sydney METRO | city & southwest

CHATSWOOD TO SYDENHAM

VICTORIA CROSS STATION AND ARTARMON SUBSTATION MODIFICATION REPORT

NSW GOVERNMENT Transport for NSW

NSW MAKING IT HAPPEN

EXECUTIVE SUMMARY

Executive summary

Sydney Metro City & Southwest has been developed within the framework of the transport and planning strategies identified in State government policies. This includes the 12 NSW Premier priorities (established to grow the economy, deliver infrastructure, and improve health, education and other services across NSW), *Sydney's Rail Future: Modernising Sydney's Trains*, *Draft Metropolitan Strategy for Sydney 2031* and the *NSW Long Term Transport Master Plan*. The project responds to these challenges delivering a step-change in the capacity of Sydney's rail network by providing a fully automated rail system across Sydney, supporting high demand with a high capacity, turn-up-and-go service.

Sydney Metro City & Southwest was declared by Ministerial Order on 10 December 2015 to be State significant infrastructure and critical State significant infrastructure. The assessment and approval process for a critical State significant infrastructure project is established under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

An Environmental Impact Statement for the Chatswood to Sydenham component of Sydney Metro City & Southwest was prepared and exhibited for 48 days from 11 May to 27 June 2016. A subsequent Submissions and Preferred Infrastructure Report was prepared and submitted to the Department of Planning and Environment in October 2016. Planning approval was granted by the Minister for Planning under Part 5.1 of the EP&A Act on 9 January 2017.

Pursuant to section 115ZI of the EP&A Act, Transport for NSW is seeking to modify the State significant infrastructure approval to include the Victoria Cross Station and Artarmon substation modifications as outlined below. This modification report includes:

- A description of the proposed modifications to the approved project
- A justification for the modifications
- Options considered for the proposed modifications
- An assessment of the environmental and community impacts and benefits of the proposed modifications.

This is one of several modification applications that are likely to occur as the detailed design is developed across the project.

Victoria Cross Station modification

The assessment of the approved project identified impacts associated with the Victoria Cross Station northern services building at 194-196A Miller Street, including exceedances of noise management levels (NMLs) at nearby sensitive receivers. The extent of these predicted impacts and the subsequent identification of the unique multi-use theatre and music space at Monte Sant' Angelo Mercy College prompted Sydney Metro to investigate alternative locations for the northern services building which could deliver better environmental outcomes. The need for this reconsideration of the northern services building location was recognised in Condition A21 of the planning approval, which provides:

A21 The Proponent must undertake a further detailed analysis of alternative locations for construction of a services building to support Victoria Cross Station. The analysis must include a rigorous options assessment which considers constructability, property impacts, operational efficiency and comparative impacts, including construction and operational noise impacts in consultation with the Acoustics Advisor required by Condition A25. The analysis must be submitted to the Secretary and where the analysis identifies a better alternative to the Victoria Cross North site identified in the EIS, the Proponent must submit the recommendation to the Secretary for approval before commencement of construction at the Victoria Cross North construction site.

Following assessment of alternatives, the preferred option for the Victoria Cross Station services building was identified as relocation of the approved northern services building to a new location at 50 McLaren Street, North Sydney. This preferred option would also incorporate a new northern station entry at this location. The associated northern construction site to support these works would be relocated to the adjacent lot at 52 McLaren Street, North Sydney. This would be a temporary site for the purpose of facilitating construction works and would be reinstated on completion of the works.

This proposed change would have improved environmental outcomes including fewer and less severe exceedances of NMLs, and avoidance of ground borne NML exceedances on the highly noise sensitive receiver (ie the recording studio) on the Monte Sant' Angelo Mercy College site. Additionally, the provision of a northern lift-only station entry at Victoria Cross Station would improve amenity and access for customers, and would increase the reach of the station catchment to include additional regional attractors such as the Mater Hospital, North Sydney Oval, North Sydney Boys High School, the residential and mixed use area to Falcon Street and Neutral Bay via the footbridge over the Warringah Freeway.

A northern entry would also benefit customers using local bus services on Miller Street by providing an alternative and improved transfer opportunity, especially for less mobile customers by reducing the distance between stops and enabling transfer to the station before reaching the busy core North Sydney CBD area.

A further benefit of adding a northern entry is that it would relieve pressure on the southern entrance. This would provide an opportunity for improved space planning around the southern entrance and would reduce the number of pedestrians, in particular school children, crossing busy roads in the morning near the intersection of Berry Street and Miller Street.

Further details of the proposed modification to the approved project at Victoria Cross Station are detailed in this report. Overall, the proposed modification is expected to have improved environmental outcomes and benefits to the customers which are expected to outweigh any potential minor impacts of the proposed modification.

Artarmon substation modification

The Artarmon substation modification involves relocating the Artarmon substation from Butchers Lane, north of the Gore Hill Freeway, to 98-104 Reserve Road, within the Artarmon industrial area. The form of the substation would be generally consistent with the approved project, and would include an aboveground building with an associated shaft to reticulate cables to the tunnels below.

The proposed relocation of the Artarmon substation to the Artarmon industrial area would reduce noise and other amenity impacts on Barton Road and Butchers Lane residences, particularly during construction. Use of the Reserve Road site would largely affect less sensitive industrial receivers and would be more compatible with the character of the surrounding area.

Further details of the proposed modification to the approved project at Artarmon substation are detailed in this report. Overall, the proposed modification is expected to have improved environmental outcomes which are expected to outweigh any potential minor impacts of the proposed modification.

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CHAPTER ONE

1 Introduction

This chapter provides an overview of the proposed modifications, their strategic context and key features, and the structure of this modification report.

1.1 Overview

Planning approval for Sydney Metro City & Southwest Chatswood to Sydenham was granted by the Minister for Planning under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 9 January 2017.

Works at Victoria Cross Station as part of the approved project involve:

- Construction of Victoria Cross metro station, located beneath Miller Street between McLaren Street and south of Berry Street, including the entrance structure within the north end of the block bordered by Miller Street, Berry Street, and Denison Street
- Construction of a northern station services building, a separate dedicated services facility at 194 and 196A Miller Street to the north of Victoria Cross metro station to support station and metro tunnel services. The facility includes an above-ground services building and a services shaft extending downwards from the basement of the building to the Victoria Cross metro station cavern.

Works at Artarmon substation as part of the approved project involve the construction of a substation beside the Gore Hill Freeway in Artarmon to provide traction power to the railway. The substation would be housed in an aboveground building with a shaft to reticulate cables to the tunnels below.

Condition A21 of the planning approval requires further detailed analysis of alternative locations for the Victoria Cross metro station northern services building. Under the condition, the analysis must be provided to the Secretary of the Department of Planning and Environment (DP&E), and if a better alternative is identified, a recommendation must be submitted to the Secretary for approval before commencement of construction at the northern Victoria Cross construction site proceeds.

The proposed modification would involve changes to the approved project at Victoria Cross Station and at Artarmon.

The Victoria Cross modification would involve the relocation of the northern station services building approved as part of the Victoria Cross metro station from 194 and 196A Miller Street, North Sydney to 50 McLaren Street, North Sydney. A new northern station entry would be integrated within the northern services building at the same location.

The Victoria Cross Station modification has been developed to reduce environmental impacts, to extend the Victoria Cross Station catchment, to improve the customer experience and to improve access to the McLaren Street precinct and northern catchment of North Sydney.

The Artarmon substation modification would involve the relocation of the Artarmon substation to the Artarmon industrial area and has been developed in response to community feedback and to reduce environmental impact.

The Victoria Cross Station and Artarmon substation modifications are being progressed as a proposed modification to the approved Sydney Metro City & Southwest Chatswood to Sydenham project in accordance with section 115ZI of the EP&A Act. This is one of several modification applications that are likely to occur as the detailed design is developed across the project.

1.2 Need for the modification

1.2.1 Victoria Cross Station modification

The proposed Victoria Cross Station modification responds to Condition A21 of the planning approval, which requires further detailed analysis of alternative locations for Victoria Cross Station northern services building. It also responds to opportunities to provide an additional station entrance to serve as a key enabler to improve access in the northern part of the North Sydney CBD and to support opportunities for future growth.

The proposed modification is consistent with the *Sydney Metro Planning Study* (North Sydney Council, 2016), which supports a second Victoria Cross Station entrance north of Berry Street.

1.2.2 Artarmon substation modification

The proposed Artarmon substation modification responds to Willoughby City Council and community feedback received during the exhibition of the Environmental Impact Statement and is consistent with the commitment given in the submission report to investigate alternative sites for the Artarmon substation.

1.3 Overview of the modification

1.3.1 Victoria Cross Station modification

The Victoria Cross Station modification proposes to relocate the northern station services building from 194 and 196A Miller Street, North Sydney, to 50 McLaren Street, North Sydney. The northern station services building would include a three storey services building and a services shaft extending downwards to the depth of Victoria Cross metro station cavern. Underground services adits would connect the services building to the northern end of the station mezzanine and platforms.

It is also proposed that a lift-only station entry be incorporated into the northern station services building to service the northern catchment of Victoria Cross Station and to increase the reach of the station catchment to include additional regional attractors. The northern station entry would include pedestrian access from the corner of Miller and McLaren streets to the Victoria Cross metro station mezzanine level via vertical transport (lift-only) and an underground pedestrian connection.

The combined services building and northern station entry is referred to in this modification report as the 'northern station entry and services building'.

Figure 1-1 shows the location of the proposed Victoria Cross Station modification site.

1.3.2 Artarmon substation modification

The Artarmon substation modification involves relocating the Artarmon substation from Butchers Lane, north of the Gore Hill Freeway, to 98-104 Reserve Road, within the Artarmon industrial area to the south of the Gore Hill Freeway. The form of the substation would be generally consistent with the approved project, and would include an aboveground building with an associated shaft to reticulate cables to the tunnels below.

Figure 1-2 shows the location of the proposed Artarmon substation modification site.

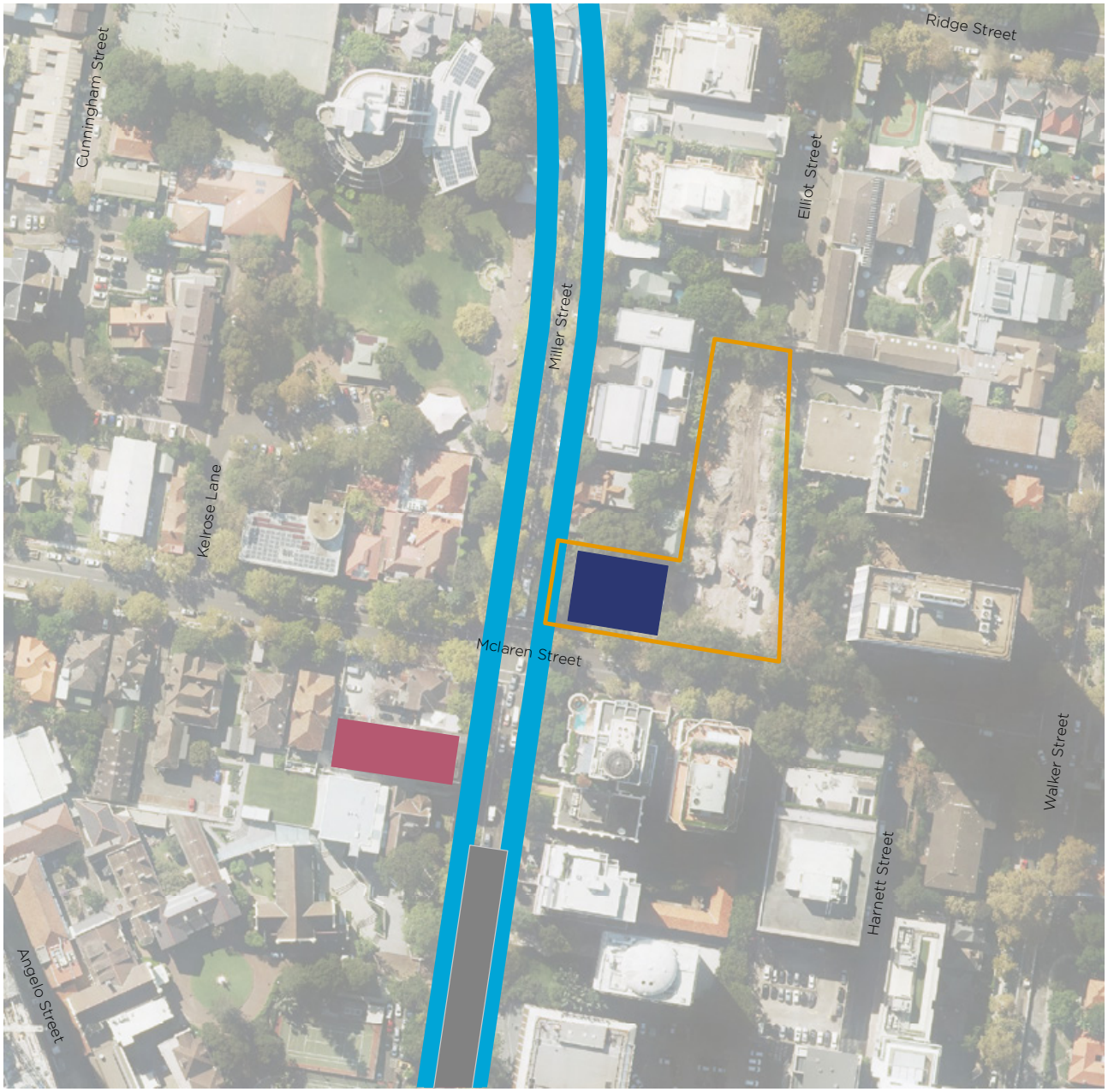

Figure 1-1 Location of proposed Victoria Cross Station modification

Figure 1-2 Location of proposed Artarmon substation modification

1.4 Purpose of this report

This report provides an assessment of the proposed modification in accordance with section 115ZI of the EP&A Act. This modification report includes:

- A description of the proposed modification to the approved project
- A justification for the modification
- Options considered for the proposed modifications
- An assessment of the environmental and community impacts and benefits of the proposed modifications.

