60**

Background air quality

Potential pollutants generated during construction and operations may include dust (including PM_{10} and $PM_{2.5}$), carbon monoxide, sulfur dioxide, oxides of nitrogen and volatile organic compounds. Measurements at the Prospect, Parramatta North, Rozelle and Randwick (former) Office of Environment and Heritage air quality monitoring stations during the 2014 to 2018 reporting periods indicate that:

- Maximum 24-hour averaged PM_{10} concentrations occasionally exceeded the 50 $\mu g/m^3$ criterion, however the 95th percentile values were in the order of 72 per cent of the criterion or less. Natural events such as large-scale hazard reduction burning, bushfires and dust storms are often the cause of elevated short-term particulate matter concentrations in the Sydney Greater Metropolitan Region (Environment Protection Authority, 2013). Exceptional events of this nature are excluded from the calculation of maximum daily and annual average concentrations for PM_{10} and $PM_{2.5}$ under Clause 18 of the National Environment Protection (Ambient Air Quality) Measure
- Annually averaged PM_{10} concentrations were found to vary between the stations considered, with the highest value of 22 $\mu g/m^3$ recorded at the Parramatta North and Prospect stations in 2018 against the 25 $\mu g/m^3$ impact assessment criterion
- The maximum 24-hour averaged $PM_{2.5}$ concentrations exhibited the same trend as for PM_{10} with the 25 $\mu g/m^3$ assessment criterion occasionally being exceeded, and the 95th percentile values below this criterion
- Annually averaged $PM_{2.5}$ concentrations varied across stations and between years, ranging from 7.2 to 9.2 $\mu g/m^3$, exceeding the 8 $\mu g/m^3$ assessment criterion in some years
- Measured results for nitrogen dioxide, carbon monoxide, and sulfur dioxide were well below the respective impact assessment criteria at all of the monitoring stations reviewed.

Surrounding land uses

The Concept would pass through a well-established urban environment comprising a range of different land uses. Table 8-49 summarises the land use and types of receivers associated with each setting within the Concept corridor.

Table 8-49: Summary of land uses and types of air quality sensitive receivers

Urban setting	Land uses and types of air quality sensitive sensitive receivers
CBDs • Parramatta • Sydney	There are a variety of land uses in the Parramatta and Sydney CBDs including commercial, retail, mixed-use and residential. Significant open and recreation spaces include Hyde Park and the Domain, and Parramatta Park. These, along with numerous other open space focal points, attract millions of visitors each year. Potential sensitive receivers include a number of educational facilities located within the CBD areas, including schools, childcare centres, university campuses and other tertiary institutions. Other sensitive receivers include medical facilities, places of worship and community facilities.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	The suburban settings include predominantly residential land use, with small centres of commercial, retail and mixed-use. Potential sensitive receivers include educational facilities such as schools and childcare centres, along with places of worship and public open spaces. Other sensitive receivers include medical facilities, recreational areas and community facilities.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The current dominant land uses within these areas tend to be specialised – Westmead by health, research and medical uses; Sydney Olympic Park by open-air sporting venues and recreation facilities; and The Bays by former industrial uses. All areas have medium to high density residential land use within or near the precincts. There are also existing train stations at Westmead and Sydney Olympic Park. Other sensitive receivers within the urban renewal precincts include educational facilities, places of worship, commercial and retail.
Industrial and urban services • Clyde • Silverwater	Land use is mainly industrial and commercial. Residential receivers are located nearby.

8.17.4 Potential operational benefits and impacts

When operational, depending on the mode shift from road to rail, the Concept could benefit local air quality by delivering an attractive alternative mode of public transport. This has the potential to reduce air pollution emissions from road transport and congestion within the corridor (when compared to the emissions that would otherwise occur if the Concept was not delivered).

Overall potential air quality impacts would present a low level of risk, would occur infrequently and would be manageable with negligible impacts on air quality.

The Concept would include fresh air ventilation systems to circulate fresh air through the tunnels and underground stations and to prevent the build-up of heat. Fresh air would be drawn into the tunnels and air would be extracted and discharged from the tunnels by mechanical ventilation at the stations and services facilities. The stations would also provide separate fresh air ventilation systems to draw fresh air in and extract air from the station environment. Air discharged from the tunnels and stations would be well diluted and dispersed into the outdoor air environment.

Negligible amounts of particulate matter (PM_{10} and $PM_{2.5}$) emissions would be generated in underground tunnels, mainly due to train brake pad wear, vaporisation of metals due to sparking, wear of steel due to friction between wheels and rail, and recirculation of particulates from tunnel walls. Most of these emissions would be vented through the fresh air ventilation system in very low concentrations.

Vented air is also likely to include minor concentrations of carbon dioxide, volatile organic compounds, oxides of nitrogen and ash and soot particulates generated during maintenance. Given the low concentrations of particulates, the Concept is very unlikely to have air quality impacts on the surrounding environment.

Contaminated soils and groundwater with the potential to cause vapour ingress into stations and tunnels have been identified at a number of locations within the Concept. As set out in Section 8.11 (Contamination - Concept), contamination would be managed during construction so that vapour causing contamination is either removed or appropriately managed to avoid operational air quality impacts.

The fresh air ventilation system would also respond to emergency conditions such as fire incidents, where smoke would be discharged through the emergency ventilation system to prevent smoke from entering stations or recirculating through fresh air ventilation shafts. The design and location of the fresh air ventilation shafts at stations and service facilities would minimise impacts on sensitive receivers and suitable emergency plans would be in place for these circumstances.

Activities with the potential to impact air quality during operation include:

- Trains operating in underground tunnels (i.e. from brake wear, metal vaporisation resulting from sparking, wearing of steel componentry and re-entrainment) – potential release of particulate matter from fresh air ventilation shafts in very low concentrations
- Routine maintenance activities – potential release of exhaust emissions from fresh air ventilation shafts in very low concentrations
- Emergency conditions (e.g. in-tunnel fire) – potential release of smoke (i.e. particulate matter) via emergency ventilation systems.

At Parramatta, Clyde, Silverwater, Sydney Olympic Park and Sydney CBD there is also potential for exposure of contamination sources which may affect air quality, although this risk would be managed through further detailed assessments at later stages.

8.17.5 Potential construction impacts

Potential air quality impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.17.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

With the implementation of effective controls, it is expected that potential air quality risks during constriction would be able to be mitigated or otherwise effectively managed within acceptable levels.

Dust generated during site clearing and demolition, excavation, materials handling, stockpiling and compaction activities has the potential for air quality-related risk during construction. Dust is a general term used to describe particulate matter in the form of total suspended solids or particulate matter with a smaller aerodynamic diameter (PM_{10} and $PM_{2.5}$). If not properly managed, elevated airborne dust levels have the potential to cause adverse human health or nuisance impacts. These types of impacts can include:

- Potential human health issues
- Nuisance impacts including dust soiling (i.e. the unwanted settling of dust on property surfaces)
- Reduced visibility
- Physical and chemical impacts to vegetation (Farmer, 1993; Doley, 2006).

Exhaust emissions from the combustion of fossil fuels in operating construction plant and equipment represent another potential air quality risk during construction. Key pollutants associated with these emissions include:

- Fine particulate matter (i.e. PM_{10} and $PM_{2.5}$)
- Oxides of nitrogen including nitrogen dioxide
- Carbon monoxide
- Sulfur dioxide
- Volatile organic compounds such as benzene.

Considering existing sources of these pollutants in areas around the Concept, the additional air quality risk is considered minor to negligible.

Odours arising from uncovered contaminated and/or hazardous materials and airborne hazardous materials represent other air quality related risks during construction although the risk is likely to be low.

The potential for these impacts to occur at different areas across the Concept corridor would depend on several factors, including:

- The intensity of construction activities and where they take place (i.e. at or above ground level, below ground, or within deep excavations)
- The proximity, density and sensitivity of surrounding land uses
- Prevailing meteorological conditions
- Mitigation and management measures that are applied.

