

Chapter 15

Soils and surface water quality

15 Soils and surface water quality

This chapter provides an assessment of the potential impacts of the proposal on soils and surface water quality and identifies mitigation measures to address these impacts. This chapter draws on information in Technical Paper 9 (Hydrology, flooding and water quality) and Technical Paper 8 (Contamination).

15.1 Overview

The existing water quality in the area is generally poor due to the heavily urbanised state of the surrounding environment. The construction of the proposal has the potential to impact on local waterbodies. Potential impacts are generally associated with construction activities which may disturb and/or spread sources of pollutants, generate soils and waste materials, soil erosion and discharge of concrete dust/slurries. Erosion and sediment mitigation measures would manage these potential pollutant sources to minimise the potential for these to be conveyed to nearby waterbodies. The water treatment plants would be designed with the aim of treating wastewater to a level as close as practicable to relevant surface water criteria to either maintain or improve the water quality of the surface waterways and marine environment. Therefore, potential impacts of the proposal on the water quality of Sydney Harbour would be negligible.

Testing would be carried out to determine the presence of acid sulfate soils within construction sites and saline soils. Any identified acid sulfate soils or saline soils would be managed in accordance with relevant guidelines.

15.2 Legislative and policy context

The Secretary's Environmental Assessment Requirements relating to soils and surface water quality, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Appendix A.

The following legislation, policies and guidelines were considered for the assessment of soils and surface water:

- *Environmental Planning and Assessment Act 1979*
- *Water Act 1912, Water Management Act 2000*
- Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011
- Water Management (General) Regulation 2018
- *Protection of the Environment Operations Act 1997*
- *State Environmental Planning Policy (Coastal Management) 2018*
- *NSW Aquifer Interference Policy* (Office of Water, 2012)
- *Groundwater Dependent Ecosystems Policy* (Department of Land and Water Conservation, 2002)
- *Guidelines for Groundwater Quality Protection in Australia* (Australian Government, 2013)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC guidelines) (ANZG, 2018)
- *Policy and guidelines for fish habitat conservation and management – Update 2013* (NSW Department of Primary Industries, 2013)
- *Framework for Biodiversity Assessment – Appendix 2* (OEH, 2014)
- *Managing Urban Stormwater: Soils and Construction, Volume 1* (Landcom, 2004)
- *Managing Urban Stormwater: Soils and Construction, Volume 2* (Department of Environment and Climate Change, 2008)
- NSW Soil and Land Information System (NSW Office of Environment and Heritage, 2019)
- *Acid Sulfate Soils Assessment Guidelines* (Department of Planning, 2008)
- *Acid Sulfate Soils Assessment Manual* (NSW Acid Sulfate Soils Management Advisory Committee, 1998)
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (Department of Environment and Conservation, 2004).

The legislative and policy context for this assessment is further described in Chapter 2 of Technical Paper 9 (Hydrology, flooding and water quality) and Chapter 2 of Technical Paper 8 (Contamination).

15.3 Assessment methodology

The assessment methodology for the soils and surface water quality impact assessment involved:

- A review of publicly available data and web-based information searches, including:
 - *NSW Department of Environment, Climate Change and Water's Soil Landscapes of Sydney 1:100,000 Sheet* (Tille et al., 2009)
 - *Soil Landscapes of the Sydney 1:100,000 Sheet map, Ed. 4, Department of Environment, Climate Change and Water, Sydney* (Chapman et al, 2009)
 - *Salinity hazard report for Catchment Action Plan upgrade – Sydney Metropolitan CMA* (Winkler et al, 2012)
 - *Australian Soil Resource Information System* (CSIRO, 2021)
 - *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC guidelines) (ANZG, 2018)
 - Sydney Harbour Water Quality Objectives
- Identification of sensitive receiving environments
- Identification of the potential for the proposal to disturb acid sulfate soils and the associated impacts
- Identification of potential impacts of the proposal on surface water quality, including an indicative water balance
- Development of mitigation measures to address potential soils and surface water quality impacts.

15.3.1 Study area

The study area for the soils assessment was defined as a 500 metre buffer surrounding:

- The five proposed construction sites – The Bays tunnel launch and support site, two Pyrmont Station construction sites and two Hunter Street (Sydney CBD) construction sites
- The tunnel alignment between The Bays and the Sydney CBD
- The power supply route identified in Chapter 5 (Project description).

The surface water quality study area includes all catchment areas where there could be potential impacts from the proposal, which is within a small area of the Sydney Harbour catchment. Relevant waterways and waterbodies are shown in Figure 14-2.

15.4 Avoidance and minimisation of impacts

The design development of the proposal has focussed on avoiding or minimising potential soil and surface water quality impacts. This has included minimising the extent of construction disturbance and avoiding direct impact on waterbodies where practicable.