1.5 Structure of this report

The structure and content of the report is outlined in Table 1-1.

Table 1-1 Structure of this report

Chapter	Description
Chapter 1	**Introduction (this chapter)** Provides an overview of the proposed modifications. Outlines the structure and content of this report.
Chapter 2	**Strategic need and justification** Provides the strategic context and explains the need for the proposed modifications.
Chapter 3	**Modification development and alternatives** Describes how the proposed modifications were developed and reviews the options that were considered.
Chapter 4	**Planning and assessment process** Provides information on the legislation and environmental planning instruments that would apply to the proposed modifications. Outlines the steps involved in the modification assessment and approval process.
Chapter 5	**Stakeholder and community engagement** Provides an overview of the community consultation and stakeholder engagement processes that have been carried out for the proposed modifications to date. Identifies issues raised during consultation and how these have been addressed.
Chapter 6	**Modification description – operation** Identifies the physical infrastructure and built form of the proposed modifications, including specific design guidelines. Describes the functionality and operation of the proposed modifications and their relationship to the approved project.
Chapter 7	**Modification description – construction** Outlines how the proposed modification are likely to be constructed and identifies the location and function of the main construction sites.
Chapter 8	**Environmental screening assessment** Considers the potential for change to the impacts described in the Sydney Metro City & Southwest Chatswood to Sydenham planning approval documentation and whether further assessment is required.
Chapter 9	**Traffic and transport** Identifies and assesses the potential changes to construction and operational impacts of the proposed modifications on the existing road, public transport, pedestrian and cyclist network.

Chapter	Description
Chapter 10	**Noise and vibration** Assesses the potential changes to construction and operational noise and vibration impacts of the proposed modifications, including surface construction, underground construction and use of operational facilities.
Chapter 11	**Land use and property** Assesses the potential changes to impacts of the proposed modifications on existing properties and land use including property acquisition, changes to land use and integration with surrounding land use.
Chapter 12	**Non-Aboriginal heritage** Assesses the potential changes to impacts on non-Aboriginal archaeological and built heritage during construction and operation of the proposed modifications.
Chapter 13	**Aboriginal heritage** Assesses the potential changes to impacts on Aboriginal heritage during construction and operation of the proposed modifications.
Chapter 14	**Landscape character and visual amenity** Assesses the potential changes to landscape character from the introduction of infrastructure and urban design elements associated with the proposed modifications, and the potential changes to visual impacts during construction and operation of the proposed modifications.
Chapter 15	**Groundwater and geology** Assesses the potential changes to impacts associated with groundwater and geology during construction and operation of the proposed modifications.
Chapter 16	**Contamination** Assesses the potential changes to impacts associated with contamination during construction and operation of the proposed modifications.
Chapter 17	**Biodiversity** Assesses the potential changes to impacts associated with biodiversity during construction and operation of the proposed modifications.
Chapter 18	**Consolidated revised environmental mitigation measures** Provides a consolidated list of the revised mitigation measures identified in Chapters 9 to 17 and considers the environmental performance outcomes of the proposed modifications.
Chapter 19	**Justification and conclusion** Confirms the justification for the proposed modifications.

STRATEGIC JUSTIFICATION AND NEED

CHAPTER TWO

2 Strategic justification and need

This chapter outlines the strategic justification and need for the proposed modifications and identifies the benefits of the proposed modifications.

2.1 Need for Sydney Metro City & Southwest (Chatswood to Sydenham)

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

These polices indicate a strategic need to:

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

The approved project will deliver a step-change in the capacity of Sydney's rail network by providing a fully automated rail system across Sydney, supporting high demand with a high capacity, turn-up-and-go service. It will increase the capacity of the rail network through the Sydney CBD from about 120 per hour during peak periods today, to up to 200 services per hour beyond 2024, including capacity for up to 60 metro trains per hour during peak periods (or 30 trains per hour in each direction). This would equate to an increase of up to 60 per cent capacity across the network. This means that the railway network across greater Sydney would have room for an extra 100,000 train customers per hour in the peak. The fully automated, Sydney Metro network would have the ultimate capacity to operate a train every two minutes through the Sydney CBD in each direction. The proposed new stations would alleviate congestion at Wynyard, Town Hall, Central, Redfern and Green Square stations.

It will also deliver a new tier for Sydney's rail network, supporting high demand with a high-capacity, turn-up-and-go service. It is being developed with an emphasis on supporting the needs of customers for 'door to door' journeys from origin to destination.

Other key benefits of the approved project include:

- Doubling the number of train paths available from the north
- Strengthening connections and access across Sydney, particularly within the Global Economic Corridor
- Providing new connections to the rail network – including connections to the T4 Eastern Suburbs Line, and direct connections between the Sydney CBD with the north west
- Improving the capacity, reliability and efficiency of the existing transport system, by relieving the pressure on existing rail lines, Sydney CBD train stations, Sydney CBD, North Sydney and Sydney South bus routes, and the Sydney CBD road network

- Providing the opportunity for urban development particularly around the new stations at Crows Nest, Victoria Cross, Barangaroo and Waterloo
- Providing a catalyst for the progressive renewal of the ageing Waterloo social housing estate including a mix of private, affordable and social housing
- Improving network resilience through the Sydney CBD and across Sydney Harbour by providing an additional route during planned and unplanned events affecting other Sydney CBD and harbour links.
- Health benefits with the creation of safer and more appealing conditions for pedestrians, cyclists and other transit users in the areas around the stations.

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

2.2 Victoria Cross Station

2.2.1 Need for Victoria Cross Station

The need for and benefits of the proposed Victoria Cross Station are discussed in Chapter 3 of the Environmental Impact Statement.

Victoria Cross Station would be in the North Sydney CBD and would provide improved connections to the commercial, retail users, restaurants and cafes of the centre. The station would also improve connections to schools and educational facilities in the locality, including the Australian Catholic University (North Sydney) campus. The station would provide another focal point to North Sydney Centre, relieving pressure on the existing North Sydney Station and extending the rail catchment to the north. The station would also improve mid-block connections between Miller Street and the eastern areas of the North Sydney CBD.

2.2.2 Opportunities for the Victoria Cross Station precinct

Opportunity to minimise project impacts

The assessment for the approved project identified that for excavation at the northern services building site during the daytime, there would be moderate exceedances of noise management levels (NML) at nearby educational receivers on the western side of Miller Street. For night-time excavation, moderate exceedances were predicted at residential receivers on McLaren Street and a minor exceedance was predicted at residential receivers on the eastern side of Miller Street.

The assessment for the approved project also identified that during the daytime the three buildings immediately adjacent to the northern services facility site would have ground-borne noise levels potentially higher than 75 dBA on several floors in each building. During the night, the five residential buildings to the east and west of the northern services facility site were predicted to have ground-borne noise levels potentially higher than 45 dBA on several floors (which exceeds ground-borne night-time NML of 35 dBA – internal).

The extent of these predicted impacts and the subsequent identification of the unique multi-use theatre and music space at Monte Sant' Angelo Mercy College prompted Sydney Metro to investigate alternative locations for the northern services building which could deliver better environmental outcomes. The need for this reconsideration of the northern services building location was recognised in Condition A21 of the planning approval, which provides:

A21 The Proponent must undertake a further detailed analysis of alternative locations for construction of a services building to support Victoria Cross Station. The analysis must include a rigorous options assessment which considers constructability, property impacts, operational efficiency and comparative impacts, including construction and operational noise impacts in consultation with the Acoustics Advisor required by Condition A25. The analysis must be submitted to the Secretary and where the analysis identifies a better alternative to the Victoria Cross North site identified in the EIS, the Proponent must submit the recommendation to the Secretary for approval before commencement of construction at the Victoria Cross North construction site.

The assessment of alternatives to the northern services building location is provided in Chapter 3 of this report.

Opportunity for additional station entrance

The location for the northern services building as assessed for the approved project is not of sufficient size or suitable configuration (narrow single street frontage) to accommodate both services functions and a station entry with provision for vertical transport (lifts) and therefore no northern station entry for Victoria Cross Station was previously proposed. Reconsideration of the location of the services facility provided an opportunity to identify a site which could primarily reduce environmental impacts, and at the same time allow for the incorporation of a lift-only station entry.

While proceeding with a Victoria Cross Station without a northern entry would still deliver important benefits as discussed above in section 2.2.1, the option of a lift-only station entry provides an opportunity to realise further benefits in terms of accessibility, support for urban growth, and better transport integration.

International examples, such as the Hong Kong MTR Island Line entrances at Hong Kong University and Sai Ying Pun stations, the Barcelona Metro Line 9 Fondo Station and the Forest Glen station in Washington DC, demonstrate lift only station entries are highly functional and can be intuitive for customers. A lift-only entry would be the first of its kind for Sydney Metro, and could be important as a product element for future metro lines. Four lifts, each with a capacity to accommodate approximately 27 persons, are proposed.

Victoria Cross Station has an estimated daily patronage of 42,100 in 2026 and 45,500 in 2036. This level of patronage supports the case for a second station entry and would be more consistent with the approach adopted for other metro stations, including Crows Nest (27,600 in 2026 and 31,000 in 2036), Barangaroo (21,100 in 2026 and 23,000 in 2036) and Pitt Street (25,800 in 2026 and 28,500 in 2036).

Further information on the proposed additional station entry is included in Chapter 6 (Modification description – operation).

2.2.3 Key benefits of the proposed modification

Improved environmental outcomes

The options assessment in Chapter 3 and the environmental assessment in chapters 8 through 17 establish that the proposed modification would have better environmental outcomes when compared with the approved project. These improved outcomes primarily relate to lower level exceedances of airborne noise management levels and the avoidance of ground borne noise management level exceedances on highly noise sensitive receivers including the recording studio on the Monte Sant' Angelo Mercy College site.

Customer benefits and extended station catchment

The provision of a northern lift-only station entry at Victoria Cross Station would improve amenity and safe access for customers. The existing Victoria Cross Station 10 minute catchment has the potential to serve around 51,000 workers and up to 5,900 dwellings by 2036. The station would also serve some of the estimated 10,000 school students in the wider precinct. An estimated 20 per cent of customers that are expected to use the Victoria Cross Station have a destination to the north of Berry Street.

An entry at the northern end of the station would also increase the reach of the station catchment to include additional regional attractors. These include the Mater Hospital, North Sydney Oval, North Sydney Boys High School, North Sydney Girls High School, Marist College North Shore, North Sydney Demonstration School, St Mary's Primary School, the residential and mixed use area to Falcon Street, and Neutral Bay via the footbridge over the Warringah Freeway (refer to Figure 2-1).

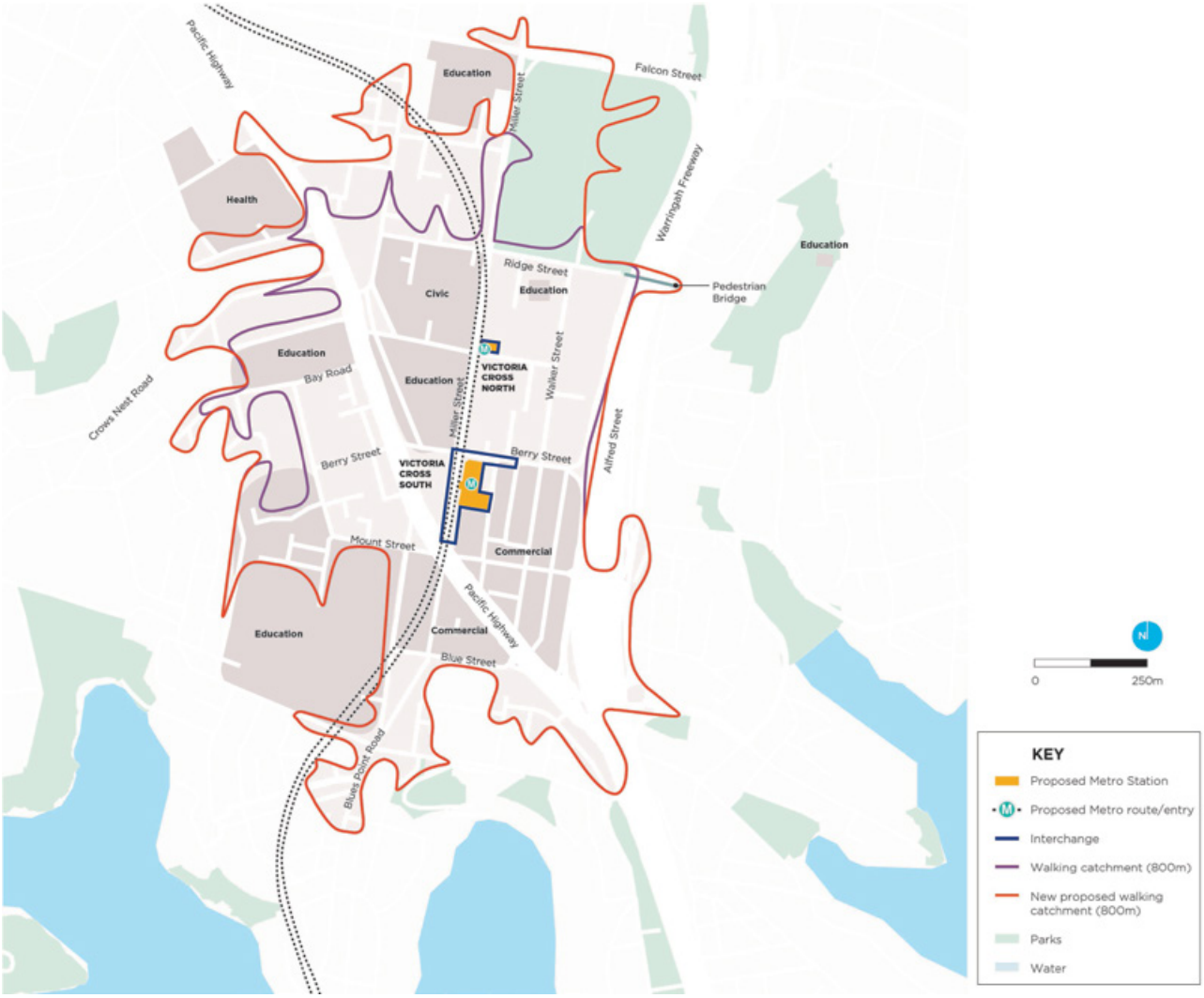

Figure 2-1 Extended Victoria Cross Station walking catchment with the proposed modification

For 2036, the updated estimate for the potential northern entry usage is around 2,300 trips during the AM peak hour, representing about 17 per cent of all entries and exits at Victoria Cross Station. An increase in patronage of five per cent is expected due to the additional walking catchment serviced by the northern entry. Table 2-1 compares the currently projected 2036 station entries / exits for the approved project and the proposed modification.