8.17.6 Performance outcomes

The identified performance outcome in relation to air quality is to minimise air quality impacts during construction and operation.

8.17.7 Matters to be addressed in staged applications

Air quality impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Air quality assessments will include, as relevant to the stage:

- Consideration of the relevant regulatory framework and guidelines
- Desktop review and identification of the types of activities that may generate potential air quality related impacts during construction and operation
- Estimation of the potential for dust-related impacts during construction using the risk-based assessment approach presented in Guidance on the assessment of dust from demolition and construction Version 1.1 (United Kingdom Institute of Air Quality Management, 2014). Other impacts during construction and operation would also be qualitatively assessed
- Identification of mitigation measures to address air quality impacts and risks
- Further consultation with the NSW Environment Protection Authority.

An air quality assessment for Stage 1 is provided in Chapter 23 (Air quality – Stage 1).

8.18 Spoil, waste management and resource use

8.18.1 Legislative and policy context

Waste management and recycling is regulated in NSW by the NSW Environment Protection Authority through the *Protection of the Environment Operations Act 1997*, the Protection of the Environment Operations (Waste) Regulation 2014 (including the requirement to track certain types of waste) and the *Waste Avoidance and Resource Recovery Act 2001*.

The *Protection of the Environment Operations Act 1997* defines waste as any substance that is discharged, emitted or deposited in the environment in such a manner as to alter the environment. This broad definition includes substances that are processed, recycled, re-used or recovered.

The *Waste Avoidance and Resource Recovery Act 2001* aims to promote waste avoidance and resource recovery through (amongst other things) the establishment of the following waste hierarchy:

- Avoidance of waste – the first priority in waste management includes actions to reduce the amount of waste generated
- Resource recovery – the second priority in waste management involves opportunities for reuse (without further processing), recycling (processing waste materials to make the same or different products), reprocessing and energy recovery
- Disposal – the least desirable option in the waste management hierarchy involves the disposal of waste in an appropriate manner so as to minimise the potential adverse environmental impacts associated with its disposal.

By minimising consumption and encouraging the efficient use of resources, the *Waste Avoidance and Resource Recovery Act 2001* aims to reduce the generation and impacts of waste.

The NSW Department of Planning, Industry and Environment's NSW Government Resource Efficiency Policy (Office of Environment and Heritage, 2019) aims to drive resource efficiency by NSW Government agencies and reduce harmful air emissions from government operations. As a government agency, Sydney Metro has a responsibility under this policy to incorporate resource-efficiency considerations in all major decisions to address rising costs for energy, water, clean air and waste management.

The *NSW Waste Avoidance and Resource Recovery Strategy 2014–21* (Environment Protection Authority, 2014a) supports the avoidance and minimisation of waste and provides a framework and targets for waste management and recycling in NSW until 2021–2022. Targets include:

- Avoiding and reducing waste generation
- Increasing recycling and diverting waste from landfill
- Improving the management of 'problem wastes' (such as toxic and hazardous products)
- Reducing litter and illegal dumping.

Sydney Metro, as a NSW Government agency, supports these targets by:

- Implementing complementary policies and programs, including sustainable procurement policies
- Incorporating resource recovery and waste reduction objectives into its operations
- Complying with relevant regulations.

A number of policies and strategic documents are relevant to waste management and resource use for the Concept. The NSW Environment Protection Authority Waste Classification Guidelines (NSW Environment Protection Authority, 2014b) assists waste generators to classify the wastes they produce. The guidelines classify waste into groups that pose similar risks to the environment and human health in order to facilitate their management and appropriate disposal. Correct classification is required in order to comply with applicable laws and safeguard the protection of the environment and human health.

The Department of Planning, Industry and Environment (which includes the NSW Environment Protection Authority) is leading the development of a 20-year Waste Strategy for NSW. The Strategy will address key priorities for waste and resource recovery for NSW and an issues paper about the strategy is expected to be released prior to a draft strategy in 2020.

8.18.2 Assessment approach

This assessment involved:

- Identifying the likely resources required for the construction and operation of the Concept
- Identifying the likely waste generating activities and waste types for the construction and operation of the Concept
- Identifying the potential environmental impacts associated with resource use and the generation (and subsequent disposal) of waste materials
- Consultation with the NSW Environment Protection Authority to discuss the approach to assessment of spoil, waste management and resource use
- Identifying performance outcomes
- Identifying the proposed scope of spoil, waste management and resource use assessments for future stages.

8.18.3 Potential operational benefits and impacts

Spoil

There would be no operational impacts associated with spoil. Potential impacts would be confined to the construction phase.

Waste management

It is anticipated that waste would be adequately managed through the application of standard mitigation measures and the waste hierarchy outlined in the *Waste Avoidance and Resource Recovery Act 2001*.

The indicative operational waste streams are outlined in Table 8-50, along with the likely waste classification under the Waste Classification Guidelines (NSW Environment Protection Authority, 2014b). The types, classifications and quantities of wastes generated during the operation of the Concept would be confirmed following further design work and considered in future stages.

Table 8-50: Indicative types of waste generated during the operation of the Concept

Waste stream	Likely waste classification
Wastes from train and systems maintenance activities	• General solid waste (non-putrescible) • Hazardous waste and/or special waste.
General wastes from the operation and maintenance of metro stations	• General solid waste (non-putrescible).
Wastewater from tunnels and metro stations (toilets and station-cleaning activities)	• Liquid waste.

A summary of potential impacts to waste management during the operation of the Concept is provided in Table 8-51.

Table 8-51: Summary of potential operational impacts on waste management

Type of impact	Description of impact
Inadequate collection, classification and disposal of waste	Waste from metro stations and maintenance activities being unnecessarily directed to landfill, potentially increasing the demand for landfill capacity within the Sydney region.
Inadequate management of bins at stations	Waste (such as litter) from station buildings being blown into the surrounding environment.
Incorrect storage, handling and disposal of putrescible waste at metro stations	Potential increase in vermin in the vicinity of metro stations.
Inadequate management of wastewater from metro stations (toilets and station-cleaning activities) and tunnels	Potential contamination of soil, surface and/or groundwater.
Excessive amounts of maintenance materials being ordered	Potentially a large amount of left-over, unused resources.

Resource use

The resources that would be required to operate the Concept include:

- Electricity
- Water
- Materials for ongoing maintenance activities.

The resource requirements for the operation of the Concept are likely to be typical for an infrastructure project of this scale and similar to other operational rail lines including the Metro North West Line. Opportunities to minimise resource consumption and maximise resource efficiency would be considered during further design development. This includes offsetting 100 per cent of operational electricity requirements through new renewable energy capacity. Although operational requirements for water use would be relatively minor, potable water use would be minimised where possible, including avoiding the use of potable water where non-potable water is available. Current best-practice water-efficient features, equipment and appliances at stations, stabling facility and construction sites would be implemented. Further commitments for minimising water use are outlined in Section 8.20 (Sustainability and Climate Change – Concept).

8.18.4 Potential construction impacts

Potential spoil, waste management and resource use impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.18.5. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Spoil

Spoil generated during the construction of the Concept would be classified in accordance with NSW Waste Classification Guidelines. Spoil that is not classified as hazardous, or special wastes, would be reused following the hierarchy of options presented in Table 8-52. As a performance outcome, Sydney Metro would target beneficial reuse of 100 per cent of the usable spoil generated during construction. The geology of the spoil material as well as its consistency and quality would determine the reuse options.

Sampling and testing of soils in areas of potential contamination concern would be conducted to determine the appropriate waste classification in accordance with the Waste Classification Guidelines. The suitability of soils for beneficial reuse would also be determined in accordance with the National Environment Protection (Assessment of Site Contamination) Measure (National Environment Protection Council, 1999) and the NSW Environment Protection Authority resource recovery framework.