15.5 Existing environment

15.5.1 Soils

Soil types

The following soil landscape types are present within the soils study area:

- Residual soils associated with the Gymea and Lucas Heights soil landscapes. These are derived from weathered siltstone and sandstone rock, except where formed by erosion. The residual soils derived from shale typically comprise stiff to hard clay of medium to high plasticity, gravelly clay, sandy clay and silt. The residual soils derived from sandstone typically comprise thin (less than 1.5 metres thick) medium plasticity silty clay to sandy clay
- Alluvial/fluvial soils associated with the Deep Creek soil landscape
- Disturbed terrain.

Soil landscapes within the soils study area have been identified from the NSW Department of Environment, Climate Change and Water's Soil Landscapes of Sydney 1:100,000 Sheet (Chapman et al., 2009). The characteristics of the major soil types identified along the tunnel alignment are shown in Figure 15-1 and summarised in Table 15-1.

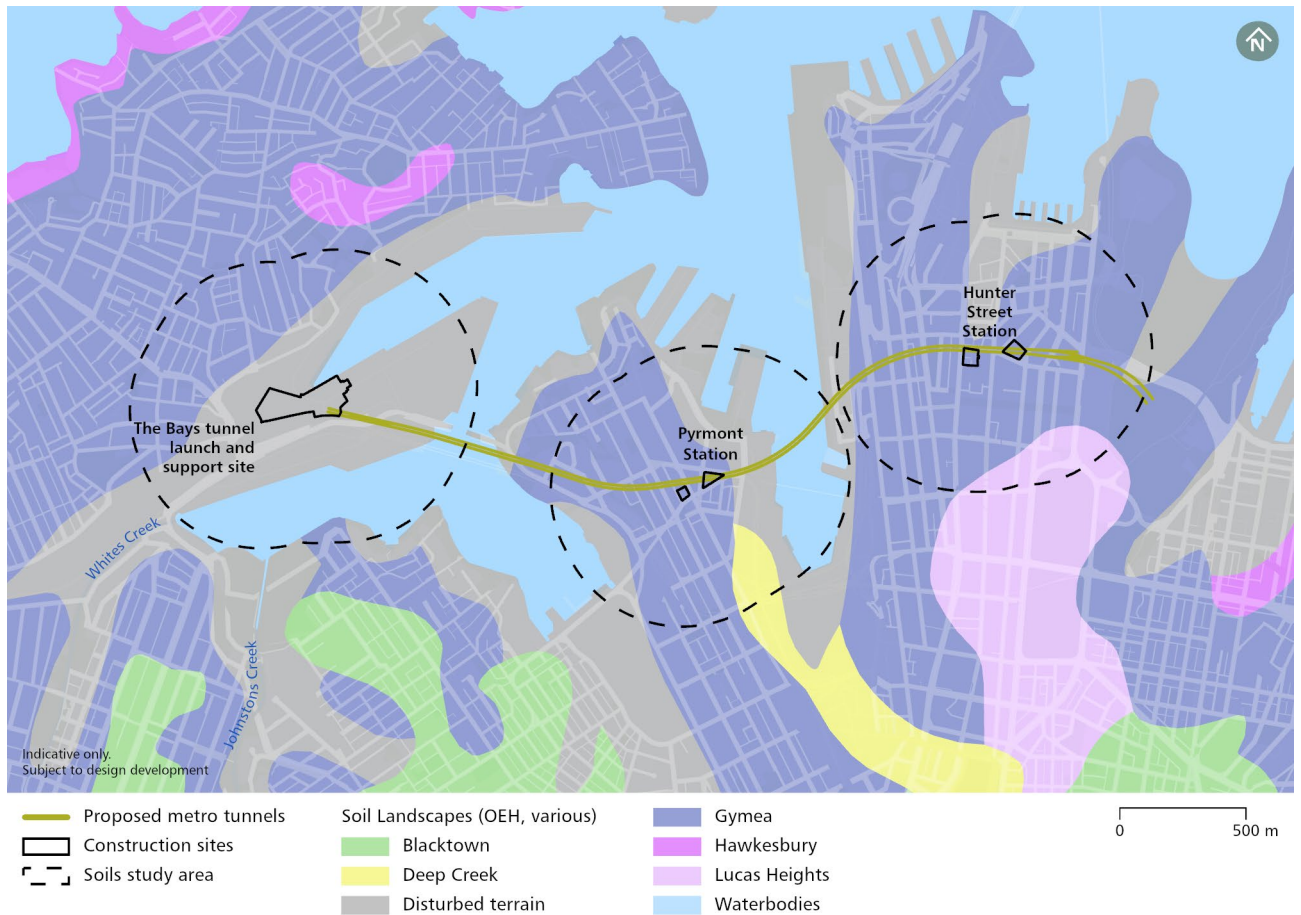


Figure 15-1 Soil landscapes underlying the study area

Table 15-1 Soil landscapes underlying the study area

Soil landscape	Description
Deep Creek	<ul style="list-style-type: none"> • Landscape: level to gently undulating alluvial floodplain draining the Hawkesbury Sandstone. Slopes are typically less than three per cent and local reliefs of less than five metres • Soils: deep (greater than 200 centimetres) • Limitations: flooding, extreme soil erosion hazard, sedimentation hazard, localised very low fertility and permanently high water tables
Disturbed Terrain	<ul style="list-style-type: none"> • 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 be 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
Gymea	<ul style="list-style-type: none"> • 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 centimetres to 100 centimetres) • Limitations: localised steep slopes, high soil erosion hazards, shallow highly permeable soil and very low soil fertility
Lucas Heights	<ul style="list-style-type: none"> • Landscape: gently undulating crests and ridges on plateau surfaces of the Mittagong Formation, with slopes of less than 10 per cent and local relief of 30 metres • Soils: moderately deep (50 centimetres to 150 centimetres) • Limitations: stony soil, low soil fertility, low available water capacity