Table 2-1 2036 AM Peak Victoria Cross Station – entries and exits

Entrance	Approved project		Proposed modification	
	Entry	Exit	Entry	Exit
South entrance	2,200	10,900	1,250	9,650
North entrance	N/A	N/A	1,050	1,250
Total	2,200	10,900	2,300	10,900

Provision of a second station entrance would distribute pedestrian demand at the station more evenly and reduce the number of people accessing the station from more constrained areas including Denison Street. Further, as Miller Street rises approximately 14.5 metres between Berry Street and McLaren Street provision of a northern entry would allow customers to avoid this steep climb, making the station more attractive and delivering a particular benefit to less mobile customers.

Safety

A secondary benefit of adding a northern entry is that it would relieve pressure on the southern entrance. This would provide an opportunity for improved space planning around the southern entrance and would reduce the number of pedestrians, in particular school children, crossing busy roads in the morning near the intersection of Berry Street and Miller Street. This intersection was identified as a potential safety risk if pedestrian crossing capacity was not improved at this location to accommodate the increased pedestrian movements expected at this intersection due to its proximity to the approved station entry. The northern entry would also allow an alternative route to exit the station in the case of a service disruption or incident at the southern entrance.

Support for the future growth of the North Sydney CBD

A northern Victoria Cross Station entrance would be a key enabler to improve access in the northern part of the North Sydney CBD and would support opportunities for future growth. The *Sydney Metro Planning Study* (North Sydney Council, 2016) recognises the opportunity that Sydney Metro presents to re-examine the land use and built form future of precincts north of the North Sydney CBD and supports a second Victoria Cross Station entrance north of Berry Street.

Transport integration

The North Sydney area is a major thoroughfare for buses with services connecting the area to the Northern Beaches and lower North Shore, including Mosman, Northbridge and Chatswood to the Sydney CBD. Most of these bus services operate along either Miller Street or the Pacific Highway.

Approximately 1,600 customers are expected to board or alight bus services on Miller Street at Victoria Cross Station during the 3.5 hour AM peak. A northern station entry would benefit these customers by providing an alternative and improved transfer opportunity. This would especially benefit less mobile customers by reducing the walking distance between stops and enabling transfer to the station before reaching the busy core of the North Sydney CBD area.

A northern station entry would also enable the transfer between modes to be segmented, with transfers to car based modes such as taxis, point to point transport and kiss-and-ride relocated to the northern entry, and transfers to mass transit, such as buses, retained at the southern entry. This has the potential to reduce demand on kerb space in the busiest, most constrained part of the interchange as well as reduce demand on the surrounding roads by distributing demand to other parts of the local road network. It would provide operational flexibility for buses (accommodation of future routes / additional kerb space for bus stands) and improve the customer interchange experience for car based transfers.

2.3 Artarmon

2.3.1 Need for the Artarmon substation

Section 6.8.2 of the Environmental Impact Statement identifies that a substation is required at Artarmon (between the northern tunnel portal and Crows Nest Station) to provide traction power to the metro tunnels below. The substation is part of the electrical power supply network for the project and needs to be located above the running tunnels with suitable access by road.

2.3.2 Key benefits of the proposed modification

The proposed change responds to Willoughby City Council and community feedback received during the exhibition of the Environmental Impact Statement and is consistent with the commitment given in the submissions report to investigate alternative sites for the Artarmon substation. Key benefits of the proposed modification are outlined below.

The proposed relocation of the Artarmon substation to the Artarmon industrial area would reduce noise and other amenity impacts on Barton Road and Butchers Lane residences, particularly during construction. The assessment for the approved project predicted greater than 20 dBA exceedances of construction noise management levels as a result of works at the Butchers Lane site during establishment, earthworks and shaft excavation phases of construction. Use of the proposed modification site along Reserve Road would mostly affect less sensitive industrial receivers.

Artarmon Primary School is currently using the existing site proposed for the substation as part of the approved project for educational purposes. Use of the alternative site would not interfere with this use should there be a demand to continue it in the medium term.

The form and function of the substation building would also be more compatible with the surrounding industrial land uses within the Artarmon industrial area.

2.4 Project objectives

Section 3.9 of the Environmental Impact Statement lists the project objectives that were developed having regard to key challenges and relevant strategic land use and transport policies. The objectives for the project are:

- Improve the quality of the transport experience for customers
- Provide a transport system that is able to satisfy long-term demand
- Grow public transport patronage and mode share
- Support the productivity of the Global Economic Corridor
- Serve and stimulate urban development
- Improve the resilience of the transport network
- Improve the efficiency and cost effectiveness of the public transport system
- Implement a feasible solution recognising impacts, constraints and delivery risk.

The proposed modifications would support these objectives, particularly those relating to the transport experience for customers, serving and stimulating urban development, and recognising impacts and constraints. The proposed modifications would also deliver safer and more efficient pedestrian movements to and from Victoria Cross Station, providing an opportunity to optimise traffic operations (vehicle / pedestrian movements) on the surrounding network.

MODIFICATION DEVELOPMENT AND ALTERNATIVES

CHAPTER THREE

3 Modification development and alternatives

This chapter describes the options evaluation process used to determine the preferred options for the Victoria Cross Station services building and Artarmon substation.

3.1 Victoria Cross Station services building

3.1.1 Background

In response to Condition A21 of the planning approval for the approved project, a further detailed analysis of alternative locations for construction of the Victoria Cross Station services building has been undertaken. This process also provided the opportunity to consider the integration of an additional Victoria Cross Station entrance at the alternative services building site.

The options development and evaluation process aimed to:

- Identify and evaluate alternative locations for the Victoria Cross Station services building
- Recommend a preferred location for the Victoria Cross Station services building
- Consider opportunities for integration of a station entrance at the site of the preferred Victoria Cross Station services building
- Address the requirements of condition A21 of the planning approval.

This chapter summarises the outcomes of the option development and evaluation process, including identifying the preferred option for the proposed modification.

3.1.2 Options considered

A comprehensive search was carried out to identify potential alternatives to the Victoria Cross Station northern services building site presented for the approved project. This involved developing an initial list of alternative sites that could meet operational requirements and then refining that list with reference to high level constructability, operational, customer access, land use, heritage and noise / vibration considerations. The operational requirements used to shortlist alternative locations included:

- Sufficient size to allow construction and to accommodate the services building
- Positioned near the northern part of the station cavern to house the electrical traction substation (which must be at or near the surface), and to allow for draft relief vents (which are needed at both ends of the station to manage air temperature and pressure within the station and tunnels)
- Minimise distances for emergency egress. Design standards require emergency egress at the northern and southern ends of every station to a relatively open area
- Minimise the extent of shaft and adit tunnel excavation and associated construction costs and environmental impacts
- Minimise the costs and energy use associated with operating longer ventilation shafts
- Avoid sites immediately adjacent to the site identified for the approved project (along the western part of McLaren Street, or south of McLaren Street on the west side of Miller Street) on the basis that these sites would most likely have similar or greater impacts.

Applying the above considerations, twelve potential sites were identified:

- SITE A – 194 and 196A Miller Street, North Sydney (Lot 1 DP781576 and Lot 1 DP734946) (approved project site)
- SITE B – 200 Miller Street, North Sydney (North Sydney Council premises) (Part Lot 3 DP1101874) (with a second frontage to McLaren Street)
- SITE C – 243 Miller Street, North Sydney (Lot 1 DP561413)
- SITE D – 50 McLaren Street, North Sydney (Lot 1 DP536008)
- SITE E – 52 McLaren Street, North Sydney (Lot 2 DP218407)
- SITE F – 237 Miller Street, North Sydney (SP56005)
- SITE G – 37-39 McLaren Street, North Sydney (SP47495)
- SITE H – 41 McLaren Street, North Sydney (Lot 1 DP557103)
- SITE I – 24 Ward Street, North Sydney (Lots 1and 2 DP541610)
- SITE J – 221 Miller Street, North Sydney (SP49696)
- SITE K – 225 Miller Street, North Sydney (Lot 11 DP1130656)
- SITE L – 229 Miller Street, North Sydney (SP11322).

Figure 3-1 shows the initial area of investigation, identifies the above sites and notes other sites that were excluded from further consideration (due to insufficient size or direct proximity to the originally proposed services building location).

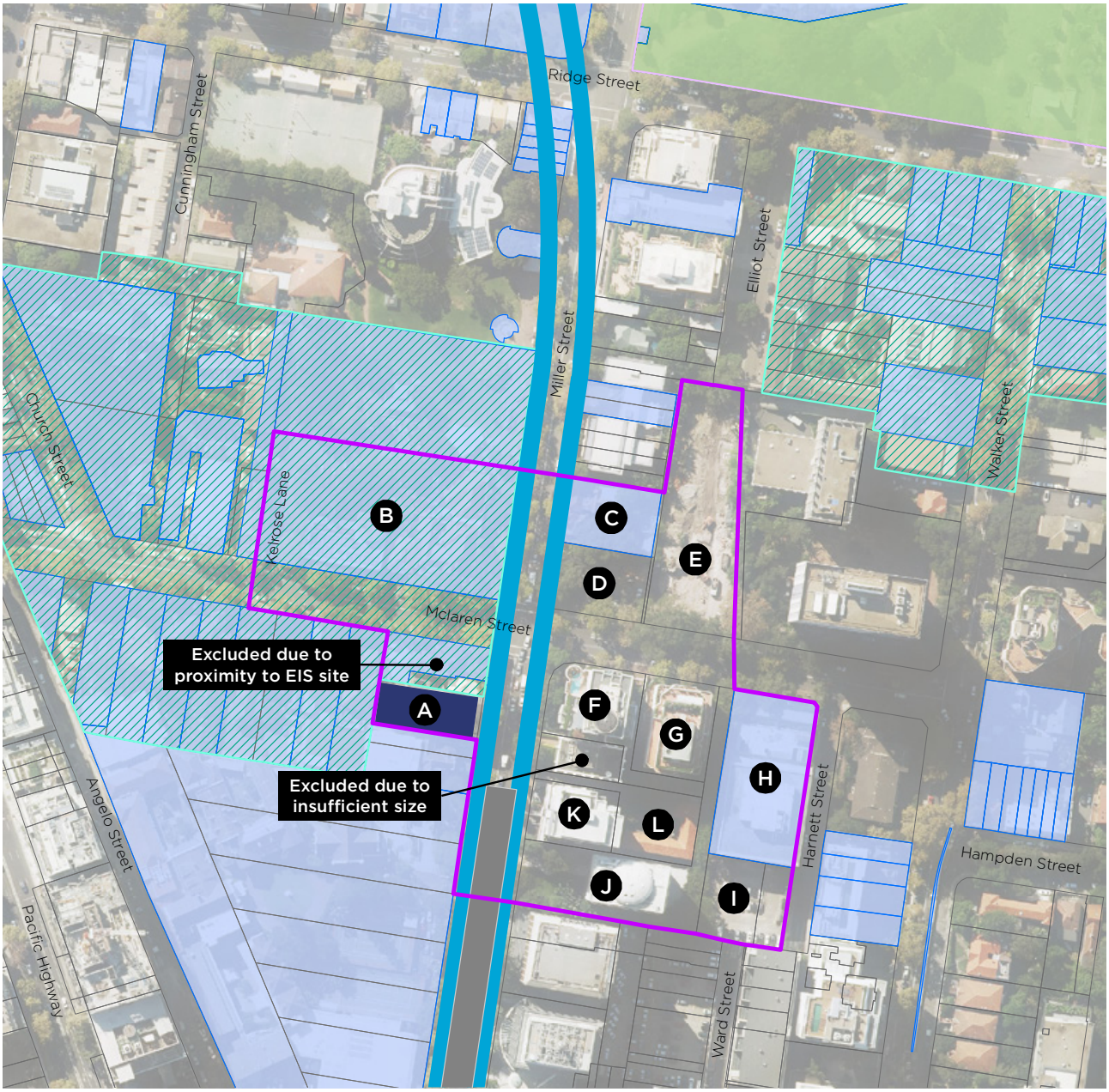

Figure 3-1 Options considered for the Victoria Cross Station services building

3.1.3 Options evaluation

Short listing of options

The twelve sites that were progressed for further consideration were evaluated with reference to high level constructability, operational, customer access, land use, heritage and noise / vibration considerations. This evaluation is summarised in Table 3-1 to Table 3-12.

Table 3-1 Evaluation of Site A – 194 and 196A Miller Street (approved project site)

Consideration	Comment
Constructability	Suitable from a constructability perspective and less likely to affect delivery of the project in line with the program. Road access off Miller Street. The small size of the site would make manoeuvring of construction vehicles more difficult and may necessitate periodic occupation of the kerbside lane and some reversing movements.
Operation	Proximate to the northern end of the Victoria Cross Station cavern and suitable from an operational perspective.
Customer access	Site is of insufficient size and an unsuitable configuration to accommodate a station entrance.
Land use, property, community	Acquisition of commercial building has occurred. Demolition of the building would be required, with associated disruption to adjoining properties.
Heritage	Immediately adjacent to four locally significant heritage items with minimal opportunity for setbacks. This site is also adjacent to the McLaren Street Conservation Area.
Noise and vibration	Immediately adjacent to educational, commercial, residential and educational receivers. Potential for high level airborne and ground borne noise impacts on nearby sensitive receivers including a recording studio / theatre within the grounds of Monte Sant' Angelo Mercy College.
Decision	**Progressed for further assessment** This the site reflected in the approved project and is suitable from an operational perspective.