Table 8-52: Spoil management hierarchy for the Concept

Priority	Re-use options
1	Within the Stage 1 construction footprint
2	Environmental projects
3	Other development projects (including other Sydney Metro projects)
4	Land restoration
5	Landfill management

Waste management

The types, classifications and quantities of construction waste generated during the construction of the Concept would be confirmed following further design work and considered in future stages. However, the volumes of construction wastes are expected to be comparable to other similar infrastructure projects including Sydney Metro Northwest (which opened in May 2019) and the Chatswood to Sydenham component of Sydney Metro City & Southwest (currently under construction).

Waste generated by the construction of the Concept would be managed in accordance with the Sydney Metro Construction Environmental Management Framework. It is anticipated that waste would be adequately managed through the application of standard mitigation measures and the waste hierarchy outlined in the *Waste Avoidance and Resource Recovery Act 2001*. General construction and demolition wastes, and wastes from site offices, would be collected for off-site recycling wherever practicable. Wastes that contain hazardous, special or otherwise contaminated, materials would be treated and disposed off-site at a licensed facility in accordance with the relevant guidelines.

The indicative construction waste streams are outlined in Table 8-53, along with the likely waste classification under the Waste Classification Guidelines (NSW Environment Protection Authority, 2014b).

Table 8-53: Indicative types of waste generated during construction of the Concept

Waste stream	Likely waste classification
Demolition waste	• General solid waste (non-putrescible) • Hazardous waste • Special waste.
Vegetation waste	• General solid waste (non-putrescible).
Spoil from tunnel excavation, station excavation and general earthworks (including contaminated soils and acid sulfate soils)	• General solid waste (non-putrescible) • General solid waste (putrescible) • Hazardous and/or special waste • Liquid waste.
Wastewater from dust suppression, wash down of plant and equipment, and staff amenities at construction sites (such as toilets)	• Liquid waste.
General construction waste	• General solid waste (non-putrescible).
Waste from the operation and maintenance of construction plant and equipment	• Hazardous waste and/or special waste.
General waste from site offices	• General solid waste (non-putrescible).

A summary of potential impacts associated with waste management during construction of the Concept is provided in Table 8-54.

Table 8-54: Summary of potential construction impacts associated with waste management

Type of potential impact	Description of potential impact
Inadequate collection, classification and disposal of waste	Waste unnecessarily being directed to landfill, potentially increasing the demand for landfill capacity within the Sydney region.
Inappropriate storage, transport and disposal of liquid and solid wastes	Potential contamination of soil, surface water and/or groundwater.
Incorrect storage, handling and disposal of putrescible waste from construction sites	Potential increase in vermin in the vicinity of construction sites.
Incorrect storage, handling and disposal of hazardous materials	Potential contamination of soil, surface water and/or groundwater and the local air shed.
Inadequate management of spoil stockpiles	Potential runoff, sedimentation and leachate of surface water and/or groundwater.
Excessive amounts of materials being ordered	Potentially z large amount of left-over, unused resources.
Lack of identification of feasible options for recycling or reuse of resources	Waste unnecessarily being directed to landfill, which would potentially increase the demand for landfill capacity within the Sydney region.

Resource use

A variety of resources would be needed to construct the Concept, including but not limited to:

- Electricity
- Fuel
- Concrete, including for tunnel lining segments
- Steel
- Water.

The resource requirements for the construction of the Concept are likely to be typical for an infrastructure project of this scale. While the resource requirements do have the potential to impact resource availability within the Sydney metropolitan region over the construction period, the concurrent construction of recent major infrastructure projects has demonstrated that the market is able to meet the resource requirements of these projects given sufficient opportunity to forward plan.

Consistent with the resource management hierarchy of the *Waste Avoidance and Resource Recovery Act 2001*, resource consumption would be further minimised during construction through reuse, where possible.

8.18.5 Performance outcomes

Identified performance outcomes in relation to spoil, waste management and resource use for operation and construction of the Concept are provided in Table 8-55.

Table 8-55: Spoil, waste management and resource use performance outcomes

Operational performance outcomes	Construction performance outcomes
• The use of potable water for non-potable purposes is avoided if non-potable water is available • The reuse of water is maximised, either on site or off site.	• 100 per cent of useable spoil is reused in accordance with the spoil reuse hierarchy • A minimum 95 per cent recycling target is achieved for construction and demolition waste • Products made from recycled content are prioritised • The use of potable water for non-potable purposes is avoided if non-potable water is available • The reuse of water is maximised, either on site or off site.

8.18.6 Matters to be addressed in staged applications

Spoil, waste management and resource use assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Spoil, waste management and resource use assessments will include, as relevant to the stage:

- Desktop review of the likely construction resources, including construction materials, water and power
- Identification of likely waste generating activities and possible waste streams in accordance with relevant legislation and guidelines
- Identification of the environmental impacts associated with resource use and the generation (and subsequent disposal) of waste materials
- Identification of mitigation measures and management strategies to address the potential impacts
- Further consultation with the NSW Environment Protection Authority.

A spoil, waste management and resource use assessment for Stage 1 is provided in Chapter 24 (Spoil, waste management and resource use – Stage 1).

8.19 Hazards

8.19.1 Legislative and policy context

The following legislation and guidelines apply to assessing and managing potential hazards:

- The Department of Planning, Industry and Environment's Hazardous and Offensive Development Application Guidelines: Applying SEPP 33 (Department of Planning, 2011)
- *Dangerous Goods (Road and Rail Transport) Regulation, 2009*
- Australian Code for the Transport of Dangerous Goods by Road and Rail (edition 7.6) (National Transport Commission, 2018)
- Storage and Handling of Dangerous Goods Code of Practice (WorkCover, 2005)
- SEPP33 - Hazardous and Offensive Development.

8.19.2 Assessment approach

This assessment involved:

- Identifying the types of hazards which could potentially occur during operation and construction of the Concept
- Assessing the potential environmental impacts and/or risks associated with the types of hazards identified
- Identifying performance outcomes
- Identifying the proposed scope of hazards assessments for future stages.

8.19.3 Existing environment

There are several elements within the Concept corridor that have the potential to become hazardous and pose a risk to the environment and/or human health under adverse conditions if activities are not properly managed. These include:

- Utilities – existing utilities within the Concept corridor include high pressure petroleum pipelines, electrical, gas, sewer, water mains and telecommunications
- Major hazard facilities – there are several classified and regulated major hazard facilities within the Concept corridor

Contaminated sites – there are several known contaminated sites within the Concept corridor, and other risk areas due to current or historical land uses and/or activities. For further discussion refer to Section 8.14 (Contamination – Concept)

Building basements and ground support structures – the highly urbanised nature of land within the Concept corridor means that building basements and ground support structures may be at risk of damage due to ground movement. Further discussion is provided in Section 8.12 (Groundwater and ground movement – Concept)

Bushfire prone land – A search of bushfire prone land mapping developed and published by the relevant local councils found the Concept is not within bushfire prone land. As such, bushfire risk is considered to be negligible and has not been considered further.

8.19.4 Potential operational benefits and impacts

Potential hazards and associated risks during operation of the Concept would be low and manageable using standard measures. The potential types of hazards and associated risks that may be encountered during operation of the Concept, and associated impacts and benefits, are shown in Table 8-56.