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. A review of the *Salinity hazard report for Catchment Action Plan upgrade – Sydney Metropolitan CMA* (Winkler et al, 2012) was carried out to identify areas where salinity may be present within the soils study area. This mapping identifies that there is a very high salinity hazard where potential acid sulfate soils are mapped.

Acid sulfate soils and saline soils are present within natural marine sediments at depth at The Bays tunnel launch and support site. Potential acid sulfate and saline soils are also likely to be present near the surface of the Pymont Station eastern construction site.

Other lithologies that may represent a salinity hazard have not been identified in the soils study area.

Acid sulfate soils

Acid sulfate soils are the common name given to naturally occurring sediments and soils containing iron sulfides (principally iron sulfide or iron disulfide or their precursors). Exposure of the sulfide in these soils to oxygen as a result of drainage, groundwater drawdown or excavation leads to the generation of sulfuric acid. Areas of acid sulfate soils are typically found in low-lying and flat locations that are often swampy or prone to flooding.

A review of the Environmental Planning Instrument – Acid Sulfate Soils (Department of Planning, Industry and Environment mapping, 2021) identifies the extent of acid sulfate soils based on the likelihood of acid sulfate soils being present in particular areas and at certain depths, as shown in Figure 15-2. A review of this database indicates that:

- Acid sulfate soils are likely to be found on and below the natural ground surface on the eastern side of Johnstons Bay, eastern side of Pymont Bay and eastern side of Darling Harbour (Class 1)
- Acid sulfate soils are likely to be found below the natural ground surface to the south of the study area along Darling Harbour and Johnstons Bay (Class 2)
- Acid sulfate soils are not typically found in other areas of the tunnel alignment (Class 5).

No areas are identified as Class 3 or Class 4 (i.e. where acid sulfate soils are likely to be found beyond one or two metres below the natural ground surface).