Table 3-2 Evaluation of Site B – 200 Miller Street (with frontage on McLaren Street)

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction. Additional excavation would be required due to the distance of this site from the station box and this would result in further costs associated with spoil removal, transport and potentially disposal. Potential road access off Miller Street or McLaren Street.
Operation	Site meets operational requirements in terms of power, draft relief and emergency egress.
Customer access	Site is of sufficient size to accommodate a station entry, however the location is positioned away from the station box and would result in longer travel time for customers accessing the station from this site. Position of station entry location with limited street frontage would have fewer passive surveillance opportunities which has potential crime prevention / security implications. While this site would provide good direct access to community services within Civic Park and the North Sydney Community Centre, sites on Miller Street are more visible and preferred for a station entrance for customer access and interchange with bus services.

Consideration	Comment
Land use, property community	Use of this site would require relocation of North Sydney Council administrative functions. It would also affect the adjacent Civic Park, which is used for recreation, the Northside Produce Market and the Twilight Food Fair.
Heritage	Use of this site would involve direct impacts on the curtilage of the following locally significant heritage items (listed by the *North Sydney Local Environmental Plan 2013*): • North Sydney Council Chambers – Wyllie Wing. The Wyllie Wing is a physical record of the growth and stature of local government in North Sydney. It also demonstrates a modernist approach by one of Australia's most prominent modernist architects – Harry Seidler. It is a representative example of a 1970s modernist style building. • North Sydney Council Chambers (including fountain in park adjacent to Council Chambers). This item is an important example of its style in a prominent corner location. Associated with early medical practice and was significant local hospital at one stage. Later associations as Council Chambers and generally an important local public building. Work of significant local architect. This site is also within the McLaren Street Conservation Area.
Noise and vibration	Residential receivers are located on the southern side of McLaren Street, while a preschool and place of worship (St Thomas North Sydney) are located with minimal setback to the west.
Decision	**Excluded from further consideration** This site does not represent a better alternative to the approved project site because it would have direct impacts on heritage items and is in immediate proximity to noise sensitive receivers. While, unlike the approved project site, it could accommodate a station entry, the site has limitations in terms of customer access when compared to options with a frontage to Miller Street.

Table 3-3 Evaluation of Site C – 243 Miller Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction. Additional excavation would be required due to the distance of this site from the station box and this would result in further costs associated with spoil removal, transport and potentially disposal. Road access off Miller Street.
Operation	Site meets operational requirements in terms of power, draft relief and emergency egress.
Customer access	Site is of sufficient size to accommodate a station entry, however the site is positioned furthest away from station box and would result in the longest travel time for customers accessing the station from this site.
Land use, property community	Requires acquisition / demolition of buildings used for commercial and residential purposes, with associated disruption to existing tenants.
Heritage	Use of this site would involve direct impacts on a locally significant heritage item ("Shop") (listed by the *North Sydney Local Environmental Plan 2013*). This item is a good example of an Arts and Crafts style house in a prominent location in area dominated by buildings of the same period. Example of local architect's work. Important stylistic and physical relationship to Council Chambers and McLaren Street Group.

Consideration	Comment
Noise and vibration	This site would also have minimal setback to Wenona School facilities (estimated at about six metres as opposed to about 30 metres for Option D) including a general purpose learning area that is used for assemblies, concerts, recitals, parent teacher evenings, regular teaching, examinations and sporting activities.
Decision	**Excluded from further consideration.** This site does not represent a better alternative to the approved project site because it would have direct impacts on heritage item and is in immediate proximity to noise sensitive receivers. While, unlike the approved project site, it could accommodate a station entry, the site has limitations in terms of customer access given its greater distance from the station cavern when compared to other options.

Table 3-4 Evaluation of Site D – 50 McLaren Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction. The absence of improvements at the site would minimise disruption associated with demolition and would assist delivery of the project in line with the program. Road access from Miller or McLaren Streets, however the proximity to the Miller Street / McLaren Street traffic signals presents challenges for traffic management (unless this site is used in conjunction with Site E – refer below).
Operation	Site meets operational requirements in terms of power, draft relief and emergency egress.
Customer access	Site is relatively close to the station box, reducing time required for customers to access the station. Site is a prominent corner site with a dual street frontage, which has high visibility and is optimal for customer access and bus interchange.
Land use, property community	Site is currently vacant pending redevelopment for the purposes of an aged care facility (which has development consent). Existing occupiers would therefore not be affected. Impacts on existent trees on and adjacent to the site would be avoided where practicable.
Heritage	Use of this site would not involve direct impacts on a heritage item but would be adjacent to the locally significant item heritage item ("Shop") (listed by the *North Sydney Local Environmental Plan 2013*).
Noise and vibration	Commercial, residential educational receivers to the north and residential receivers on the southern side of McLaren Street. Setbacks to receivers are greater than at other sites.
Decision	**Progressed for further assessment** This site potentially represents a better alternative to the approved project site because it is optimal for customer access. Like the approved project site, it also avoids direct impacts on heritage items. This site has the advantage of being a vacant site thereby avoiding disruption to existing occupants and impacts associated with demolition.

Table 3-5 Evaluation of Site E – 52 McLaren Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction. The absence of improvements at the site would minimise disruption associated with demolition and would assist delivery of the project in line with the program. Road access from McLaren Street.
Operation	Site meets operational requirements in terms of power, draft relief and emergency egress.
Customer access	Site is not considered suitable for a station entrance. McLaren Street slopes steeply to the east making it difficult to provide an accessible entry at this location. Sites on Miller Street are more visible and preferred for a station entrance for customer access and interchange with bus services.
Land use, property community	Site is currently vacant pending redevelopment for the purposes of an aged care facility. Existing occupiers would therefore not be affected. Site E is owned by the same owner as Site D and subdivision / severance would potentially have a significant impact on the development potential and value of the remaining site to that owner.
Heritage	Use of this site would not involve direct impacts on a heritage item but would be adjacent to the locally significant heritage item ("Shop") (listed by the *North Sydney Local Environmental Plan 2013*).
Noise and vibration	Educational receivers are located to the north and residential receivers are located to the east (at 243 Miller Street) on the southern side McLaren Street. Setbacks to receivers are greater than at other sites.
Decision	**Excluded from further consideration as a standalone option, however progressed in conjunction with Site D to facilitate construction** This site when considered on its own does not represent a better alternative to the approved project site due to the steeply sloping nature of the site making it difficult to provide an accessible entry location. Additionally existing property interests would be impacted. However when considered in conjunction with the adjacent site D, this site potentially represents a better alternative to the approved project site because it has the advantage of being a vacant site thereby avoiding disruption to existing occupants and impacts associated with demolition. Like the approved project site, it also avoids direct impacts on heritage items.

Table 3-6 Evaluation of Site F – 237 Miller Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction, however the duration of the acquisition process for this site would also potentially delay the program for the delivery of the project (in contrast to sites with fewer affected owners). Road access from Miller Street and McLaren Street is feasible, however the proximity to the Miller Street / McLaren Street traffic signals presents challenges for traffic management.
Operation	Site meets operational requirements in terms of power, draft relief and emergency egress.
Customer access	Site is relatively close to the station box, minimising time required for customers to access the station. Site is a prominent corner site with a dual street frontage, which is optimal for customer access and bus interchange.

Consideration	Comment
Land use, property community	Use of this site would involve acquisition of a substantial number of residential strata lots with associated disruption to owners and/or occupiers.
Heritage	Use of this site would not involve direct or indirect impacts on heritage items.
Noise and vibration	Immediately adjacent residential receivers are located to the east and south of this site with minimal setbacks.
Decision	**Excluded from further consideration** This site does not represent a better alternative to the approved project site due to disruption and program implications associated with acquisition of multiple residential strata lots and the likely level of construction noise impacts on immediately adjacent residential receivers.

Table 3-7 Site G – 37-39 McLaren Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction, however the duration of the acquisition process for this site would also potentially delay the program for the delivery of the project (in contrast to sites with fewer affected owners). Road access would be on the steep section of McLaren Street.
Operation	Site meets operational requirements in terms of power, draft relief and emergency egress.
Customer access	Site is not considered suitable for a station entrance. McLaren Street slopes steeply to the east making it difficult to provide an accessible entry at this location. Site is of sufficient size to accommodate a station entry, however location away from station box would result in longer travel time for customers accessing the station from this site. Sites on Miller Street are more visible and preferred for a station entrance for customer access and interchange with bus services.
Land use, property community	Use of this site would involve acquisition of a substantial number of residential strata lots with associated disruption to owners and/or occupiers.
Heritage	Use of this site would not involve direct impacts on a heritage item, but the site is located adjacent to the locally significant item (“Simsmetal House”) (listed by the *North Sydney Local Environmental Plan 2013*).
Noise and vibration	Immediately adjacent residential receivers are located to the east, west and south of this site with minimal setbacks.
Decision	**Excluded from further consideration** This site does not represent a better alternative to the approved project site due to disruption and program implications associated with acquisition of multiple residential strata lots and the likely level of construction noise impacts on immediately adjacent residential receivers. It is also not a suitable location for a station entrance.

Table 3-8 Site H – 41 McLaren Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction. Additional excavation would be required due to the distance of this site from the station box and this would result in further costs associated with spoil removal, transport and potentially disposal. Road access from McLaren Street.
Operation	Site can meet operational requirements in terms of power, draft relief and emergency egress, but is less desirable when compared to sites closer to the station box.
Customer access	Site is not considered suitable for a station entrance. McLaren Street slopes steeply to the east making it difficult to provide an accessible entry at this location. Site is of sufficient size to accommodate a station entry, however its location away from station box would result in longer travel time for customers accessing the station from this site. Sites on Miller Street are more visible and preferred for a station entrance for customer access and interchange with bus services.
Land use, property community	Requires acquisition / demolition of a commercial building, with associated disruption to existing tenants. Use of this site for an above ground services building would be inconsistent with the *North Sydney Centre Ward Street Precinct Masterplan* (North Sydney Council, 2017), which envisages retention of the commercial building and the provision of upper level residential uses.
Heritage	Use of this site would directly impact on the locally significant item ("Simsmetal House") (listed by the *North Sydney Local Environmental Plan 2013*).
Noise and vibration	Immediately adjacent residential receivers are located to the east and west with minimal setbacks.
Decision	**Excluded from further consideration** This site does not represent a better alternative to the approved project site because it would have direct impacts on a heritage item, and would have construction noise impacts on immediately adjacent residential receivers. It is also not a suitable location for a station entrance.

Table 3-9 Site I – 24 Ward Street

Consideration	Comment
Constructability	Site is of sufficient size to allow construction. Additional excavation would be required due to the distance of this site from the station cavern. While still within the investigation area, this site is a greater distance from the station cavern when compared to other viable options. It would also require the services adit to extend beneath the basements of the new residential development which is currently under construction at 221 Miller Street. The five basements levels at 221 Miller Street once constructed would extend to a depth of around 20 metres below the Miller Street level (with the base at around RL 56). With the top of the services adit at around RL 50, there would be minimal separation between the adit and the basement. This could result in structural issues and result in the need for additional structural support (either to the basement or adit tunnel).
Operation	Site can meet operational requirements in terms of power and draft relief, however the exit point might not be sufficiently open for emergency egress. This site is less desirable when compared to sites closer to the station cavern.

Consideration	Comment
Customer access	Site is of sufficient size to accommodate a station entry, however location away from station box would result in longer travel time for customers accessing the station from this site. The location of this site to the south of McLaren Street limits the potential to realise the benefits of extending the station catchment to the north. Sites on Miller Street are preferred for a station entrance for customer access and interchange with bus services.
Land use, property community	Requires acquisition / demolition of a car park. Use of this site for an above ground services building would be inconsistent with the *North Sydney Centre Ward Street Precinct Masterplan* (North Sydney Council, 2017), which envisages community, retail, commercial and residential uses in this area.
Heritage	Use of this site would not involve direct impacts on a heritage item, but is located adjacent to the locally significant item ("Simsmetal House") (listed by the *North Sydney Local Environmental Plan 2013*).
Noise and vibration	Immediately adjacent residential receivers are located to the west with minimal setbacks. There would also likely be ground borne and vibration impacts on the new development currently under construction at 221 Miller Street due to the proximity of the works in relation to the construction of a new adit below.
Decision	**Excluded from further consideration** This site does not represent a better alternative to the approved project site due to the level of likely construction noise impacts on immediately adjacent residential receivers and potential constructability and noise & vibration impacts on the new development currently under construction at 221 Miller Street. It is also not a suitable location for a station entrance.

Table 3-10 Site J – 221 Miller Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction. While demolition work for a new residential development is currently underway, the absence of improvements at the site would minimise disruption associated with demolition and would assist delivery of the project in line with the program. Road access from Miller Street.
Operation	Site meets operational requirements in terms of power, draft relief and emergency egress.
Customer access	Site is of sufficient size to accommodate a station entry, however the location of this site to the south of McLaren Street limits the potential to extend station catchment to the north.
Land use, property community	Demolition works are currently occurring at this site, with future development for the purposes of a residential apartment building. Advantages associated with a currently vacant site
Heritage	Use of this site would not involve direct or indirect impacts on a heritage items.
Noise and vibration	Due to the minimal setbacks to adjacent residential buildings, this site would be unlikely to deliver better noise / vibration outcomes when compared to the approved project option.

Consideration	Comment
Decision	**Excluded from further consideration** This site does not represent a better alternative to the approved project site due to the level of likely construction noise impacts on immediately adjacent residential receivers. It is also a sub-optimal location for a station entrance.

Table 3-11 Site K – 225 Miller Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction, however the duration of the acquisition process for this site would also potentially delay the program for the delivery of the project (in contrast to sites with fewer affected owners). Road access from Miller Street.
Operation	Site meets operational requirements in terms of power, draft relief and emergency egress.
Customer access	Site is of sufficient size to accommodate a station entry, however the location of this site to the south of McLaren Street limits the potential to extend the station catchment to the north.
Land use, property community	Use of this site would involve acquisition of a substantial number of residential strata lots with associated disruption to owners and/or occupiers.
Heritage	Use of this site would not involve direct or indirect impacts on a heritage items.
Noise and vibration	Immediately adjacent residential receivers are located to the west, with minimal setbacks.
Decision	**Excluded from further consideration** This site does not represent a better alternative to the approved project site due to the level of likely construction noise impacts on immediately adjacent residential receivers and because of program implications associated with acquisition of multiple residential strata lots. It is also a sub-optimal location for a station entrance.