Table 8-56: Potential hazards and risks during operation of the Concept

Type of hazard	Potential impacts and/or risk associated with hazard
On-site storage, use and transport of dangerous goods and hazardous substances	**Environmental contamination in the event of a spill.** The volumes of dangerous goods stored on site would be low. Regulatory requirements and best practice regarding the on-site storage, use and transport of dangerous goods and hazardous substances would be complied with to minimise risks.
Potential for hazards to customer and public safety and security	**Security and public safety risks.** A key metro characteristic is to provide a system that is inherently safe for customers on trains, at stations, and at the interface with the public domain. As described in Chapter 6 (Concept description) and Chapter 7 (Placemaking), the safety of passengers and the general public has been, and will continue to be, a key consideration during the design process. The Concept would incorporate measures to eliminate security and public safety risks as much as practicable, including implementation of the principles from Crime Prevention Through Environmental Design. Key safety characteristics that would be incorporated into the Concept are described in Chapter 6 (Concept description) and include CCTV cameras, emergency help points and passenger information signage.
Unauthorised access to the rail corridor	**Risk of injury or fatality.** The risk would be minimised by measures such as the installation of platform screen doors, security fencing, and a trackside intruder detection system, including closed circuit television.
Emergency situation – derailment, fire or deliberate sabotage	**Risk of injury or fatality; risks to property or infrastructure.** While the risk of an emergency situation is very low, Sydney Metro emergency response procedures would be implemented as required.
General worker health and safety issues for drivers and maintenance staff	**Risks undertaking regular maintenance and operational tasks.** Maintenance activities and other works within the rail corridor would be undertaken in accordance with Sydney Metro standard operating procedures, reducing the potential for impacts to the health and safety of workers, visitors, and customers.

8.19.5 Potential construction impacts

Potential hazards during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.19.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The potential types of hazards that may be encountered during construction of the Concept, and the associated impacts, are shown in Table 8-57.

Table 8-57: Potential hazards during construction of the Concept

Type of potential hazard	Potential associated impact and/or risk	Discussion
On-site storage, use and transport of dangerous goods and hazardous substances	Environmental contamination in the event of a spill.	Typically, low volumes of potentially hazardous materials would be stored on site. Construction sites would be planned so that hazardous materials are stored appropriately and at a suitable distance from sensitive receivers. Environmental hazards associated with the on-site storage, use and transport of chemicals, fuels and materials would be managed through standard mitigation measures.
On-site handling and transport of contaminated soil and hazardous wastes	Community risk or environmental contamination in the event of a spill.	The handling and transport of contaminated soil and hazardous wastes would comply with regulatory requirements and standard mitigation measures.
Ground movement	Risk of damage to existing building basements and ground support structures Tunnelling challenges.	The tunnels and many elements of the Concept are designed as tanked structures and therefore long-term settlement effects associated with groundwater drawdown is not anticipated at most locations. The potential risks to buildings and structures would be assessed with reference to construction methodologies and geotechnical conditions in each relevant stage, including measures to mitigate potential impacts.
Impacts to utilities	Release of untreated sewage and/or gas from a sewer main Release of natural gas from a gas main Release of large electrical currents through the ground surface from an underground electricity cable (known as earth potential rise) Release of high pressure petroleum or gas products from petroleum, gas or oil pipelines Explosion or fire from ruptured underground pipelines.	The risk associated with utility related hazards would be mitigated by carrying out utility checks and consulting with the relevant utility providers. Construction methodologies for construction works near utilities would be developed to comply with relevant standards in consultation with utility providers to minimise environmental hazards. Measures to manage potential risks to utilities would be developed for each future stage as part of the assessment process.
Interaction with major hazard facilities	Major hazard event if construction works result in an uncontrolled interaction with a major hazard facility.	Appropriate construction methodologies would be developed for works (if proposed) near major hazard facilities. Risks associated with major hazard facilities would be assessed in the assessment of each relevant stage.

8.19.6 Performance outcomes

The identified performance outcome in relation to hazards is that dangerous goods are to be transported, stored and used so as to not cause a hazardous event.

8.19.7 Matters to be addressed in staged applications

Hazards assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Hazards assessments will include, as relevant to the stage:

- Desktop review of the relevant regulatory framework and guidelines
- Identification of the types of activities that may generate potential hazards
- Identification of the potential environmental impacts associated with the potential hazards
- Identification of mitigation measures to address the potential hazards.

An assessment of potential hazards for Stage 1 is provided in Chapter 25 (Hazards – Stage 1).

8.20 Sustainability and climate change

8.20.1 Sustainability overview

The NSW Government has defined sustainability in the NSW public sector as 'addressing the needs of current and future generations through the integration of social justice, economic prosperity and environmental protection in ways that are transparent, accountable and fiscally responsible' (NSW Government, 2006).

Four principles of Ecologically Sustainable Development are defined in the Environmental Planning and Assessment Regulation 2000 as:

- The precautionary principle – if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- Inter-generational equality – the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the future generations
- Conservation of biological diversity and ecological integrity – conservation of biological diversity and ecological integrity should be a fundamental consideration
- Improved valuation and pricing of environmental resources – environmental factors should be included in the valuation of assets and services, including the principle of polluter pays, consideration of full life cycle costs and incentive structure to enable those best placed to maximise benefits or minimise costs.

Chapter 27 (Synthesis of the Environmental Impact Statement) details how the Concept addresses these four principles.

8.20.2 Legislative and policy context

Sustainability considerations (particularly for the NSW public sector agencies) have been incorporated into various legislative and policy mechanisms. These mainly relate to efficient use of resources, including waste and energy.

The key legislative and policy mechanisms are:

- NSW Climate Change Policy Framework (NSW Government, 2016) aims to maximise the economic, social and environmental wellbeing of NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change. It includes an aspirational long-term objective to achieve net-zero emissions by 2050
- NSW Government Resource Efficiency Policy (NSW Government, 2019) aims to reduce the NSW Government's operating costs and increase the efficiency of its resource use
- Transport for NSW Corporate Plan – Connecting NSW (Transport for NSW, 2016) identifies the delivery of sustainable and innovative solutions to transport needs in NSW
- Future Transport Strategy 2056 (NSW Government, 2018) identifies sustainability as one of six key outcomes of the vision of the plan
- Transport for NSW Environment and Sustainability Policy (Transport for NSW, 2020) reflects the Transport for NSW duty to undertake activities in the interest of the greater good, moving beyond compliance, and being a genuine leader in environment and sustainability performance
- Transport Environment and Sustainability Policy Framework (Transport for NSW, 2013) is a collective and coordinated approach to deliver the NSW Government's environmental and sustainability agenda across the transport sector
- *National Greenhouse and Energy Reporting Act 2007* is the national framework for reporting and disseminating information on greenhouse gas emissions, energy use and energy production associated with the activities of Australian corporations
- Commonwealth Renewable Energy Target currently commits Australia to generating 33,000 GWh per year of electricity from 'low emission' sources by 2020 in order to achieve the goal of a 23.5 per cent share of renewable energy in Australia's electricity supply by 2020
- Greater Sydney Commission - A Metropolis of Three Cities (Greater Sydney Commission, 2018a) – promotes integrated approaches to deliver sustainable outcomes, such as planning and delivering green infrastructure.

Other relevant legislation and policy includes:

- *Waste Avoidance and Resource Recovery Act 2001*
- National Strategy for Ecologically Sustainable Development (Ecologically Sustainable Development Steering Committee, 1992)
- Sustainable Procurement Guide (Australian Government, 2018).

An Environment and Sustainability Policy has been developed to articulate Sydney Metro's commitment to sustainable outcomes. This policy has been reproduced below in Table 8-58, and captures the social and environmental sustainability objectives of Sydney Metro.