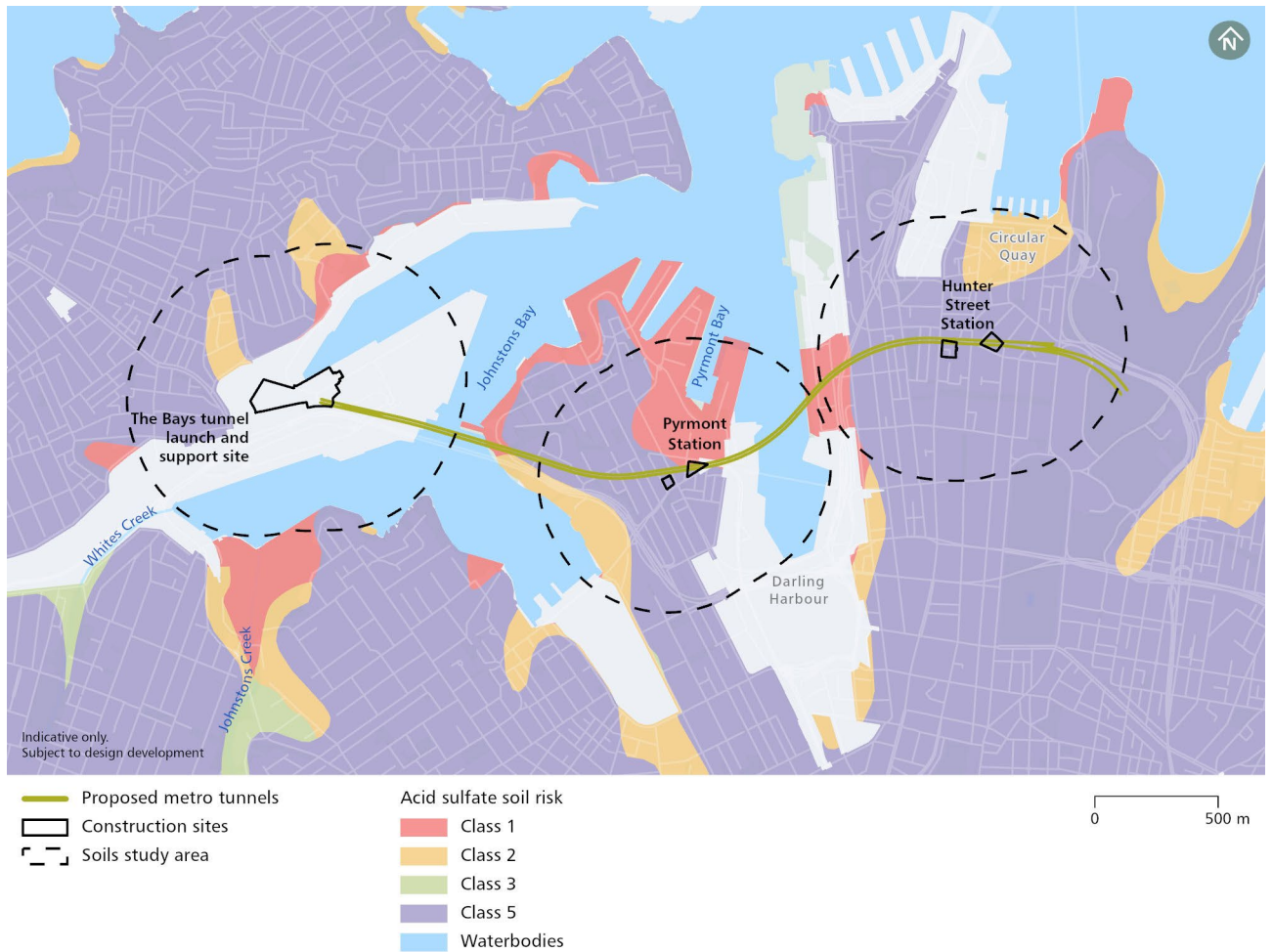


Figure 15-2 Acid sulfate soil risk within the study area

15.5.2 Surface water

Catchments and waterbodies

The proposal would be located entirely within the Sydney Harbour catchment. The water flow from all construction sites would drain to Sydney Harbour, generally via a network of underground stormwater channels, pipes and drainage systems. The catchment is highly urbanised and altered from its natural state. Catchment areas draining to flow paths and waterbodies in the vicinity of the construction sites contain a mixture of low, medium and high density residential, commercial and industrial land uses, with some parklands and open spaces. The catchment areas also include several main rail and road transport corridors. These land uses influence the water quality, quantity and speed of flows within the catchment.

The waterbodies, waterways and catchments for each construction site are shown in Figure 14-2 (Chapter 14 (Groundwater and ground movement)) and Table 15-2.

Table 15-2 Relevant waterbodies and catchments

Construction site	Waterbody	Receiving waters
The Bays tunnel launch and support site	White Bay	Sydney Harbour
Pyrmont Station construction sites	Blackwattle Bay, Cockle Bay and Pyrmont Bay	Sydney Harbour
Hunter Street Station (Sydney CBD) construction sites	Sydney Cove	Sydney Harbour

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 catchment:

- **Aquatic ecosystems** – Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term
- **Visual amenity** – Aesthetic qualities of waters
- **Primary contact recreation** – Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed
- **Secondary contact recreation** – Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed
- **Aquatic foods (cooked)** – Protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.

Table 15-3 shows the environmental values assigned to the relevant waterbodies.

Table 15-3 Assigned environmental values for waterbodies

Waterbody	Environmental Value				
	Aquatic ecosystems	Visual amenity	Primary contact recreation	Secondary contact recreation	Aquatic foods (cooked)
White Bay	●	●	●	●	●
Blackwattle Bay, Cockle Bay and Pyrmont Bay and Sydney Cove	●	●	●	●	●

The water quality of Sydney Harbour is influenced by several factors including:

- Current and historical land uses
- Wastewater overflows and leachate from contaminated and/or reclaimed land
- Urbanisation of the catchments and subsequent reduction in permeable area and a resulting increase in run-off
- Illegal dumping
- Contaminants entering the Sydney Harbour via stormwater including:
 - Sediments (e.g. soil erosion)
 - Pathogens (e.g. bacteria from leaking septic tanks) and animal faeces
 - Gross pollutants (e.g. litter)
 - Toxicants (e.g. pesticides, accidental spills or deliberate dumping)
 - Nutrients (e.g. wastewater overflows, fertilizers, detergents and animal faeces)
 - Oils and lubricants from road and boat-based pollutants
 - Organic matter (e.g. leaf litter)
 - Anti-fouling paints, disposal or overflow of sewerage and galley wastes from boats.

A review of available water quality data shows that the water quality within the Sydney Harbour catchment is characterised by elevated nutrient and heavy metal concentrations and high turbidity. Water quality in the Sydney Harbour catchment was identified as having elevated levels of:

- Total nitrogen
- Total phosphorus
- Chlorophyll-a
- Enterococci
- Sediment.

Existing water quality and relevant studies carried out are further described in Section 4.9 of Technical Paper 9 (Hydrology, flooding and water quality).

Sensitive receiving environments

A sensitive receiving environment has 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.

Sydney Harbour is identified as a sensitive receiving environment due to the presence of:

- *State Environmental Planning Policy (Coastal Management) 2018* listed Coastal Wetlands
- Type 1 (highly sensitive) Key Fish Habitat
- Potential habitat for threatened aquatic species and protected aquatic vegetation.