Table 3-12 Site L – 229 Miller Street

Consideration	Comment
Constructability	Site is of sufficient size and is in a suitable location to allow construction, however the duration of the acquisition process for this site would also potentially delay the program for the delivery of the project (in contrast to sites with fewer affected owners). This site has limited road access.
Operation	Site can meet operational requirements in terms of power and draft relief, however the exit point might not be sufficiently open for emergency egress. This site is less desirable when compared to sites closer to the station cavern.
Customer access	Site is of sufficient size to accommodate a station entry, however location away from station box would result in longer travel time for customers accessing the station from this site. The location of this site south of McLaren Street limits the potential to extend the station catchment to the north. Sites on Miller Street are more visible and preferred for a station entrance for customer access and interchange with bus services.
Land use, property community	Use of this site would involve acquisition of a substantial number of residential strata lots and associated disruption to owners and/or occupiers.

Consideration	Comment
Heritage	Use of this site would not involve direct impacts on a heritage item, but the site is located adjacent to the locally significant item ("Simsmetal House") (listed by the *North Sydney Local Environmental Plan 2013*).
Noise and vibration	Immediately adjacent residential receivers are located to the north, west and south, with minimal setbacks.
Decision	**Excluded from further consideration** The site does not represent a better alternative to the approved project site due to the disruption and program implications associated with acquisition of multiple residential strata lots and potential noise and vibration impacts on adjacent residential receivers. It is also a sub-optimal location for a station entrance.

Based on this evaluation, two options were identified for detailed comparative assessment as follows:

- Option 1: Site A located at 194 and 196A Miller Street, North Sydney. This is the location assessed as part of the approved project
- Option 2: Site D and E combined, located at 50 McLaren Street, North Sydney and 52 McLaren Street, North Sydney respectively, with Site E included to facilitate construction works only.

Evaluation of short-listed options

The short-listed options were evaluated by the project team with reference to seven criteria as follows:

- Constructability
- Property and land use
- Noise and vibration
- Heritage
- Traffic and transport
- Visual amenity
- Opportunities.

The criteria were selected with reference to the considerations in Condition A21 of the planning approval as well as other considerations which could help differentiate between the options.

The preferred option was selected based on a consideration of all the factors identified during the options analysis. Evaluation of each option against the noise and vibration criteria occurred in consultation with the Independent Acoustic Advisor appointed in accordance with Condition A25 of the planning approval.

Option 1 evaluation

The outcomes of the evaluation of Option 1 (194 and 196A Miller Street) are presented in Table 3-13.

Table 3-13 Option 1 evaluation summary

Criterion	Discussion
Constructability	While a constrained site with buildings on three sides, this site is of sufficient size for construction of the services building and associated shaft. As this site forms part of the approved project, selecting this site would be unlikely to affect delivery of the project in line with the program.
Property and land use	Permanent loss of commercial site and associated building, resulting in an inactive frontage to Miller Street. Disruption associated with relocation of commercial tenants (which has already occurred) and additional construction related impacts on the operation of the adjacent business to the north (restaurant).
Noise and vibration	Modelling indicates that for Option 1, exceedences of airborne noise management levels (NML) by more than 20 dBA are predicted during the enabling works and earthworks phases for nearby educational and commercial receivers, and at the recording studio / theatre within the grounds of the Monte Sant' Angelo Mercy College site. Greater than 20 dBA exceedances for the recording studio would persist for all remaining phases of construction. Exceedances of between 10 dBA and 20 dBA are predicted for nearby residential receivers during the enabling works and earthworks phases and exceedances of less than 10 dBA are predicted during the excavation and building construction / fit out phases. The constrained Option 1 site provides little opportunity to arrange construction buildings / activities to maximise distances and noise attenuation for nearby receivers. Ground borne noise levels are predicted to exceed NMLs by more than 20 dBA at adjacent commercial, residential and educational receivers, but also at the recording studio / theatre within the grounds of the Monte Sant' Angelo Mercy College. The assessment of the approved project identified that for McLaren Street, Miller Street and Berry Street the predicted construction traffic noise level would exceed the base road traffic noise criteria, but that the increase associated with construction traffic would comply with the accepted 2 dB increase allowance. Further, while there is predicted exceedance of the sleep disturbance screening criterion (of up to 10 dB) and external sleep disturbance NML of 65 dBA (of up to 11 dB) (based on 6 heavy vehicle and 2 light vehicle movements per hour during the night), the LAmax levels would be similar to other heavy vehicles using McLaren Street, Miller Street and Berry Street. The closest façades of adjacent buildings would experience construction vibration above the 7.5mm/s screening level for cosmetic damage (unreinforced or light framed structures – residential or light commercial type buildings).

Criterion	Discussion
Traffic and transport	The assessment of the approved project identified that the level of service at each intersection modelled would not deteriorate with the addition of construction vehicles, including those generated by the Option 1 site. Impacts on the road network would therefore be minimal. The Option 1 site would have left-in / left-out access / egress with ready access to the arterial road network. The bus stop on the south western corner of the Miller Street / McLaren Street intersection, adjacent to the Option 1 site, would need to be relocated during construction and this may result in additional walking distance for some users. There would be some impacts on pedestrians associated with the narrowing of footpaths on Miller Street during construction. This would particularly affect school students who currently use these footpaths to access public transport services to the south. Option 1 would involve a minor loss of on-street parking on Miller Street during construction.
Heritage	Immediately adjacent to the following heritage items and / or conservation areas with minimal opportunity for setbacks: • 'O'Regan' (I0899) 192 Miller Street (Lot 1, DP 780403; Lot 4, DP 5030) • 'House' (I0884) 31 McLaren Street (Lot 5, DP 5030) • 'Restaurant' (I0900) 196 Miller Street (Lot 2, DP 734946) • McLaren Street Conservation Area The assessment for the approved project identified either minor or neutral indirect impacts (views and vistas) on these items. The closest façades of these items would experience vibration above the 7.5mm/s screening level for cosmetic damage.
Visual amenity	The assessment of the approved project noted that there would be a minor adverse visual impact at the northern services building site due to the introduction of a utilitarian structure and the associated loss of visual interest and reduced visual compatibility. The short frontage to Miller Street would however minimise the visibility of the services building.
Customer access and redevelopment opportunities	The Option 1 site offers no associated redevelopment opportunities and is of insufficient size and an unsuitable configuration to accommodate a station entry.

Option 2 evaluation

The outcomes of the evaluation of Option 2 (50-52 McLaren Street) are presented in Table 3-14.

Table 3-14 Option 2 evaluation summary

Criterion	Discussion
Constructability	The site is of sufficient size for construction of the services building and associated shaft.
Property and land use	Vacant site and therefore no disruption associated with relocation of existing occupiers. Potential for future redevelopment of Lot 2 DP218407 would be retained.

Criterion	Discussion
Noise and vibration	Noise modelling conducted for the Option 2 site indicates that construction at this site would result in lower level exceedances of NMLs airborne noise when compared to Option 1. Key results are as follows • No predicted exceedances of airborne NMLs greater than 20 dBA • Predicted exceedances of NMLs by between 10 dBA and 20 dBA for adjacent educational receivers during the enabling works, earthworks and building construction / fit out phases. • Predicted exceedances of NMLs by between 10 dBA and 20 dBA for adjacent commercial receivers during the earthworks phase. • Predicted exceedances of NMLs by less than 10 dBA at various nearby receivers during all construction phases. This includes exceedances of less than 10 dBA for the nearest residential receiver during the earthworks, acoustic shed construction and building construction / fit out phases. Ground borne noise levels are predicted to exceed NMLs by more than 20 dBA at adjacent commercial and residential receivers and by between 10 dBA and 20 dBA at adjacent educational receivers. There are no predicted exceedances for the recording studio / theatre receiver category. The nearest building on the Wenona School site is a general purpose learning area that is used for assemblies, concerts, recitals, parent teacher evenings, regular teaching, examinations and sporting activities. While some of these activities are more sensitive than others, it is not considered necessary to assign specific noise management levels to individual uses within the subject building. The Life Connect psychology practice is located at 243 Miller Street and has been classified as a commercial receiver for assessment purposes. The larger available construction site area associated with Option 2 provides an opportunity to increase the barrier attenuation for airborne noise by staff offices and amenities buildings between noise sources and receivers. For McLaren Street and Miller Street the base road traffic noise criteria are likely to be exceeded and the predicted noise level increase (L_{Aeq}) associated with construction traffic is greater than 2 dB (Miller Street 0.8 / 2.5 and McLaren Street 0.4 / 2.2). Therefore, sensitive receivers may notice some increase in the average road traffic noise levels during construction. There are expected to be up to 24 heavy vehicle and 10 light vehicle movements or events per hour during the night (as the larger Option 2 site provides more opportunity to support excavation and spoil removal activities), and while there is a predicted exceedance of the sleep disturbance screening criterion (of up to 13 dB) and external sleep disturbance NML of 65 dBA (by up to 14 dB), the L_{Amax} levels would be similar to other heavy vehicles using McLaren Street and Miller Street. During construction of the proposed shaft using a medium rockbreaker, vibration levels are anticipated to remain below the vibration screening levels associated with minor cosmetic building damage at surrounding buildings, except for the commercial building immediately to the north of the Option 2 site (which is a locally significant heritage item).

Criterion	Discussion
Traffic and transport	The Option 2 site would have left-in / left-out access to McLaren Street with ready access from / to the arterial road network via Miller Street (inbound) and Walker Street and Berry Street (outbound). In contrast to the Option 1 site, this site is large enough to accommodate internal circulation of haulage vehicles thereby minimising the need for road occupancy adjacent to the site and reversing movements. Walker Street southbound between McLaren Street and Berry Street is regulated with 'No Stopping' signage and has recently been widened resulting in adequate lane widths to accommodate haulage vehicles. It is also relatively lightly trafficked making the right turn from McLaren Street feasible. The proposed secondary route via the McLaren Street eastern approach to Miller Street is very steep, and this would result in poor operational performance for fully laden vehicles accelerating from a stopped position. There is also an opportunity for secondary access and egress to be established to the north of 50 and 52 McLaren Street on Elliot Street (restricted to special deliveries). Traffic modelling indicates that the level of service at potentially affected intersections would not deteriorate with the addition of construction vehicles associated with Option 2. The Option 2 location would not impact on public transport services and is fronted by a footpath which currently carries significantly lower numbers of pedestrians when compared to Option 1. While there is currently an informal pedestrian route used by Wenona Students that extends from Elliot Street along the eastern boundary of 52 McLaren Street, this connectivity is likely to be retained (in conjunction with suitable pedestrian management measures along the McLaren Street frontage). Overall, Option 2 is expected to have lower level impacts on the local active transport network during construction. The Option 2 location would relieve pedestrian traffic at the southern entrance and would result in fewer people walking on the Miller Street footpath between Berry Street and McLaren Street. This would also reduce the number of pedestrians, including school children, crossing busy roads near the busy Berry Street / Miller Street intersection in the morning peak. This represents a distinct safety benefit. Use of the Option 2 site would permanently affect motorcycle parking and car share parking located on the McLaren Street frontage.

Criterion	Discussion
Heritage	The Option 2 site is immediately adjacent to the locally significant 'Shop' at 243 Miller Street (Lot 1, DP 561413). With the implementation of appropriate mitigation measures, there would be no direct impacts on this item and indirect impacts would be minimised through general compliance with the height and setback controls in the *North Sydney Development Control Plan 2013*. The closest façade of the heritage item immediately to the north of the Option 2 site would experience vibration above the 7.5mm/s screening level for cosmetic damage. More detailed assessment of the structure and attended vibration monitoring would therefore need to be carried out to ensure vibration levels remain below appropriate limits for this building.
Visual amenity	Option 2 consists of a prominent corner site with long frontage to both Miller Street and McLaren Street which creates greater potential for construction and operational visual impact, but also provides an opportunity to activate the Miller Street frontage. The mature trees along Miller Street would be retained, therefore maintaining the canopy and associated comfort and amenity of the streetscape. The CBD character statement in the *North Sydney Development Control Plan 2013* requires new development north of McLaren Street to maintain the setback of existing buildings (s.2.1.3, P8). The new services building would be set back 12 metres from the Miller Street property boundary, and 4.5 metres from the McLaren Street boundary, therefore aligning with 31 McLaren Street (within the McLaren Street conservation area), which has a strong frontage and address. Overall, there would be a noticeable improvement in the landscape quality of the site and these streetscapes, which are of local sensitivity. Impacts on local views would be minor.

Criterion	Discussion
Customer access and redevelopment opportunities	Site is of sufficient size and in an optimal corner location on Miller Street to accommodate a lift only station entry. Various international examples, such as the Hong Kong MTR Island Line entrances at Hong Kong University and Sai Ying Pun stations, the Barcelona Metro Line 9 Fondo Station and the Forest Glen station in Washington DC, demonstrate lift only station entries are highly functional and can be intuitive for customers. A lift-only entry would be the first of its kind for Sydney Metro and could be important as a product element for future metro lines, particularly as stations get deeper. The existing Victoria Cross Station 10-minute catchment has the potential to serve around 51,000 workers and up to 5,900 dwellings by 2036. The station would also serve some of the estimated 10,000 school students in the wider precinct. An estimated 20 per cent of customers using Victoria Cross Station have a destination to the north of Berry Street. An additional entry at the Option 2 location would increase the reach of the station catchment to include additional regional attractors such as the Mater Hospital and North Sydney Oval, North Sydney Boys High School and the residential and mixed use area to Falcon Street and Neutral Bay via the footbridge over the Warringah Freeway. For 2036, the potential northern entry usage is estimated to be around 2,300 trips during the AM peak 1 hour, representing about 17 per cent of all peak rail entries and exits at Victoria Cross Station. An increase in patronage of five per cent is expected due to the additional walking catchment serviced by the northern entry. Approximately 1,600 customers are expected to board or alight bus services on Miller Street at Victoria Cross Station during the 3.5 hour AM peak. A northern entry would benefit these customers by providing an improved transfer opportunity. This would especially benefit mobility impaired customers by reducing the walking distance between stops and enabling transfer to the station before reaching the busy core North Sydney CBD area. A northern entry would relieve congestion around the southern entrance which would potentially improve the station planning opportunities at this busy entrance. A northern entry would provide an alternative egress route for station passengers in the event of an incident in the station or at the southern entrance. A northern entry to Victoria Cross Station is also consistent with the *Sydney Metro Planning Study* (North Sydney Council, 2016), which recognises the opportunity that Sydney Metro presents to re-examine the land use and built form future of precincts north of the North Sydney CBD and supports a second Victoria Cross Station entrance north of Berry Street. Opportunity for redevelopment of 52 McLaren Street (Lot 2 DP218407) would be retained, including the opportunity for a north-south pedestrian connection between Elliot Street and McLaren Street.