Table 8-58: Sydney Metro Environment and Sustainability Policy

Sydney Metro Environment and Sustainability Policy
This policy reflects a commitment in the delivery of the Sydney Metro program to: • Align with, and support, Transport for NSW Environment and Sustainability Policy • Optimise sustainability outcomes, transport service quality, and cost effectiveness • Develop effective and appropriate responses to the challenges of climate change, carbon management, resource and waste management, land use integration, customer and community expectation, and heritage and biodiversity conservation • Be environmentally responsible, by avoiding pollution, enhancing the natural environment and reducing the project ecological footprint, while complying with all applicable environmental laws, regulations and statutory obligations • Be socially responsible by delivering a workforce legacy which benefits individuals, communities, the project and industry, and is achieved through collaboration and partnerships. • To deliver on these commitments, the Sydney Metro team will: **Industry leadership** • Implement coordinated and transparent decision making, by engaging with stakeholders and suppliers, encouraging innovation and demonstrating sustainability leadership • Explore new benchmarks for the transport infrastructure sector by requiring high standards from our designers, contractors and suppliers, building on experience gained through development of Sydney Metro Northwest. **Community and customer** • Provide accessible, safe, pleasurable, and convenient access and transport service for all customers • Establish positive relationships with community and stakeholders to maximise opportunities to add value to local communities. **Land use integration and place making** • Create desirable places, promote liveability and cultural heritage, and optimise both community and economic benefit • Balance transit oriented development opportunities with stakeholder expectations. **Embedding environmental and social sustainability** • Establish robust sustainability objectives and targets • Maintain an environmental management system that is integrated into all our project activities • Ensure thorough and open environmental assessment processes are developed and maintained • Develop and maintain an environmental management framework to embed best practice pollution management and sustainable outcomes during construction • Apply effective assurance processes to monitor performance against the project environment and sustainability objectives and identify appropriate reward or corrective action, as required • Apply environment and sustainability specific processes to the procurement of delivery activities. **Accountability** • Undertake public sustainability reporting • Hold employees and contractors accountable for proactively meeting their environmental and social sustainability responsibilities • Provide appropriate training and resources necessary to meet our responsibilities.

8.20.3 Sydney Metro West Sustainability Plan

A Sydney Metro West Sustainability Plan is being developed to set out the sustainability principles, objectives and initiatives including performance targets and outcomes which will be adopted from planning, procurement, design, construction and operations to end-of-life. This encompasses all three aspects of sustainability – environmental, social and economic.

Sydney Metro West (including Stage 1) would also achieve an equivalent or improved level of sustainability performance compared to previous metro projects. This would include achieving a minimum Infrastructure Sustainability Council of Australia (ISCA) IS rating of 75 – Version 1.2 (or equivalent) and a 5-Star Green Star rating.

Sustainability principles, initiatives and targets for Sydney Metro West identified as part of the development of the Sydney Metro West Sustainability Plan are discussed in Section 8.20.3. Where relevant, social sustainability has been addressed in Section 8.11 (Social impacts - Concept), and economic sustainability has been addressed in Section 8.10 (Business impacts - Concept).

8.20.4 Sustainability principles, initiatives and targets

Six principles have been developed to govern environmental and socio-economic outcomes and performance for Sydney Metro West. The principles are designed to deliver on the Sydney Metro Environment and Sustainability Policy commitments and are set out in Figure 8-9.

Figure 8-9: Sustainability principles and objectives

Targets and initiatives have been developed to support the sustainability principles. These are outlined in Table 8-59. These initiatives and targets would be further refined as part of the design process, committed to in the Sydney Metro West Sustainability Plan and included in the contract documents for all detailed design, construction and operations contracts.

Table 8-59: Sydney Metro West sustainability initiatives and targets

Principle	Category	Sustainability initiatives and targets	Project life cycle phase				
			Planning	Design	Construction	Operations	End of life
Demonstrate leadership *Deliver a world class metro that is environmentally and socially conscious, and demonstrates innovation.*	**Embedding sustainability objectives into decision making**	• Integrate environmental and social principles into the project framework	●			●	●
		• Establish collaborative working relationships with stakeholders	●	●	●	●	●
	Transparency and assurance	• Develop performance targets across all sustainability focus areas	●	●	●	●	●
		• Develop a streamlined outcomes-focussed approach to applying sustainability rating tools on the project	●				
		• Obtain a high Infrastructure Sustainability rating for relevant infrastructure		●	●	●	
		• Obtain a high Green Star rating for relevant infrastructure and precincts		●	●	●	
		• Develop an assurance framework and reporting system to assist Sydney Metro and contractors in reliably reporting against sustainability targets		●	●	●	
		• Monitor sustainability performance and provide public sustainability reports			●	●	●
	Capture sustainability benefits	• Document and evaluate environmental and social costs and benefits	●	●	●	●	●
		• Adopt whole of life costing model to maximise benefits	●	●	●	●	●
	Encourage innovation that delivers sustainability benefits	• Identify pathways to pilot new technology and approaches	●	●	●	●	●
		• Identify opportunities to enable better sustainable approaches	●	●	●	●	●
		• Engage with research organisations and look for opportunities to facilitate the uptake of new technologies and approaches	●	●	●	●	●
	Emerging trends, approaches and priority areas for consideration	• Adopt circular economy principles and practices, including increased use of recycled and innovative materials in the construction supply chain		●	●	●	●
		• Prioritise blue (water related) and green (natural and designed greening such as landscaping/planting) infrastructure	●	●			
		• Engage with local Aboriginal communities to develop integrate Aboriginal cultural values appropriately into design	●	●	●	●	
		• Consider the future role of emerging technologies in relation to transport infrastructure and precinct development	●	●	●	●	

Principle	Category	Sustainability initiatives and targets	Project life cycle phase				
			Planning	Design	Construction	Operations	End of life
Tackle climate change *Integrate a comprehensive climate change response, and drive excellence in low carbon solutions*	**Infrastructure and operations will be resilient to the impacts of climate change**	• Identify all relevant climate change risks		●	●	●	
		• Identify and implement adaptation measures to mitigate all very high, high and medium risks for the project	●	●	●	●	
		• Identify sites vulnerable to flooding, and mitigate impacts where feasible	●	●	●	●	
		• Ensure sensitivity testing is carried out on ventilation and air conditioning equipment		●	●	●	
		• Ensure emergency procedures adequately address extreme weather events				●	
		• Protect sensitive construction equipment from the effects of extreme climate and weather			●	●	
		• Continued engagement with key stakeholders to develop and implement appropriate responses to interdependent risks		●	●	●	
	Reduce energy use and carbon emissions	• Identify and prioritise areas where the greatest reductions in carbon and energy can be achieved	●	●	●	●	
		• Use energy efficient equipment, methods, and practices			●		
		• Local sourcing of materials where feasible	●	●	●	●	
		• Adopt 25kV AC traction system	●	●	●		
		• Use an Under Platform Supply system to reduce the cooling load at stations	●	●	●		
		• Passive design features such as daylight, natural ventilation and passive cooling	●	●	●		
		• Energy efficient ventilation, air conditioning, pumps, escalators, lifts and appliances	●	●	●		
		• Efficient lighting and light control systems	●	●	●		
		• Adopt battery storage, other enabling technology where feasible	●	●	●		●
	Establish energy efficiency and renewable energy/offset targets	• Achieve at least a 20 per cent reduction in carbon emissions associated with operations, when compared to business as usual		●		●	
		• Offset 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction			●		
		• Offset 100 per cent of the greenhouse gas emissions associated with consumption of electricity during operations	●			●	
		• Develop the Electricity and Offsets Procurement and Management Strategy and develop capacity to support implementation	●			●	
		• Mandate a minimum 15 per cent improvement on the current (2019) minimum performance requirement stipulated in the National Construction Code/Building Code of Australia	●	●			
		• Source 10 – 20 per cent of the low voltage electricity required at above ground stations and stabling facility from onsite renewable energy sources	●	●	●		
Manage resources efficiently *Achieve whole-of-life value through efficient use and management of resources*	**Minimise potable water use**	• Set targets and monitor potable water use		●	●	●	
		• Integrate current best-practice water-efficient features, equipment and appliances at stations, stabling facility and construction sites	●	●	●	●	
		• Avoid use of potable water for non-potable purposes if non-potable water is available	●	●	●	●	
		• Set and implement targets for the use of non-potable water in concrete	●	●	●		
	Maximise non-potable water opportunities	• Undertake a water balance to inform feasibility for reuse initiatives		●	●	●	
		• Identify and implement opportunities for treatment and reuse on the project, including water from tunnelling works, concrete batching, casting facilities		●	●		
		• Connect to district recycled water networks where feasible	●	●	●	●	
		• Harvest and reuse rainwater at permanent and temporary facilities where feasible	●	●	●	●	
	Minimise waste through the project lifecycle	• Target 95 per cent construction and demolition waste recycling	●		●		
		• Enable recycling of waste streams from office facilities and customers	●	●	●	●	
		• Plan for final disposal of operational assets, such as train carriages		●	●		●
		• Use modular, prefabricated and precast structural and finishing materials	●	●	●	●	