Although the entire Sydney Harbour catchment is mapped as Key Fish Habitat and classified as Type 1 Key Fish Habitat, the bays in the vicinity of this proposal are unlikely to contain significant aquatic habitat due to being heavily modified and are therefore not considered Key Fish Habitat in accordance with the *Policy and guidelines for fish habitat conservation and management – Update 2013* (NSW Department of Primary Industries, 2013). No threatened species listed under the *Fisheries Management Act 1994* have potential habitat within the relevant areas of Sydney Harbour.

15.6 Potential impacts

15.6.1 Soils

Surface soils could be impacted by heavy metals, hydrocarbons and asbestos during excavation of surface materials. Increased potential for impact is likely to be associated with the removal of potentially contaminated surface soils, potential acid sulfate soils or saline soils to facilitate any minor surface work associated with the construction sites or excavation of crossover caverns (where potentially contaminated materials, potential acid sulfate soils or saline soils need to be disturbed and handled during construction).

Soil erosion

Mitigation measures would be implemented to manage potential impacts of construction on the soil environment. It is expected that soil erosion would be adequately managed in accordance with measures, given the relatively small areas of surface disturbance anticipated during construction. Measures would be applied from the *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction Volume 2* (Department of Environment and Climate Change, 2008a). Relevant measures would be designed for the 80th percentile; five-day rainfall event.

Potential impacts could include temporary exposure of the natural ground surface and sub-surface through the removal of sporadic vegetation, overlying structures (such as buildings and footpaths) and excavation for shafts, structures and foundations. The temporary exposure of soil to water runoff and wind erosion could potentially increase soil erosion potential, particularly where construction is carried out in soil landscapes characterised by a high and extreme erosion hazard. There is the potential that exposed soils – and other unconsolidated materials, such as spoil, sand and other aggregates – could be transported from the construction sites into waterbodies via stormwater runoff.

Acid sulfate soils

Compared to the surrounding soils, increased potential for acid sulfate soils impact is likely at The Bays tunnel launch and support site and Pyrmont Station eastern construction site where known and potential acid sulfate and saline soils are present. This would be associated with the removal of surface soils for excavation of the station shafts or other supporting surface construction work.

If acid sulfate soils are encountered, they would be effectively managed in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee, 1998). The manual includes procedures for the investigation, handling, treatment and management of such soils.

Disturbance of potential acid sulfate soils at depth during tunnelling work, at the Pyrmont Station western construction site or at the Hunter Street Station (Sydney CBD) construction sites is considered unlikely.

15.6.2 Surface water quality

Construction work

Standard construction management measures would be implemented to minimise potential and temporary risks to downstream water quality from the construction of the proposal. Construction work may potentially impact on waterbodies and watercourses through the disturbance and mobilisation of soil or other materials, which may affect the water quality and ecosystem health of receiving environments. Water quality impacts could potentially arise from:

- Surface work, such as demolition, earthwork, stockpiling, vegetation removal, concreting
- Tunnelling and excavation work at station construction sites.

The mitigation measures in Section 15.8 would be implemented to manage potential impacts to water quality which would be low and temporary, with no long term impacts expected. A summary of potential impacts to surface water quality from surface work is provided in Table 15-4. Surface construction work would generally be carried out in highly modified and urban environments and would not be located within or near waterways.

Table 15-4: Potential impacts on surface water quality from construction work

Construction work	Potential impacts
Demolition work	The removal of existing buildings and structures would be required for the proposal. Demolition work has the potential to disturb and/or spread sources of pollutants that could affect water quality. Demolition could also generate dust and airborne pollutants. Once mobilised, these pollutants could potentially enter stormwater runoff and be distributed to downstream receiving watercourses and waterbodies via the drainage network.
Earthwork and stockpiling	Potential exposure of soils during earthwork (including stripping of topsoil, excavation, removal of existing paved areas, stockpiling and transport of materials) could result in temporary soil erosion and off-site movement of eroded sediments by wind and/or stormwater into receiving waters. If sediments enter watercourses and waterbodies, they could potentially directly and indirectly impact on the aquatic environment by increasing turbidity, reducing dissolved oxygen levels, and increasing the concentration of nutrients and heavy metals.
Construction of power supply routes	The construction of power supply routes would be carried out for Pymont Station construction sites. Routes would be constructed using open trenching and underboring methods and has the potential to increase the risk of temporary erosion and sedimentation, particularly in areas near waterbodies and watercourses.
Discharges from construction water treatment plants	Discharge of large volumes of treated wastewater at all proposal construction sites via the local stormwater network has the potential to increase soil erosion through scour and increase the turbidity of downstream watercourses and waterbodies.
Removal of vegetation	The removal of vegetation has the potential to increase the risk of erosion and sedimentation. As described in Chapter 18 (Biodiversity), limited vegetation would be cleared as part of the proposal.
Accidental spills	Accidental spills or leaks could 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. Contaminants could potentially be transported downstream to receiving waters via drainage infrastructure.
Disturbance of contaminated land	Potential disturbance of contaminated soils, groundwater, or acid sulfate soils during construction of the proposal could result in the mobilisation of contamination or acid sulfate soils by stormwater runoff and subsequent transportation to downstream watercourses and waterbodies, potentially increasing contaminant concentrations in the receiving environment. There are isolated areas of potential acid sulfate soils which could potentially affect surrounding waterbodies and watercourses if not managed appropriately (refer to Section 15.5.1).
Concrete activities	Concreting activities during the proposal could result in the discharge of concrete dust, concrete slurries or washout water to downstream watercourses and waterbodies. This could potentially increase the alkalinity and pH of downstream watercourses and waterbodies which can be harmful to aquatic life. Concrete solids contained in the discharge also have the potential to clog stormwater pipes and cause flooding.