3.1.4 Preferred option

The preferred option is Option 2 (50-52 McLaren Street). The main considerations underpinning the selection of the preferred option were as follows:

- Option 2 meets constructability and operational requirements
- Option 2 would generate lower levels of disruption to existing and adjacent owners / occupiers because it is vacant and there are no existing buildings requiring demolition
- Option 2 would result in overall lower level exceedances of airborne and ground borne noise management levels
- While Option 2 would result in exceedances of road traffic noise levels during construction by more than 2 dBA (in contrast to Option 1), the level of predicted exceedance is small
- While neither option would directly affect listed heritage items, Option 2 would have indirect impacts on fewer items
- Option 2 would result in fewer buildings (including listed heritage items) being affected by exceedance of the 7.5mm/s screening level for cosmetic damage due to construction vibration
- During construction, Option 2 would not affect the level of service at nearby intersections and have fewer impacts on public transport and the active transport network when compared to Option 1
- The Option 2 site is of sufficient size and in a suitable location to allow the inclusion of a lift only station entry which would provide for the estimated 20 per cent of customers with a destination to the north of Berry Street. An additional station entrance at the Option 2 location would extend the station catchment to include additional regional attractors such as the Mater Hospital, the North Sydney Oval, North Sydney Boys High School, North Sydney Girls High School, Marist College North Shore, North Sydney Demonstration School and St Mary's Primary School, the residential and mixed use area to Falcon Street, and Neutral Bay via the footbridge over the Warringah Freeway. It would also improve transfer opportunities for customers using buses on Miller Street and would be consistent with the *Sydney Metro Planning Study* (North Sydney Council, 2016), which supports a second Victoria Cross Station entrance north of Berry Street
- Option 2 would have safety benefits for pedestrians and station users by relieving pressure on the southern entrance and reducing associated pedestrian activity at the intersection of Berry Street and Miller Street.

3.2 Artarmon substation

As identified in Chapter 2, the consideration of an alternative site for the Artarmon substation within the Artarmon industrial area responds to Willoughby City Council and community feedback received during the exhibition of the Environmental Impact Statement. It is also consistent with the commitment given in the submissions report to investigate alternative sites. The submissions report noted that any alternative site would need to meet the following criteria:

- Directly located above the track running tunnels
- Accessible by a public road
- Located such that compliance with relevant NSW noise policy guidance may be achieved.

The site at 98-104 Reserve Road, within the Artarmon industrial area, was the only available site identified that could meet the above criteria and is therefore the preferred option. Further, when compared to the approved project site, use of the Reserve Road site would:

- Have significantly lower levels of airborne and ground borne noise impacts on sensitive receivers
- Be more suitable for the substation in terms of land use compatibility, given the predominantly industrial nature of the immediate surrounds
- Have no impacts on potential medium term educational uses at the approved project site by Artarmon Primary School.

PLANNING AND ASSESSMENT PROCESS

CHAPTER FOUR

4 Planning and assessment process

This chapter describes the statutory planning process for the Victoria Cross Station and Artarmon substation modifications.

4.1 NSW environmental planning approvals

Sydney Metro City & Southwest was declared by Ministerial Order on 10 December 2015 to be State significant infrastructure and critical State significant infrastructure. The assessment and approval process for a critical State significant infrastructure project is established under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). An Environmental Impact Statement for the Chatswood to Sydenham component of Sydney Metro City & Southwest was prepared and exhibited for 48 days from 11 May to 27 June 2016. A subsequent Submissions and Preferred Infrastructure Report was prepared and submitted to the Department of Planning and Environment in October 2016. Planning approval was granted by the Minister for Planning under Part 5.1 of the EP&A Act on 9 January 2017.

Pursuant to section 115ZI of the EP&A Act, Transport for NSW is seeking to modify the State significant infrastructure approval to include the works associated with the Victoria Cross and Artarmon modification. These works would fall within the definition of the critical State significant infrastructure declaration.

Appendix A provides consideration of the Secretary's environmental assessment requirements issued for the Environmental Impact Statement for Sydney Metro City & Southwest Chatswood to Sydenham, including the relevance of each assessment requirement to the proposed modifications and, for the relevant requirements, where they have been addressed in this report.

4.2 NSW legislation that may still be applicable

The assessment for the approved project considered other NSW legislation that may be applicable to the project. Table 4-1 provides further consideration of this legislation in relation to the proposed modification.

Table 4-1 Environmental related legislation of potential relevance to the proposed modification

Legislation	Requirement	Where addressed
Aboriginal Land Rights Act 1983	The NSW *Aboriginal Land Rights Act 1983* applies to Crown lands that are not lawfully needed for an essential public purpose; referred to as claimable Crown land. No claimable Crown lands would be affected by the proposed modifications.	Aboriginal heritage impacts are assessed in Chapter 13 Property impacts are assessed in Chapter 11
Contaminated Land Management Act 1997	This Act outlines the circumstances in which notification of the Environment Protection Authority (EPA) is required in relation to the contamination of land. This may become relevant during construction and / or operation of the proposed modifications.	Chapter 16
Crowns Lands Act 1989	Ministerial approval is required to grant a 'relevant interest' (ie a lease, licence, permit, easement or right of way) over a Crown Reserve if required. The proposed modifications would not be carried out on Crown land.	Chapter 11

Legislation	Requirement	Where addressed
Greater Sydney Commission Act 2015	This Act establishes the Greater Sydney Commission which has a principal objective of leading metropolitan planning for the Greater Sydney Region. The core functions of the Greater Sydney Commission are to provide advice to Government and assist local Councils plans or proposals relating to development in the Greater Sydney Region. The Greater Sydney Commission would not have a formal statutory role for the proposed modifications but would be consulted with respect to its core functions.	Chapter 11
Heritage Act 1977 (Section 146)	The Heritage Council must be notified of a relic that is uncovered during construction and if it is reasonable to believe that the Heritage Council is unaware of the location of the relic.	Chapter 12
Land Acquisition (Just Terms Compensation) Act 1991	This Act would apply to the acquisition of land required for the proposed modifications. However, the provisions of the *Transport Administration Act 1988* have the affect that for underground station acquisition compensation is not payable except in certain circumstances.	Chapter 11
Native Title (New South Wales) Act 1994	This Act provides for native title in relation to land or waters. The proposed modifications would not affect land subject to native title or to which an Indigenous Land Use Agreement applies.	Aboriginal heritage impacts are assessed in Chapter 13 Property impacts are assessed in Chapter 12
Water Management Act 2000	The *NSW Aquifer Interference Policy* (Department of Primary Industries, 2012) documents the NSW Government's intention to implement the requirement for approval of 'aquifer interference activities' under the *Water Management Act 2000*. The requirement for aquifer interference approvals has not yet commenced.	Chapter 15

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas.

The assessment for the approved project did not identify any impacts to matters of national environmental significance. As such, the project was not referred to the Commonwealth Department of the Environment and Energy.

With respect to matters of national environmental significance, the assessment carried out for the proposed modifications did not identify any changes to the impacts as assessed for the approved project. That is, the assessment for the proposed modification did not identify any potential impacts to matters of national environmental significance. Similarly, the proposed modifications would not involve any actions on Commonwealth land. As such, a referral to the Commonwealth Department of the Environment for the proposed modification is not considered necessary.

4.3.2 Native Title Act 1993

The main objective of the Commonwealth *Native Title Act 1993* is to recognise and protect native title. Section 8 states that the *Native Title Act* is not intended to affect the operation of any law of a State or a Territory that is capable of operating concurrently with the Act. Searches of the register maintained by the National Native Title Tribunal indicate there are no native title claims registered with respect to land within the area of the Victoria Cross Station or Artarmon substations modifications. The proposed modifications would not directly affect any Crown land that is currently the subject of a native title claim.

4.3.3 Disability Discrimination Act 1992

The *Disability Discrimination Act 1992* aims to eliminate as far as possible discrimination against persons on the ground of disability in areas including access to premises and the provision of facilities, services and land. The proposed additional entry at Victoria Cross Station would be designed to be independently accessible and in compliance with the objectives and requirements of the Disability *Discrimination Act 1992*. Suitable workplace access would be provided at the Artarmon substation site.

4.3.4 Disability Standards for Accessible Public Transport 2002

Section 33.1 of the *Disability Standards for Accessible Public Transport 2002* requires all new public transport premises, infrastructure and conveyances to be compliant with the requirements of the standard and referenced to the Australian Standards and Design Rules therein, unless unjustifiable hardship is incurred by implementation. The elements of the proposed modifications would be designed to be compliant with the requirements of the *Disability Standards for Accessible Public Transport 2002*.

4.3.5 Copyright Act 1968

Section 195AT of the *Copyright Act 1968* deems certain treatment of copyright works not to constitute an infringement of the author's (ie the architect's) right of integrity. With respect to the demolition of a building, an architect's right of integrity will not be infringed if, when wishing to demolish a building, the architect is provided with a written notice of such intentions and is provided access to make a record of the artistic work and consult in good faith. Notification would be provided in accordance with these legislative requirements where necessary. In this regard, it is noted that no buildings would need to be demolished at the site of the proposed Victoria Cross modification, while two industrial buildings would need to be demolished at the site of the proposed Artarmon modification.

STAKEHOLDER AND COMMUNITY ENGAGEMENT

CHAPTER FIVE

5 Stakeholder and community engagement

This chapter provides an outline of the consultation carried out for the proposed modifications. It identifies who has been consulted, how the consultation was carried out, the issues raised and how those issues have been addressed.

5.1 Overview

Engagement with the community and stakeholders about Sydney Metro City & Southwest began in June 2014 and has continued through the preparation of the Chatswood to Sydenham Environmental Impact Statement (including this modification). Sydney Metro will continue to proactively engage with the community and stakeholders during planning and construction of the project.

Key stakeholders include (but are not necessarily limited to):

- State government agencies
- Local councils
- Public utilities
- Business and industry groups
- Public transport customers
- Directly impacted stakeholders
- Directly impacted communities and businesses
- The broader community.

This chapter provides an overview of the consultation activities carried out to date for the proposed modifications. Consultation activities during construction would be consistent with the approach for the approved project.

5.2 Victoria Cross Station

5.2.1 Consultation to date

Preliminary discussions with Wenona School and Uniting Care occurred in early 2017 to advise that alternative options were being explored for the location of the northern services building and to seek early feedback. Further discussions were held during May 2017 to provide an update and details of the forthcoming public exhibition process. Consultation has also been undertaken with North Sydney Council, Monte Sant' Angelo Mercy College and Rydges North Sydney. Other schools in the surrounding area including St Mary's Primary School, North Sydney Boys High School and Marist College North Shore were also contacted.

Residents and businesses in the vicinity of the proposed site were contacted by telephone, email or door knock during May 2017 to explain that alternative options for the northern services building had been investigated and a preferred option identified at 50-52 McLaren Street. Information about the forthcoming public exhibition process and opportunities to make a submission on the modification report was also provided.

5.2.2 Feedback

A number of stakeholders expressed support for the proposal, particularly the inclusion of a northern station entrance in the services building. There were also requests for more details to be provided on various aspects of the proposal including the design of the services facility, construction activities and timing.

A summary of issues raised during consultation activities is provided in Table 5-1. The table also provides details of where in this document more information can be found about each issue.

Table 5-1 Issues raised during consultation

Issues raised	Where addressed in this document
Traffic impacts during construction, including haulage routes	Chapter 9
Traffic impacts during operation	Chapter 9
Impacts on property access	Chapter 9
Noise impacts during construction	Chapter 10
Dust impacts during construction	Chapter 8
Potential emissions from the services building	Chapter 8 and Chapter 10
Vibration impacts and potential for property damage during tunnelling in the area	Chapter 10
Future development of the site – above the services building and on adjoining land	Chapter 11

5.3 Artarmon substation

5.3.1 Consultation to date

In November 2016, Sydney Metro distributed a project update which advised that as a result of feedback received during the Environmental Impact Statement public exhibition period, further design work has occurred and an alternative location for the Artarmon substation has been identified at 98-104 Reserve Road, within the Artarmon industrial area. The release of the project update was accompanied by doorknocking of ten properties and 19 businesses.

Follow-up contact was made during May 2017 to advise that further assessment of the alternative location for the substation has continued and a Modification Report would be on public exhibition the following month. Information about the opportunities to review the report and provide feedback were also discussed.

5.3.2 Feedback

Local businesses surrounding the proposed substation site were mostly interested in finding out more information about the proposal, in particular the design of the substation, construction activities and timing. A limited number of issues have been raised to date and these issues are summarised in Table 5-2.

Table 5-2 Issues raised during consultation

Issues raised	Where addressed in this document
Noise impacts during construction	Chapter 10
Traffic impacts during construction, including haulage routes	Chapter 9
Dust impacts during construction	Chapter 8
Property impacts during tunnelling in the area	Chapter 10

Community engagement will continue in this area prior to and during the public exhibition of this report, at which time more information will be available about the proposal, potential impacts and how they would be managed.