Principle	Category	Sustainability initiatives and targets	Project life cycle phase				
			Planning	Design	Construction	Operations	End of life
	Reduce materials consumption	• Minimise the use of concrete and steel	●	●			
		• Dematerialisation of components and finishes		●	●		
	Reduce embodied carbon and increase use of recycled materials	• Undertake lifecycle assessments and minimise the embodied impacts of materials, through the selection of low carbon alternatives and considering durability and local sourcing	●	●	●		
		• Minimise the embodied impacts of concrete through the adoption of project-wide supplementary cementitious materials use target and set targets for the use of alternate binder systems on non-structural elements		●	●		
		• Minimise the embodied impacts of steel through maximising the use of recycled steel and steel produced using energy-reducing processes		●	●		
		• Maximise the use of engineered timber for structural elements	●	●	●		
		• Investigate and implement trials and pilot programs to demonstrate the viability of recycled alternatives		●	●		
		• Engage with industry bodies to identify best practice low-impact alternative materials		●	●		
		• Prioritise products made from recycled content		●	●	●	
	Manage spoil effectively	• Minimise volumes of excavation	●	●	●		
		• Beneficial reuse of 100 per cent of usable spoil	●	●	●		
	Practice environmentally responsible sourcing	• Source 100 per cent of all timber products from either re-used timber, post-consumer recycled timber, Forest Stewardship Council or Programme for the Endorsement of Forest Certification certified sources	●	●	●		
Drive supply chain best practice *Collaborate with key stakeholders to drive a lasting legacy in workforce development, industry participation and sustainable procurement*	**Influence contractors, subcontractors and materials suppliers**	• Ensure procurement strategies are consistent with ISO:20400 Sustainable Procurement Guidelines	●	●	●	●	●
		• Ensure supply chain sustainability objectives are adopted downstream	●	●	●	●	●
		• Provide sustainability training to high impact suppliers		●	●		
	Increase supply chain transparency and responsibility	• Adopt ethical governance principles and practices, including the use of Environmental Product Declarations and eco-labelling		●	●	●	●
		• Conduct due diligence to ensure supply of materials and equipment align with human rights legislation and environmental standards	●	●	●	●	●
	Drive improvements in workforce development and industry participation	• Increase diversity within the workforce and supply chain	●	●	●	●	
		• Develop workforce skills which support skill shortages, transferable skills and new technologies	●	●	●	●	
		• Increase local employment and participation of small and medium enterprises including Recognised Aboriginal Businesses	●	●	●	●	
		• Inspire future talent and develop capacity in the sector	●	●	●	●	
		• Provide opportunities for social enterprise		●	●	●	●
Value community and customers *Respond to community and customer needs, promote heritage, liveable places and wellbeing for current and future generations*	**Protect and promote Aboriginal and non-Aboriginal heritage and culture**	• Avoid or minimise impacts to heritage	●	●	●		
		• Identify and implement opportunities to enhance heritage and cultural values via design and interpretation	●	●	●		
		• Develop partnerships with relevant stakeholders to identify heritage places and promote heritage values	●	●		●	
		• Ensure key Aboriginal stakeholders are meaningfully engaged	●	●	●	●	
		• Create opportunities for archaeological research and interpretation	●	●	●		
		• Develop Aboriginal cultural design principles for the project and integrate into project outcomes	●	●	●	●	

Principle	Category	Sustainability initiatives and targets	Project life cycle phase				
			Planning	Design	Construction	Operations	End of life
	Prioritise community and customer wellbeing	• Design in accordance with best practice urban design principles	●	●			
		• Incorporate Crime Prevention Through Environmental Design principles	●	●		●	
		• Design to minimise urban heat island and associated health risks	●	●	●	●	
		• Prioritise indoor environmental quality	●	●	●		
		• Promote Customer Centric Design	●	●	●	●	
		• Provide new public spaces which are adaptable and appropriate for a range of uses by the community	●	●	●	●	
		• Ensure efficiency and durability of built infrastructure that requires minimum expenditure in maintenance and upkeep by users including housing	●	●	●	●	●
	Enable and promote active transport access and public transport usage	• Provide secure access, covered bicycle parking and safeguard for future expansion	●	●	●	●	
		• Design to enhance connectivity to Blue-Green Grids and integrate with surrounding active transport network such as footpaths, public and green spaces, and bicycle paths	●	●	●	●	
		• Station interchanges designed in accordance with the modal hierarchy to prioritise more equitable, safe and sustainable modes of transport and an enjoyable station environment for users	●	●	●		
		• Measure health benefits of active transport and public transport as an outcome of the project	●			●	
	Deliver community benefits	• Ensure the community and local stakeholders are engaged and kept informed of project activities		●	●	●	●
		• Provide information in ways that are easily accessible, taking into consideration dominate language groups	●	●	●	●	●
		• Deliver initiatives that benefit local communities and provide positive social outcomes		●	●	●	
		• Consider opportunities for residual land to enhance precinct development and assist local communities	●	●	●	●	●
Respect the environment *Minimise impacts and take opportunities to provide environmental improvements*	**Minimise environmental impact**	• Target zero major pollution incidents			●	●	●
		• Reduce sources of pollution through the development and implementation of a Construction Environmental Management Framework	●	●	●	●	
		• Ensure environmental management plans and systems are in place		●	●	●	
		• Avoid or minimise noise and vibration impacts	●	●	●	●	
		• Early identification and management of soil and groundwater contamination issues	●	●	●	●	
		• Design to minimise light spill in accordance with standards	●	●	●	●	
		• Develop an appropriate response to reduce air pollution	●	●	●	●	
		• Develop appropriate responses to manage stormwater and groundwater contamination and runoff	●	●	●	●	
	Promote ecological functions and biodiversity	• Avoid or minimise impacts to biodiversity, particularly with regard to endangered, vulnerable and threatened species, habitats and communities	●	●	●	●	
		• Preserve ecological function through appropriate planning, management and financial controls	●	●	●	●	
		• Contribute to the restoration and conservation of local ecological communities	●	●	●	●	
		• Consider connectivity of existing ecosystems and impact on fauna movements	●	●	●	●	
	Provide and promote green infrastructure	• Provide a high level of open green space at precincts, where feasible		●	●	●	
		• Provide green roofs and green walls at stations, inside the corridor and precincts, where feasible	●	●	●	●	
		• Use endemic species in landscaping and prioritise use of Aboriginal knowledge (six seasons) in asset management	●	●	●	●	
		• Integrate water sensitive urban design solutions	●	●	●	●	

8.20.5 Climate change

Identification and risk assessment approach

The climate change risk assessment and adaptation planning process carried out for Sydney Metro West has been designed to align with the principles of AS5334-2013 Climate change adaptation for settlements and infrastructure – a risk-based approach. This document draws extensively on AS/NZS ISO31000-2009 Risk management – principles and guidelines.

A climate change workshop was undertaken as part of the definition design process at which participants considered climate change projections for the region and the potential impact these would have on a range of aspects related to construction and operation.

The identification and assessment of climate change risks for the Concept involved consideration of hazards, potentially affected project elements, likelihood and consequence. The approach is summarised below:

- Hazard – climate or climate-influenced attributes with potential to influence the operation and maintenance of Sydney Metro West
- Affected element – the component of the operation and/or maintenance of Sydney Metro West that would be impacted by the hazard. This may also include users of Sydney Metro West and affected elements of the surrounding environment
- Risk rating – utilising a likelihood and consequence rating system, an assessment of the way hazards could influence the element is made and a risk rating assigned.