Tunnelling and excavation work

Tunnelling and excavation work would result in wastewater being generated from the following sources:

- Water used in the tunnel boring machine process
- Groundwater ingress
- Rainfall runoff into tunnel portals and excavations
- Machinery wash down runoff
- Dust suppression.

Wastewater would be tested and treated at construction wastewater treatment plants prior to reuse or discharge. Water volumes generated during the construction of this proposal would vary based on construction work both above and below the ground surface, the amount of groundwater infiltrating into the tunnels and the length of tunnels that have been excavated. Groundwater ingress is expected to be the main contributor to wastewater volumes. The re-use of wastewater would be maximised during construction work (including use for dust suppression and tunnelling activities) and any surplus wastewater would be discharged to the local stormwater system.

Estimated volumes of construction wastewater are included in Table 15-5. It is noted that these estimates are indicative only, and that water volumes generated during this proposal would vary during construction.

Temporary water treatment plants would be constructed at each construction site as described in Table 15-5 to treat the wastewater generated. Wastewater treatment plants would be configured so that treated water does not negatively impact the water quality of the receiving waterbody, as further described in sections below.

Table 15-5 Construction wastewater treatment plants

Wastewater treatment plant location	Indicative capacity (litres per second)	Discharge location	Receiving waterbody
The Bays tunnel launch and support site	30	Local stormwater infrastructure	White Bay
Pymont Station	30	Local stormwater infrastructure	Blackwattle Bay, Cockle Bay and Pymont Bay
Hunter Street Station (Sydney CBD)	30	Local stormwater infrastructure	Sydney Cove

Water balance

Non-potable sources (e.g. treated wastewater and harvested rainwater) would be used to meet construction water demand requirements where possible. The deficit for the non-potable demand and any potable demand would be sought from the Sydney Water supply network. The use of non-potable water over potable water would depend on the location and nature of the water use activity, as well as the quantity and quality of available water at the time. Water availability would vary as construction progresses, as well as seasonally.

Sydney Metro is further investigating options to minimise potable water use and maximise wastewater reuse. This includes investigating opportunities to:

- Increase or extend storage capacity of treated wastewater on site. This would provide additional opportunities for the reuse of water both on site and off site
- Carry out additional treatment of wastewater to enable additional end uses (such as concrete batching, wash down, toilet flushing etc). This would further reduce reliance on potable water supply
- Provide wastewater to others for reuse (e.g. to local councils for parkland and sporting field irrigation, or to nearby golf courses for irrigation). This would reduce reliance on potable water for these uses.

The indicative water balance for the construction of the proposal based on average groundwater inflows, and the estimated treated discharge quantities are shown in Table 15-6. Non-potable water uses would include dust suppression, plant wash-down and rock bolting. Some demand activities are consumptive, such as water used in the offices which would be discharged to the sewerage network. The water balance shows that water demand exceeds supply.

Table 15-6 Indicative construction water balance

Water Source / Activity	Type	Megalitres per year
Demand		
Construction activities for station excavation	Potable	10
	Non potable	30
Construction activities for crossover cavern	Potable	5
	Non potable	20
Construction activities for tunnels	Potable	20
	Non potable	80
Total demand		165
Supply		
Groundwater inflow, stations and tunnels (50 per cent)	Non potable	19
Sydney Water supply (Demand)	Potable	35
Recycled water for non potable use (33 per cent)	Non potable	11
Supply total		65
Difference		100

Surface water availability and flows

The proposal would result in treated wastewater discharges to downstream waterways via the local stormwater network. Discharge of high volumes of treated water also has the potential to scour the waterways and increase turbidity of receiving waters. Water extraction from surface water is not proposed.

Impacts on NSW Water Quality Objectives

The Water Quality Objectives relevant to this proposal and the potential impacts as a result of construction work are described in Table 15-7. In summary, the proposal would not impact any water quality objectives.

Standard erosion and sediment control measures would be implemented for all surface work areas to minimise pollutant loading to the downstream waterbodies during construction. Wastewater would be tested and treated at construction wastewater treatment plants prior to reuse or discharge. Wastewater treatment plants would be configured so that treated water is compliant with the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines, which would either maintain or improve the water quality of surface waterways and the marine environment.

The proposal will work towards enhancement of water quality objectives. Runoff from construction work would be designed to meet the standards outlined in *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008).

Discharges from the wastewater treatment plants would be monitored to ensure compliance with any discharge criteria in an environment protection licence(s) issued for the proposal. As such, the impacts on the water quality of the catchment would be negligible.