5.4 Public exhibition of this report

The Department of Planning and Environment will place this report on public exhibition. During the exhibition period, government agencies, stakeholders and the community will be able to review the modification report and will have an opportunity to make a written submission to the Department of Planning and Environment for consideration in its assessment of the proposed modifications.

Advertisements will be placed in newspapers to advise of the public exhibition period and where the modification report can be viewed. Consultation activities during the public exhibition of the modification report will include:

- Three community information sessions in the local area
- Information distributed by letterbox drop to properties surrounding each site and sent to affected stakeholders
- Doorknocks with neighbouring properties
- Newspaper advertising
- Stakeholder meetings and briefings
- Information updates on the project website and facebook page
- Contact facilities and information points:
  - 24-hour community information line – 1800 171 386
  - Postal address – PO Box K659, Haymarket, NSW 1240
  - Community email address – sydneymetro@transport.nsw.gov.au
  - Project website – www.sydneymetro.info
  - Facebook – www.facebook.com/SydneyMetro.

Submissions report

At the completion of the public exhibition period for the modification report, the Department of Planning and Environment will collate and provide Transport for NSW with a copy of all submissions received. After reviewing the submissions, Transport for NSW will prepare a submissions report that responds to the relevant issues raised. The submissions report will be made publicly available on the Department of Planning and Environment website. Anyone making a public submission will receive a letter notifying them of the publication of the submissions report on the Department of Planning and Environment website.

5.5 Future consultation and engagement

Should the proposed modifications be approved, the project team would continue to consult with the community and key stakeholders during the planning and construction of the project. In general, this consultation would involve:

- Ongoing consultation with key stakeholders, local councils and other government agencies
- Provision of regular updates to commuters and the nearby community
- Development and implementation of a Community Communications Strategy.

Further details regarding stakeholder and community involvement requirements during project delivery are outlined in the Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report for the approved project). Transport for NSW would also specifically consult with stakeholders to fulfil mitigation measures outlined in this modification report. These consultation activities are identified in the relevant mitigation measures in Chapter 18 (Consolidated revised environmental mitigation measures).

MODIFICATION DESCRIPTION – OPERATION

CHAPTER SIX

6 Modification description – operation

This chapter identifies the physical infrastructure and built form, and describes the functionality and operation of the Victoria Cross Station and Artarmon substation components of the proposed modifications.

6.1 Victoria Cross Station modification overview

6.1.1 Approved Sydney Metro works at Victoria Cross

The Sydney Metro City & Southwest Chatswood to Sydenham project was approved by the Minister for Planning on 9 January 2017. At Victoria Cross Station, the approved works associated with Sydney Metro include:

- Victoria Cross Station, located beneath Miller Street between McLaren Street and south of Berry Street. The station footprint includes:
  - Pedestrian plaza and station entry opening to Miller, Denison and Berry streets
  - Below-ground station lobby and metro platforms
  - Back-of-house operational areas
  - New interchange facilities, including cycle parking and kiss-and-ride bays
  - Station services.
- Northern station services building, a separate dedicated services facility at 194 and 196A Miller Street to the north of the station to support Victoria Cross Station and metro tunnel services. The services building includes an above-ground services building and a services shaft extending downwards from the basement of the building to the Victoria Cross metro platforms. The services building is needed to house the electrical traction substation (which must be at or near the surface), allow for draft relief vents (which are needed at both ends of the station to manage air temperature and pressure within the station and tunnels) and for emergency egress. It includes:
  - Vent fans and shafts
  - A traction substation
  - Station plant.

As identified in chapter 2, Condition A21 of the planning approval requires further detailed analysis of alternative locations for the Victoria Cross Station northern services building. Under the condition, the analysis must be provided to the Department of Planning and Environment, and if a better alternative is identified, a recommendation must be submitted to the Secretary for approval before commencement of construction at the northern Victoria Cross Station construction site proceeds.

6.1.2 Key features

The key features of the Victoria Cross Station component of the modification, as shown in Figure 6-1, would include:

- Relocation of the northern station services building to 50 McLaren Street from 194 and 196A Miller Street
- Addition of a lift-only pedestrian entry to Victoria Cross Station within the northern station services building.

The proposed modification is described in more detail in the following sections.

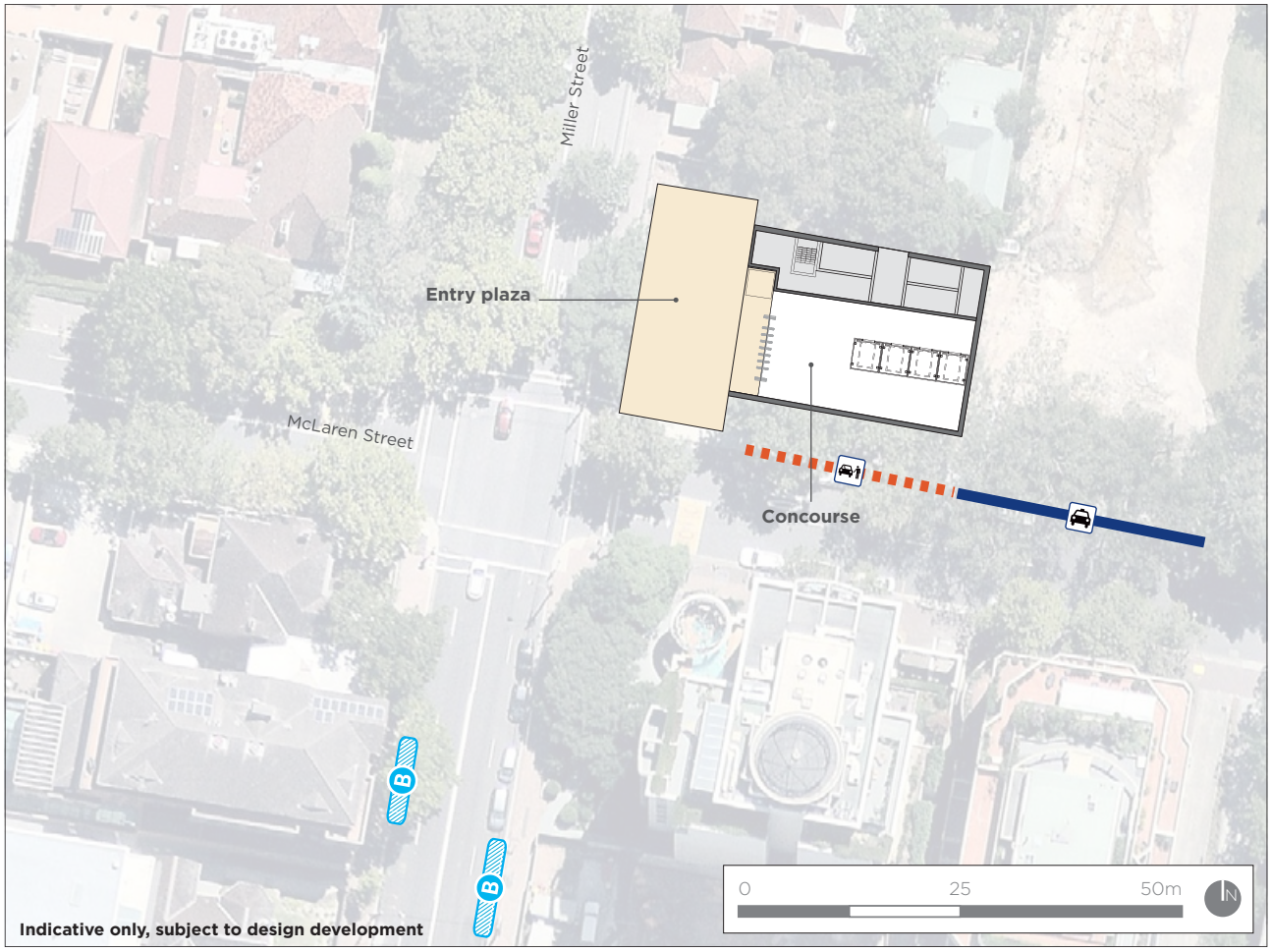

Figure 6-1 Victoria Cross Station modification key features

6.2 Victoria Cross Station modification

The Victoria Cross Station modification comprises the following:

- Relocation of the northern station services building to 50 McLaren Street from 194-196A Miller Street
- Addition of a lift-only pedestrian entry to Victoria Cross Station within the northern station services building.

Collectively, the two components would form the 'northern station entry and services building'. The components are described in further detail below.

Relevant development controls in the *North Sydney Local Environmental Plan 2013* and the *North Sydney Development Control Plan 2013* would be considered in the design of the services and station entry building as well as consideration for the character of the existing area (see Figure 6-1). This includes a twelve metre setback to Miller Street and setbacks to McLaren Street to preserve the mature fig trees along the frontage. Figure 6-2 shows a cross section of the proposed modification, along with building envelopes that reference *North Sydney Local Environmental Plan 2013*.

6.2.1 Northern station services building

The northern station services building included in the approved project is proposed to be relocated to 50 McLaren Street from 194 and196A Miller Street, as shown in Figure 6-1. The 1,080 square metre site at 50 McLaren Street is larger than the Miller Street (about 930 square metres) site and allows the inclusion of a station entry as part of the building. The larger adjacent site at 52 McLaren Street would primarily be used for construction, but may also be needed for access during operation. The site would include a three storey services building (combined with a station entry) and a services shaft extending downwards to the depth of Victoria Cross Station platforms (see Figure 6-2). For context, Figure 6-2 also shows the building envelope for the aged care facility which is currently approved for the site. An underground services adit would connect the services building to the northern end of the station mezzanine and platforms (see Figure 6-3). Maintenance vehicle access would be provided from the eastern side of the building via McLaren Street.

6.2.2 Additional station entry

A new northern entry to Victoria Cross Station would be included in the modified northern station services building. The additional entry would better support pedestrian access to Victoria Cross Station for customers and extend the northern catchment of the station to include the Mater Hospital, North Sydney Oval, North Sydney Boys High School North Sydney Girls High School, Marist College North Shore, North Sydney Demonstration School and St Mary's Primary School, and additional residential and mixed-use areas (refer to Figure 2-1 in Chapter 2). It would also improve access for metro customers to the McLaren Street precinct of North Sydney and support future growth in the locality (refer to Chapter 2 and Chapter 3).

The northern station entry would include pedestrian access from the corner of Miller Street and McLaren Street and a ticket gateline. Vertical transport, including four lifts, would provide access for customers to the Victoria Cross Station (see Figure 6-3). The lifts would have a capacity to accommodate approximately 27 persons and would be 'through' lifts whereby the entry doors open a few seconds after the exit door so the entry and exit sequence overlaps.

As identified in Chapter 2, international examples demonstrate lift-only station entries are highly functional and can be intuitive for customers. The proposed four lifts would deliver a good level of service for customers. Based on expected patronage, there would be a maximum queue at any given time of 20 people and a maximum wait time of 21 seconds. With one of the four lifts out of service the maximum queue would be 33 people with a wait time of 48 seconds. A suitable lift maintenance strategy would be developed to ensure ongoing reliable operation of the lifts while minimising delays for customers.

An underground pedestrian walkway about 38 metres long would be located within the underground services adit connecting the northern station entry to the northern end of the station mezzanine level and platforms (see Figure 6-3). Kiss-and-ride and taxi facilities are also proposed (refer to Figure 6-1).

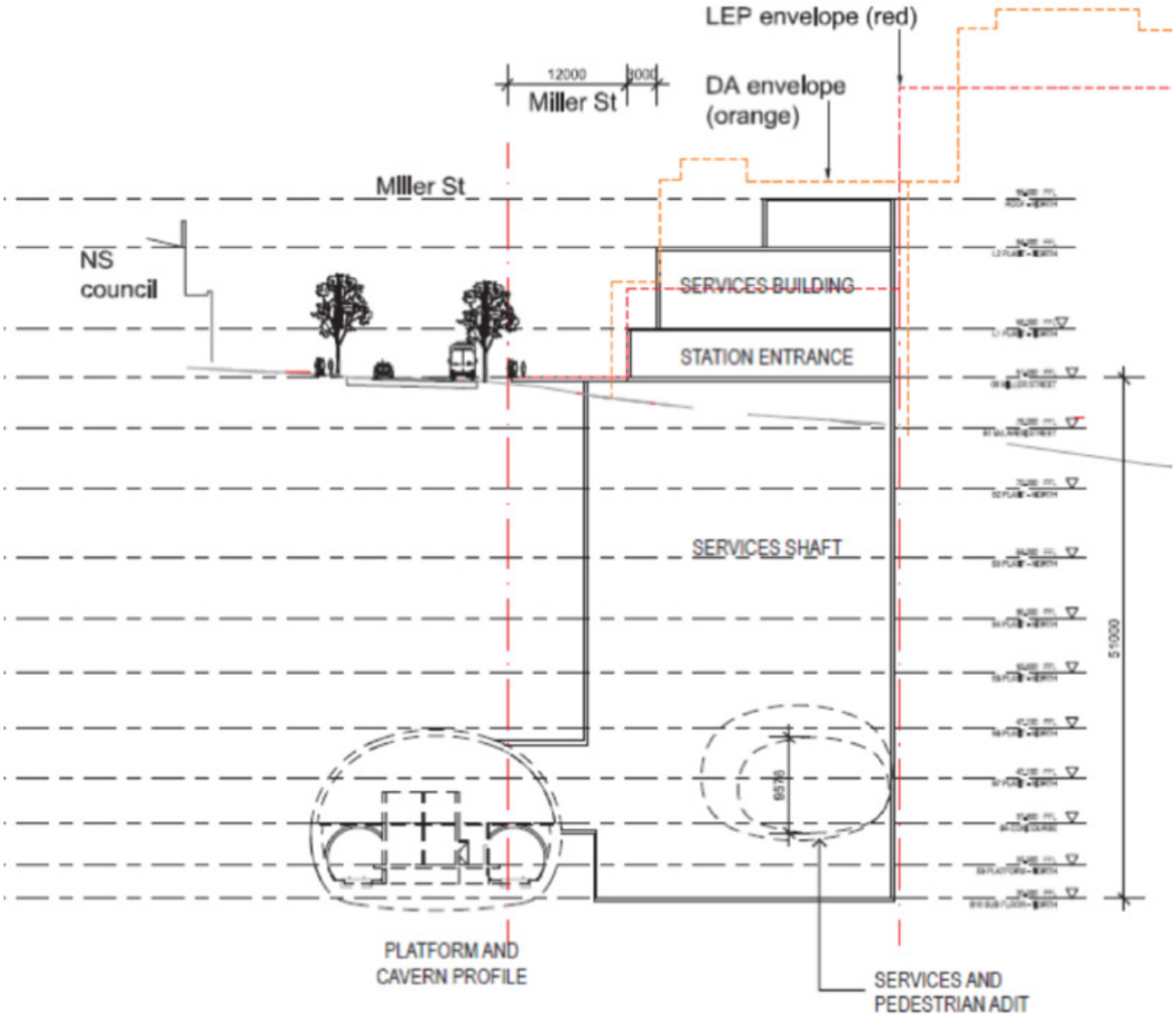

Figure 6-2 Section view of proposed Victoria Cross Station modification

Note: Figure 6-2 also shows the building envelope for the aged care facility which is approved for the site (DA67/11).