Future climate

The Australian climate is likely to experience a greater frequency and severity of extreme weather events due to climate change.

Detailed projections based on regional climate models for the east coast of Australia and modelling reported in the Intergovernmental Panel on Climate Change Fifth Assessment Report (Intergovernmental Panel on Climate Change, 2013) are presented below in Table 8-60.

Table 8-60: Summary of climate change projections – Sydney region

	Baseline (1986-2005)	2030	2070	2090
Temperature				
Sydney CBD				
Average maximum temperature (°C)	22.6	23.6	25.2-26.1	26.4-27.4
Average temperature (°C)	18.6	19.6	21.3-22.0	22.2-23.3
Average minimum temperature (°C)	14.6	15.6	17.4-18.0	18.0-19.3
Days over 35°C	4.1	5.3	9.2-11.8	12.6-16.6
Parramatta CBD				
Mean average maximum temperature (°C)	23.4	24.4	26.1-26.9	27.2-28.2
Average temperature (°C)	17.8	18.8	20.6-21.3	21.4-22.6
Mean average minimum temperature (°C)	12.2	13.3	15.1-15.6	15.6-16.9
Days over 35°C	12.3	16.1	25.0-31.9	32.1-42.6
Rainfall				
Sydney CBD				
Mean annual rainfall (mm)	1276	1380	1135-1173	836-890
2.5% Annual Exceedance Probability daily rainfall event (mm)	328	346	379-392	397-413
Parramatta CBD				
Mean annual rainfall (mm)	1027	1097	918-944	699-730
2.5% Annual Exceedance Probability daily rainfall event (mm)	293	309	339-350	355-369
Extreme rainfall (all)				
Climate change factor for extreme rainfall events (%)	-	+5.6	+15.8	+21.3
Wind speed (all)				
Average wind speed (%)	-	-0.5	N/A	-1.1
Relative humidity (all)				
Average relative humidity (%)	-	-0.6	N/A	-1.5
Atmospheric concentration of CO2 (all)				
Atmospheric concentration of CO2 (ppm)	369 (in 2000)	449	541	935

As a consequence of these projections (especially increased temperatures and reduced annual rainfall) there could be increases in the number of days during which the Forest Fire Danger Index will be greater than 50 (Severe).

Potential risks

Operation

Climate change could have potential direct and indirect impacts relevant Greater Sydney and more specifically to the Sydney Metro West infrastructure and operations. While the types of impacts are relatively well understood, their severity and extent are uncertain. Risks therefore need to be identified and assessed and strategies to address them developed. To effectively manage climate change risks, each stage in the project should consider the most up to date climate change projections and design guidelines. The climate risks require ongoing review and response by designers and constructors.

The climate change risk assessment process for the Concept identified the following risks after the implementation of climate change adaption measures (residual risks):

- Fourteen medium ('tolerable') risks
- Thirteen low ('acceptable') risks
- No very high ('unacceptable') risks or high ('undesirable') risks were identified.

The fourteen medium risks included issues in the following categories:

- Increasing daily, annual and extreme temperatures – which could lead to rail infrastructure damage (for example track twisting) and inability of air conditioning units to maintain design temperatures for customers and staff
- Increase in the intensity of extreme rainfall and changes to flooding – which means potential for inundation of station entrances and damage to rail infrastructure
- Increase in sea levels – leading to potential inundation of rail infrastructure
- Combined effect of increase in extreme temperatures, severe weather events and natural disasters – which could cause disruptions to services and hazards within stations
- Increase in atmospheric concentrations of carbon dioxide in addition to hotter and wetter climate – which could result in carbonation of concrete and structures not lasting their required lifespan and/or requiring additional maintenance.

The types of climate change adaption measures considered (in addition to the 'business as usual' measures that would be implemented) included:

- Space proofing of tunnels and stations to allow for expansion ventilation and cooling systems
- Providing appropriate redundancy and back up for key systems including power, ventilation and cooling
- Consideration of microclimates (including cooling via landscape treatments and planting) around stations as part of the design process.

Construction

The types of climate change risks during construction would be associated with severe weather events, such as the increased frequency and severity of rainfall events placing increased pressure on erosion and sediment control measures and/or resulting in the flooding of the tunnels and/or construction sites.

However, construction of the initial stages of the Concept is likely to occur in the near future at a time when climate change risks cannot be differentiated from the current climate.

8.20.6 Greenhouse gas emissions

Greenhouse gas is a collective term for a range of gases that absorb outgoing infra-red radiation reflected from the earth which in turn generates heat. This heat warms the atmosphere. This is known as the greenhouse effect and is linked to climate change. Human activities, including the combustion of carbon-based fuels increase the concentration of greenhouse gases in the atmosphere. This leads to greater absorption of infra-red radiation and an increase in atmospheric temperature. This is known as the enhanced greenhouse effect.

Operation

When operational, Sydney Metro West would provide an attractive alternative mode of public transport that may result in a mode shift from road to rail. Subject to the extent of mode shift, the Concept would have the potential to result in a net reduction in greenhouse gas emissions.

Operational greenhouse gas emissions would predominantly be associated with electrical consumption to power the following:

- Metro trains
- Station facilities
- Signalling and communications
- Tunnel ventilation
- Stabling and maintenance facility
- Water treatment plants.

Construction

Greenhouse gas emissions would be generated during the construction of the Concept, with substantial energy-consuming activities anticipated to occur over the construction period. Greenhouse gas emissions would predominantly be generated as a result of:

- Combustion of fuel in construction plant, equipment and vehicles – these would be Scope 1 emissions (direct emissions occurring on-site)
- Electricity consumption for the tunnel boring machines – these would be Scope 2 emissions (occurring off-site at power stations)
- Electricity used at construction sites – these would be Scope 2 emissions (occurring off-site at power stations)
- Embodied emissions in key construction materials, including cement and steel – these would be Scope 3 emissions (energy and resources of construction materials consumed to produce a particular construction material)
- Emissions from vegetation clearance or construction waste – these would be Scope 1 but would be very low to negligible as minimal vegetation clearing is required.

8.20.7 Management approach and performance outcomes

Identified performance outcomes for sustainability are:

- The construction and operation of Sydney Metro West is consistent with the Sydney Metro Environment and Sustainability Policy
- Sustainability initiatives are incorporated into the planning, detailed design and construction of the Concept
- Infrastructure Sustainability Council of Australia (ISCA) IS rating of 65 Gold – Version 2.0 (or equivalent) and a 5-Star Green Star rating are achieved during design and construction for appropriate components
- Design of stations and stabling buildings achieve at least a 15 per cent improvement over performance requirements set out in Section J of the National Construction Code.

Identified performance outcomes in relation to climate change and greenhouse gas emissions for operation and construction of the Concept are provided in Table 8-61.

Table 8-61: Climate change and greenhouse gas emissions performance outcomes

Operational performance outcomes	Construction performance outcomes
• Comprehensively address climate change risks during the design life of Sydney Metro West for all risks rated 'medium' or higher • 100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation are offset.	• 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction are offset.

The management approach for sustainability and climate change would be established for each stage of the Concept. For Stage 1, the management approach is described in Chapter 26 (Sustainability and climate change – Stage 1).

8.20.8 Matters to be addressed in staged applications

Sustainability, climate change and greenhouse gas and energy assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Sustainability

The Environmental Impact Statement for each stage application would confirm consistency with the Sydney Metro West Sustainability Plan.

Climate Change

The climate change assessments will include, as relevant to the stage:

- Identification of possible climate related impacts with an emphasis on any that are projected to undergo a substantial change
- Identification of components that may be vulnerable to the climate change impacts
- Identification of possible current and future controls that may increase the resilience of future stage components to climate impacts
- Recommendation what should be considered, and how to establish if further information is needed, to adequately assess climate change risk.