Table 15-7 Assessment of the proposal against the NSW water quality objectives

Water quality objective	Indicators	Associated trigger values or criteria	Construction impacts
Aquatic ecosystems			
Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	Total phosphorus	Estuaries – 30 micrograms per litre	With the implementation of management measures, pollutant loading to the receiving waterbodies would be minimised and the existing water quality maintained. Therefore, the proposal would not impact aquatic ecosystems of the receiving waterbodies.
	Total nitrogen	Estuaries – 300 micrograms per litre	
	Chlorophyll-a	Estuaries – four micrograms per litre	
	Turbidity	Estuaries – 0.5 – 10 NTU	
	Dissolved oxygen	Estuaries – 80-100 per cent	
	pH	Estuaries – 7.0 – 8.5	
	Chemical contaminants or toxicants	Set by ANZG (2018) – online platform	
	Temperature	As per table 3.3.1 of ANZECC/ ARMCANZ (2000)	
Visual Amenity			
Maintaining the aesthetic quality of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20 per cent 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 per cent	With the implementation of management measures, pollutant loading to the receiving waterbodies would be minimised and the existing water quality maintained. Therefore, the proposal would not impact the visual amenity of the receiving waterbodies.
	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	
Primary Contact Recreation			
Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed	Turbidity	A 200 millimetre diameter black disc should be able to be sighted horizontally from a distance of more than 1.6 metres (approximately 6 NTU)	With the implementation of management measures, pollutant loading to the receiving waterbodies would be minimised and the existing water quality maintained. Therefore, the proposal would not impact the suitability for primary contact recreation of the receiving waterbodies.
	Enterococci	NHMRC (2008) microbial assessment based on 95th percentile of enterococci (cfu per100 millilitres): <ul style="list-style-type: none"> • Category A – <40 • Category B – 41-200 • Category C – 201-500 • Category D – >500 ANZECC 2000 guidelines: <ul style="list-style-type: none"> • Median over bathing season of < 35 enterococci per 100 millilitres (maximum number in any one sample: 60-100 organisms per 100 millilitres) 	
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water	

Water quality objective	Indicators	Associated trigger values or criteria	Construction impacts
Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed cont.	Algae & blue-green algae	NHMRC (2008) suitability for coastal and estuarine recreational waterbodies should not contain ≥ 10 cells per mL <i>Karenia brevis</i> and/or have <i>Lyngbya majuscula</i> and/or <i>Pfiesteria</i> present in high numbers	
	pH	6.5-8.5	
	Temperature	16°-34°C	
	Chemical Contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation Toxic substances should not exceed the concentrations provided in tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines 2000, and ANZG (2018)	
Secondary Contact Recreation			
Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed	Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100 millilitres (maximum number in any one sample: 450-700 organisms per 100 millilitres)	With the implementation of management measures, pollutant loading to the receiving waterbodies would be minimised and the existing water quality maintained. Therefore, the proposal would not impact the suitability for secondary contact recreation of the receiving waterbodies.
	Algae & blue-green algae	< 15,000 cells per millilitre	
	Nuisance organisms	Large numbers of midges and aquatic worms are undesirable	
	Chemical contaminants	Set by ANZG (2018) – online platform	
Aquatic Foods (cooked)			
Protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	Algae & blue-green algae	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms	With the implementation of management measures, pollutant loading to the receiving waterbodies would be minimised and the existing water quality maintained. <i>Note: At the time of developing the catchment water quality objectives, consumption of aquatic foods was nominated for protection. However due to contamination, particularly dioxins, current recommendations are that no fish or crustaceans caught west of the Sydney Harbour Bridge should be eaten</i>
	Faecal coliforms	Guideline in water for shellfish: The median faecal coliform concentration should not exceed 14 MPN per 100 millilitres; with no more than 10 per cent of the samples exceeding 43 MPN per 100 millilitres Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli per gram of flesh with a standard plate count of 100,000 organisms per gram	
	Toxicants	Metals: <ul style="list-style-type: none"> • Copper: less than five micrograms per litre • Mercury: less than one microgram per litre • Zinc: less than five micrograms per litre Organochlorines: <ul style="list-style-type: none"> • Chlordane: less than 0.004 micrograms per litre (saltwater production) • PCB's: less than two micrograms per litre 	
	Physio-chemical indicators	Suspended solids: less than 40 micrograms per litre for saltwater production and less than 75 micrograms per litre for brackish conditions. Temperature: less than two degrees Celsius change over one hour.	

Sensitive receiving environments

As the impacts of the proposal on the water quality of the catchment would be negligible, the proposal is anticipated to result in negligible impacts to the water quality of Sydney Harbour, the only identified sensitive receiving environment for the proposal.

15.7 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of the proposal with other projects that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology). The proposal is not likely to contribute to any cumulative soils and surface water quality impacts as the proposed construction site mitigation measures would be implemented and wastewater treated so that all discharges from the construction site would maintain the existing water quality.

With the implementation of mitigation measures to manage potential impacts of construction on the soil environment, it is expected that soil erosion would be adequately managed in accordance with measures. Given this, and given the relatively small areas of surface disturbance anticipated during construction, no cumulative soil erosion impacts are anticipated.

15.8 Mitigation and management measures

The Construction Environmental Management Framework (Appendix C) describes the approach to environmental management, monitoring and reporting during construction. Specifically, it lists the requirements to be addressed by the construction contractor in developing the Construction Environmental Management Plans, sub-plans, and other supporting documentation for each specific environmental aspect. This includes standard mitigation measures, including the preparation of a Soil and Water Management Plan and progressive erosion and sediment control plans.

The environmental management approach for the project is detailed in Chapter 23 (Synthesis of the Environmental Impact Statement). Under these broad frameworks and as outlined within the Concept assessment, a series of performance outcomes have been developed to define the minimum environmental standards that would be achieved during construction of the proposal (see Section 15.8.1), and mitigation measures that would be implemented during construction to manage potential identified impacts (see Section 15.8.2).

15.8.1 Performance outcomes

Construction performance outcomes were developed for the proposal as part of the Concept assessment. Performance outcomes for the proposal identify measurable, performance-based standards for environmental management. Identified performance outcomes in relation to soils and surface water quality for construction of the proposal include:

- The discharge water quality requirements outlined in applicable environment protection licence(s) are met
- Existing water quality of receiving surface waterbodies 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.

Chapter 23 (Synthesis of the Environmental Impact Statement) describes how the proposal addresses these performance outcomes. Wastewater from tunnelling activities would be tested and treated, and standard erosion and sediment control measures would be implemented for all surface work areas to minimise pollutant loading to the downstream waterways during construction. With these management measures, pollutant loading to the receiving waterways would be low. The proposal would effectively manage acid sulfate soils in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee, 1998).

15.8.2 Mitigation measures

The mitigation measures that would be implemented to address potential soils and surface water quality impacts are described in Table 15-8.

Table 15-8 Mitigation measures – Soils and surface water quality

Reference	Impact	Mitigation measure	Applicable location(s)
SSWQ1	Acid sulfate soils	Prior to ground disturbance in areas of potential acid sulfate soil occurrence, testing would be carried out to determine the presence of actual and/or potential acid sulfate soils. If acid sulfate soils are encountered, they would be managed in accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998).	The Bays tunnel launch and support site Pyrmont Station construction sites
SSWQ2	Soil salinity	Prior to ground disturbance in high probability salinity areas, testing would be carried out to determine the presence of saline soils. If salinity is encountered, excavated soils would not be reused or would be managed in accordance with Book 4 Dryland Salinity: Productive Use of Saline Land and Water (NSW DECC, 2008). Erosion controls would be implemented in accordance with the 'Blue Book' (Landcom, 2004).	The Bays tunnel launch and support site Pyrmont Station construction sites
SSWQ3	Erosion and sedimentation	Erosion and sediment measures would be implemented at all construction sites in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom, 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008), commonly referred to as the 'Blue Book'. Additionally, any water collected from construction sites would be appropriately treated and discharged to avoid any potential contamination or local stormwater impacts. Temporary sediment basins would be designed in accordance with Managing Urban Stormwater: Soils and Construction and Managing Urban Stormwater, Volume 2D: Main Road Construction (DECC, 2008).	All
SSWQ4	Working in low lying areas	Work in waterbodies and surrounding low lying areas would be carried out in accordance with progressive erosion and sediment control plans.	The Bays tunnel launch and support site
SSWQ5	Wastewater discharge	The water treatment plants would be designed with the aim of treating wastewater to a level as close as practicable to the ANZECC/ARMCANZ (2000), ANZG (2018) and draft ANZG (2020) default guidelines for 95 per cent species protection and 99 per cent species protection for toxicants that bioaccumulate, unless other discharge criteria are agreed with relevant authorities.	All
SSWQ6	Water quality monitoring	A surface water monitoring program would be implemented to observe any changes in surface water quality that may be attributable to construction and inform appropriate management responses. The program would be developed in consultation with the EPA and relevant councils. The program would consider monitoring being carried out as part of other infrastructure projects. Monitoring would occur during pre-construction and during construction at all waterways with the potential to be impacted. Monitoring would include sampling for key indicators of concern.	All
SSWQ7	Local stormwater capacity	Further design development would confirm the local stormwater system capacity to receive construction water treatment plant inflows. In the event there is a stormwater infrastructure capacity issue with existing infrastructure, mitigation measures such as storage detention to control water outflow during wet weather events would be implemented.	All

15.8.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential soils and surface water quality impacts include:

- **Chapter 14 (Groundwater and ground movement)** – Specifically measures which address groundwater levels and the migration of contaminants through groundwater
- **Chapter 16 (Contamination)** – Specifically measures which address the disturbance of contaminated land during construction
- **Chapter 22 (Sustainability, climate change and greenhouse gas)** – Specifically measures which relate the use of non-potable water during construction.

Together, these measures would minimise the potential soils and surface water quality impacts of this proposal. A full list of mitigation measures is presented in Chapter 23 (Synthesis of the Environmental Impact Statement).

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