Greenhouse gas and energy

The greenhouse gas and energy assessments will include, as relevant to the stage:

- Identification of the potential greenhouse gas emissions
- Identification of mitigation and management measures to reduce potential emissions of greenhouse gas.

An assessment of sustainability and climate change for Stage 1 is provided in Chapter 26 (Sustainability and climate change – Stage 1).

8.21 Cumulative impacts

8.21.1 Overview of cumulative benefits or impacts

Cumulative benefits or impacts have the potential to occur when benefits or impacts from a project interact or overlap with benefits or impacts from other projects and can potentially result in a larger overall effect (positive or negative) on the environment, businesses or local communities. Cumulative impacts may occur during construction stages when projects are constructed or operated concurrently or consecutively. Projects constructed consecutively (or sequentially) can have construction activities occurring over extended periods of time with little or no break in construction activities. This has the potential for increased impacts and construction fatigue for local communities.

The overall effect of cumulative benefits or impacts could be positive or negative, depending on the nature of the project and the nearby communities and environment. Once Sydney Metro West is operational, other projects which interrelate may enhance the Concept and create positive cumulative benefits.

The extent to which another development or activity could interact with the construction and/or operation of the Concept would depend on its scale, location and/or timing of construction. Generally, cumulative impacts would be expected to occur where multiple long-duration construction activities are undertaken close to, and over a similar timescale of, construction activities for the Concept, or where consecutive construction activities occur in the same area. Additionally, operation of the Concept could cause cumulative benefits or impacts when it interrelates or possibly enhances the construction or operation of other projects.

Projects with potential to generate cumulative impacts with the Concept can be broadly categorised as:

- Major transport infrastructure projects, including public transport and road projects
- Large-scale urban development and other infrastructure projects.

Local strategic plans should also be considered where they may result in future development with potential cumulative impacts.

The following screening criteria would be applied to determine the projects to be included in the assessment of cumulative impacts for future project stages:

- Location – proximity to areas and activities assessed as part of each staged assessment
- Timeframe – whether the project occurs in the recent past or present or foreseeable future
- Scale – potential impacts of a scale that could cause cumulative impacts with each staged assessment
- Status – the stage of the project at the time of each staged assessment (including forecast timeframes for construction and operation). Stages includes approved projects, proposed projects and local strategic plans.

Potential cumulative impacts that may occur during either the operation or construction of the Concept was considered.

8.21.2 Assessment approach

This assessment involved:

- Identifying the types of projects and plans likely to generate cumulative impacts with the Concept
- Identifying the potential cumulative impacts during operation and construction of the Concept Developing a management approach to address the potential impacts identified
- Identifying performance outcomes
- Identifying the proposed scope of cumulative impact assessments for future stages.

8.21.3 Potential operational benefits and impacts

Sydney Metro West is planned and developed as part of the integrated transport network. Working with other projects, this would provide cumulative transport benefits where other public transport projects complement the operation of the Concept such as by increasing the number of people located within a station's catchment and improving travel times for customers.

Similarly, other transport and urban renewal projects in the vicinity of the Concept would provide cumulative placemaking benefits.

A summary of the potential types of cumulative benefits and impacts that could occur during operation of the Concept is provided in Table 8-62.

Table 8-62: Summary of potential cumulative operational benefits and impacts

Issue	Description of potential benefits and impacts
Placemaking	• Additional opportunities for urban renewal due to the combined operation of multiple projects • Additional amenity and placemaking benefits from enhanced pedestrian environments such as active transport links, improved surface and lighting.
Transport and traffic	• Additional benefits to public transport services where other projects complement the operation of the Concept such as by increasing the number of people located within a station's catchment and improving travel times for customers • Additional changes to the distribution of traffic and access arrangements, and associated changes in amenity, including noise, due to the combined operation of multiple projects.
Non-Aboriginal and Aboriginal heritage	• Improved sightlines for heritage-listed structures as a result of changes to buildings • Additional impacts (both positive and negative) to the setting or significance of heritage listed items and/or conservation areas due to changed views, access or functionality of an area as a result of multiple projects.
Landscape character and visual amenity	• Additional permanent and improved changes to the visual and landscape context of the Concept corridor where other urban renewal projects are developed.
Social impacts	• Extension of public transport catchments (as described above) could increase social benefits of the Concept, such as further reducing travel related stress by reducing time spent in congested conditions; and improving social cohesion from increased access to jobs, universities, services and social facilities.
Hydrology and flooding	• Additional changes to existing stormwater catchment flows due to the operation of multiple projects • Additional change in flooding behaviour if the loss of floodplain storage from multiple projects occurs.

8.21.4 Potential construction impacts

Potential cumulative impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.21.5. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

A summary of potential types of cumulative impacts during construction of the Concept, associated with consecutive and/or concurrent projects is provided in Table 8-63.

Table 8-63: Summary of potential cumulative construction impacts

Issue	Description of potential impacts
Transport and traffic	• Potential temporary increase in traffic congestion and associated amenity impacts (such as noise, visual and air quality) on sensitive receivers near construction traffic routes • Potential temporary additional loss of street parking and other kerbside uses • Potential temporary additional disruptions or changes to the public transport network.
Noise and vibration	• Potential temporary increase in construction noise and vibration impacts to sensitive receivers in the short term due to multiple projects under construction at the same time • Potential construction noise and vibration impacts over long timeframes due to projects being constructed consecutively.
Property and land use	• Potentially additional temporary loss of public open space, parks and recreational facilities within localities • Additional private property acquisition.
Landscape character and visual amenity	• Potentially additional temporary visual impacts and changes to landscape character due to the presence of construction sites for multiple projects.
Business impacts	• Potentially additional temporary alterations to access, visibility and amenity of businesses • Potentially additional temporary changes (increases or decreases) in passing trade for local businesses and services • Potentially additional and prolonged increased demand for businesses that provide products and services to construction workers, providing benefits for local workers.
Social impacts	• Potentially additional temporary changes to the character of local areas • Potentially additional temporary amenity effects on local residents and use of community facilities • Potentially additional temporary effects on the way of life for residents where disruption occurs from the construction of other projects nearby or from projects that have been recently completed.

Issue	Description of potential impacts
Groundwater and ground movement	• Potentially additional groundwater drawdown impacts due to dewatering from multiple tunnelling or excavation projects • Potentially additional impacts on groundwater users due to reduced groundwater yields, reduced groundwater quality and/or direct impacts and damage to existing groundwater bores.
Surface water quality	• Potentially additional risk to water quality from surface water runoff due to increased areas of impervious surfaces.
Contamination	• Potentially additional mobilisation and interaction of contaminated groundwater with neighbouring lands with existing contamination.
Biodiversity	• Potentially additional loss of fauna habitat and native vegetation • Potentially additional impacts to habitat connectivity • Potentially increased threat to threatened or endangered communities and native flora and fauna.
Spoil, waste management and resource use	• Increased volume of spoil being generated within the Sydney metropolitan region due to concurrent tunnelling and construction projects, which may impact spoil reuse opportunities.

8.21.5 Performance outcomes

The identified performance outcome in relation to cumulative impacts is that cumulative impacts are to be minimised through co-ordination of construction activities and communication processes with nearby projects.

8.21.6 Matters to be addressed in staged applications

Cumulative impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Cumulative assessments will include, as relevant to the stage:

- Identification of projects with the potential to generate cumulative impacts through consultation with stakeholders and review of the Department of Planning, Industry and Environment's Major Projects planning portal, government agency databases and local council development application registers
- Application of a screening criteria – including location, timeframe, scale and status – to determine which of these projects are likely to generate cumulative impacts
- Identification of potential cumulative impacts
- Identification of mitigation measures and management strategies to address the potential cumulative impacts.

Assessment of cumulative impacts for Stage 1 are provided in each Stage 1 assessment chapter (Chapters 10 to 26).

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