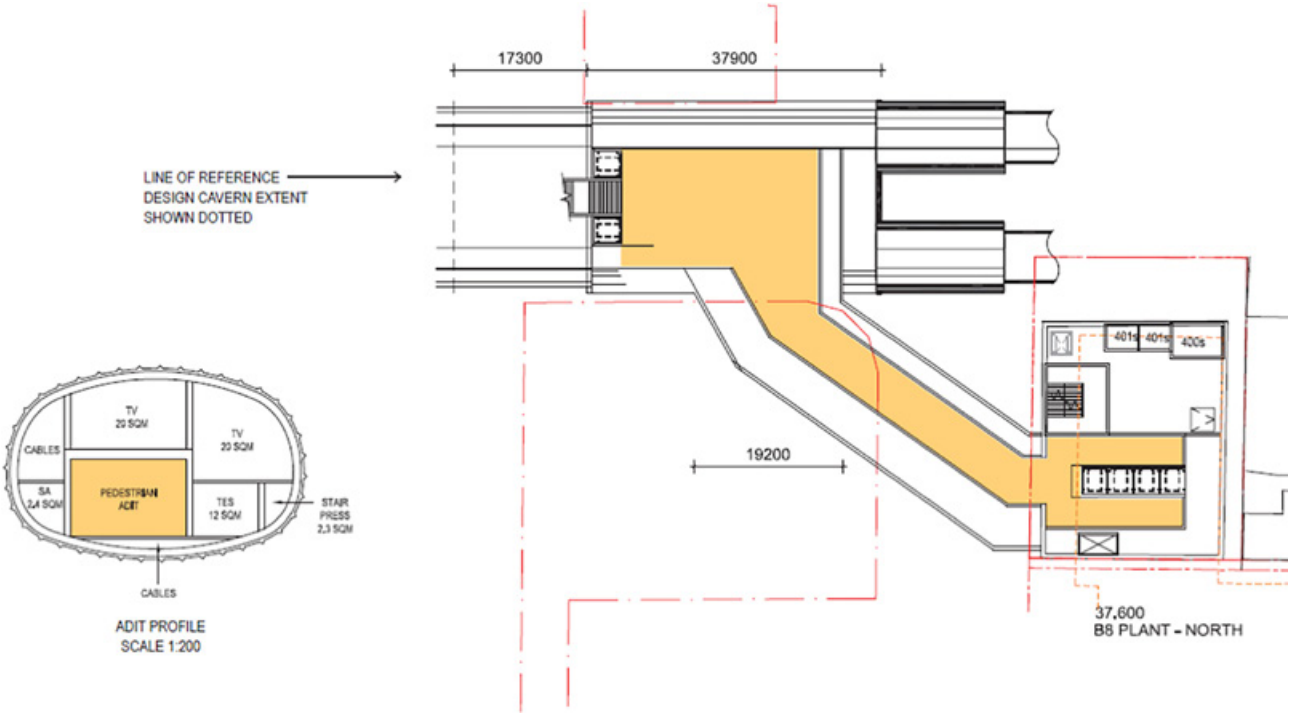

Figure 6-3 Services adit with pedestrian connection to Victoria Cross Station mezzanine and platforms

Figure 6-4 Artist's impression of Victoria Cross Station northern entry

6.3 Artarmon substation modification overview

6.3.1 Approved Sydney Metro works at Artarmon

At Artarmon substation, the approved project includes a substation at Butchers Lane (between the northern tunnel portal at Chatswood and Crows Nest Station) to provide traction power to the tunnels. The approved substation is located above the tunnels near the edge of the Gore Hill Freeway as shown in Figure 6-35 of the Environmental Impact Statement. The traction substation and ancillary equipment were identified as being housed in an aboveground building (around five metres above ground level) with a shaft (with a diameter of around three metres) to reticulate cables to the tunnels below.

6.3.2 Key features

The Artarmon substation component of the proposed modification involves the relocation of the substation from Butchers Lane, north of the Gore Hill Freeway, to 98-104 Reserve Road, within the Artarmon industrial area. The form of the substation would be generally consistent with the approved project, and would include an aboveground building with an associated shaft to reticulate cables to the tunnels below.

6.4 Artarmon modification

The Artarmon component of the modification includes demolition of existing buildings (motorcycle sales and service building) and construction of:

- A substation building approximately 28 metres x 20 metres, set back approximately one metre from Reserve Road and four metres from Whiting Street
- Vehicle access (from Whiting Street) and parking for around two to three vehicles
- An excavated shaft for conduits
- Three metre high security fencing
- Landscaping along the Whiting Street frontage (within an approximate four metre buffer).

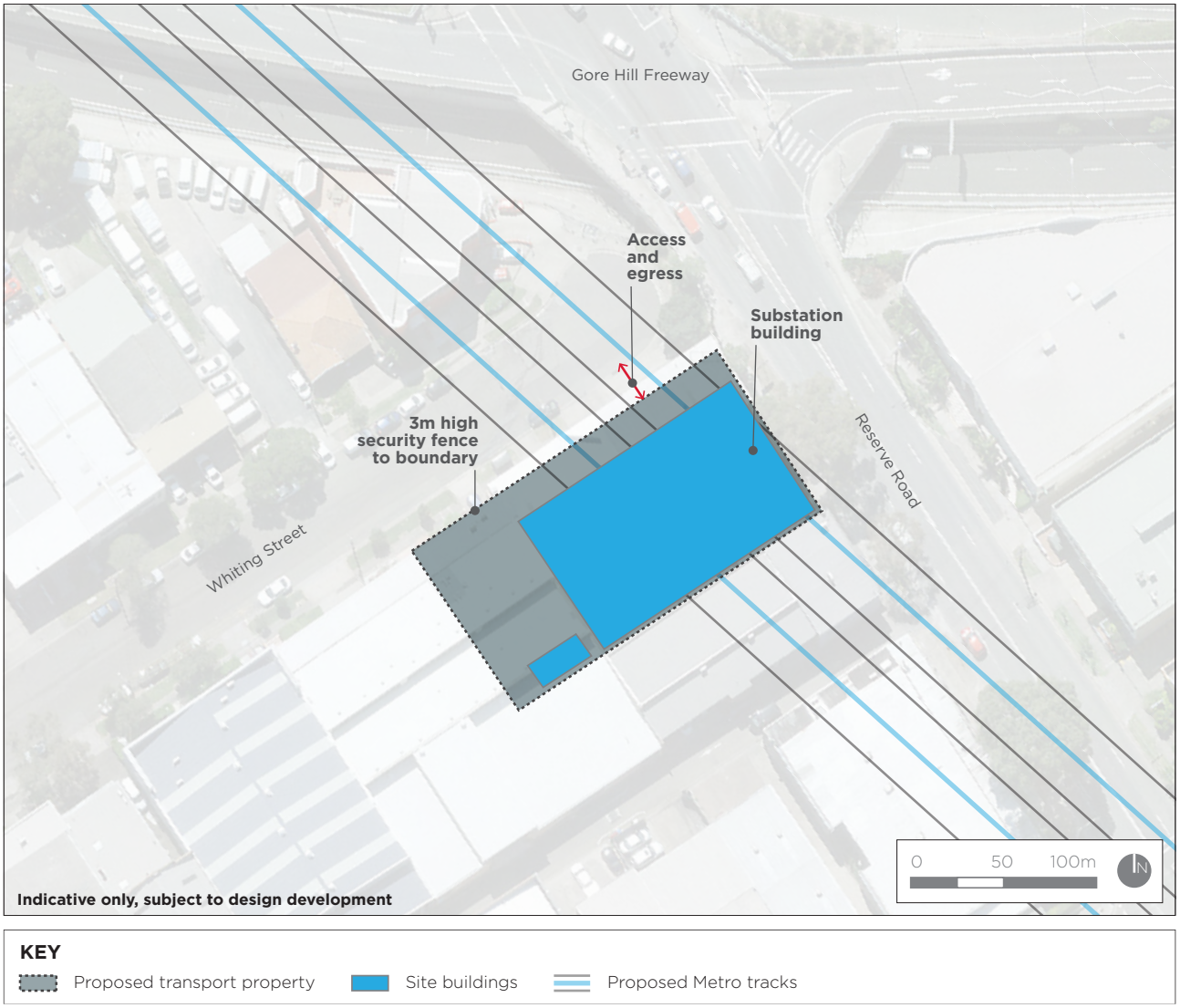

Figure 6-5 Proposed Artarmon substation key features

6.5 Design guidelines

Sydney Metro has developed design guidelines to guide the design development process and establish the aesthetic standards for the project. The Chatswood to Sydenham design guidelines were provided as part of the approved project.

The design of the proposed modification would also be progressed in accordance with relevant conditions of approval, including:

- E100 Design Review Panel
- E101 Station Design and Precinct Plans (Victoria Cross Station only).

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MODIFICATION DESCRIPTION – CONSTRUCTION

CHAPTER SEVEN

7 Modification description – construction

This chapter describes the likely key construction activities for the Victoria Cross Station and Artarmon substation components of the proposed modification and identifies the construction sites required. A description of the proposed modifications once operational is provided in Chapter 6 (Modification description – operation).

7.1 Victoria Cross Station

7.1.1 Overview

The construction activities required for the Victoria Cross Station component of the proposed modification are generally consistent with the approved project. Construction activities for the approved project and proposed modification are described below.

The construction site for the proposed northern services building and station entry is at 50 and 52 McLaren Street, North Sydney, and is shown on Figure 7-1.

Approved Sydney Metro works at Victoria Cross Station

The key construction activities that form part of the approved project for the Victoria Cross Station northern services building are:

- Demolition of one commercial building and other structures at 194 and196A Miller Street
- Construction of an acoustic shed over the site
- Excavation of a shaft to the underground station cavern for the future services facility using excavators, rock hammers and blasting. This shaft may also be used throughout the construction period for the delivery of materials
- Underground structural work to stabilise and reinforce the shaft
- Above-ground building associated with northern station services building using reinforced concrete methods
- Fit-out of the northern station services building and shaft with service plant and equipment and associated mechanical and electrical infrastructure.

The indicative construction program was identified as extending between the first quarter of 2017 and the fourth quarter of 2022. Construction hours were described in section 7.11.3 of the Environmental Impact Statement and involve most of the station fit-out and other aboveground construction activities being carried out during the standard construction hours:

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

Other activities were identified as being carried out up to 24 hours per day, seven days per week, including:

- Tunnelling
- Underground excavation at station and ancillary sites
- Tunnel and station fit-out (underground)
- Construction traffic (with restrictions during peak times) for material supply to, and spoil removal from, tunnelling and underground excavation (station and ancillary facility sites).

Spoil generation was estimated to be 175,000 cubic metres (for both the northern and southern construction sites), while the required construction plant and equipment was varied as described in section 7.11.10 of the Environmental Impact Statement.

Access to the site was identified as being direct from Miller Street as a left-in, left-out arrangement.

7.1.2 Victoria Cross Station modification

Northern station entrance and services building construction site

The northern station entrance and services building construction site would cover about 4,180 square metres on the north-east corner of McLaren and Miller streets. This contrasts with an approximate area of 700 square metres at the 194 and 196A Miller Street site included as part of the approved project. The construction site comprises two adjacent lots at 50 and 52 McLaren Street, both of which are currently vacant and do not contain any buildings.

Construction activities for the proposed modification would be largely consistent with the construction activities described for the approved project. Modifications to the construction methodology of the approved project are outlined below:

- Demolition of existing structures on the construction site would not be required as the construction site is currently vacant
- Excavation of a shaft using the same methods as described for the approved project
- Construction of the services adit to connect the services building to the station cavern would use a mined method using a roadheader to minimise impacts to the buildings above. This method is consistent with the station cavern construction method in the approved project
- Additional fit-out works would be required for the proposed modification to incorporate the station entry into the northern station services building. Fit-out works for the services building would be generally consistent with the approved project
- Opportunity for a more even distribution of construction activity between the northern and southern sites including support for cavern excavation and associated spoil removal
- Construction site access and egress is indicatively as follows (with final arrangements to be determined during the preparation of the Construction Traffic Management Plan in consultation with stakeholders and with reference to potential cumulative impacts associated with other construction projects):
  - Primary access to and egress from the construction site would be left-in and left-out of 52 McLaren Street
  - Right-turn movements out of 50 and 52 McLaren Street would be limited to avoid school set-down and pick-up times
  - Secondary access and egress may also be established to the north of 50 and 52 McLaren Street from Elliot Street but would be restricted to special deliveries
  - Alternative vehicular access points may also be established at 50 and 52 McLaren Street from both the McLaren Street and Miller Street frontages.

The construction site would also house support services including office, amenities, spoil handling, spoil storage, a water treatment plant and workshops in accordance with the approved project. The construction site would also include a turning bay for rigid trucks to turn around before egress. Following the initial site establishment and earthworks phases of construction, an acoustic shed would be established at the site and would cover the shaft, on-site vehicle turning movements and temporary spoil storage.

The location and indicative layout of the construction site, including vehicle access and egress, are illustrated in Figure 7-1.

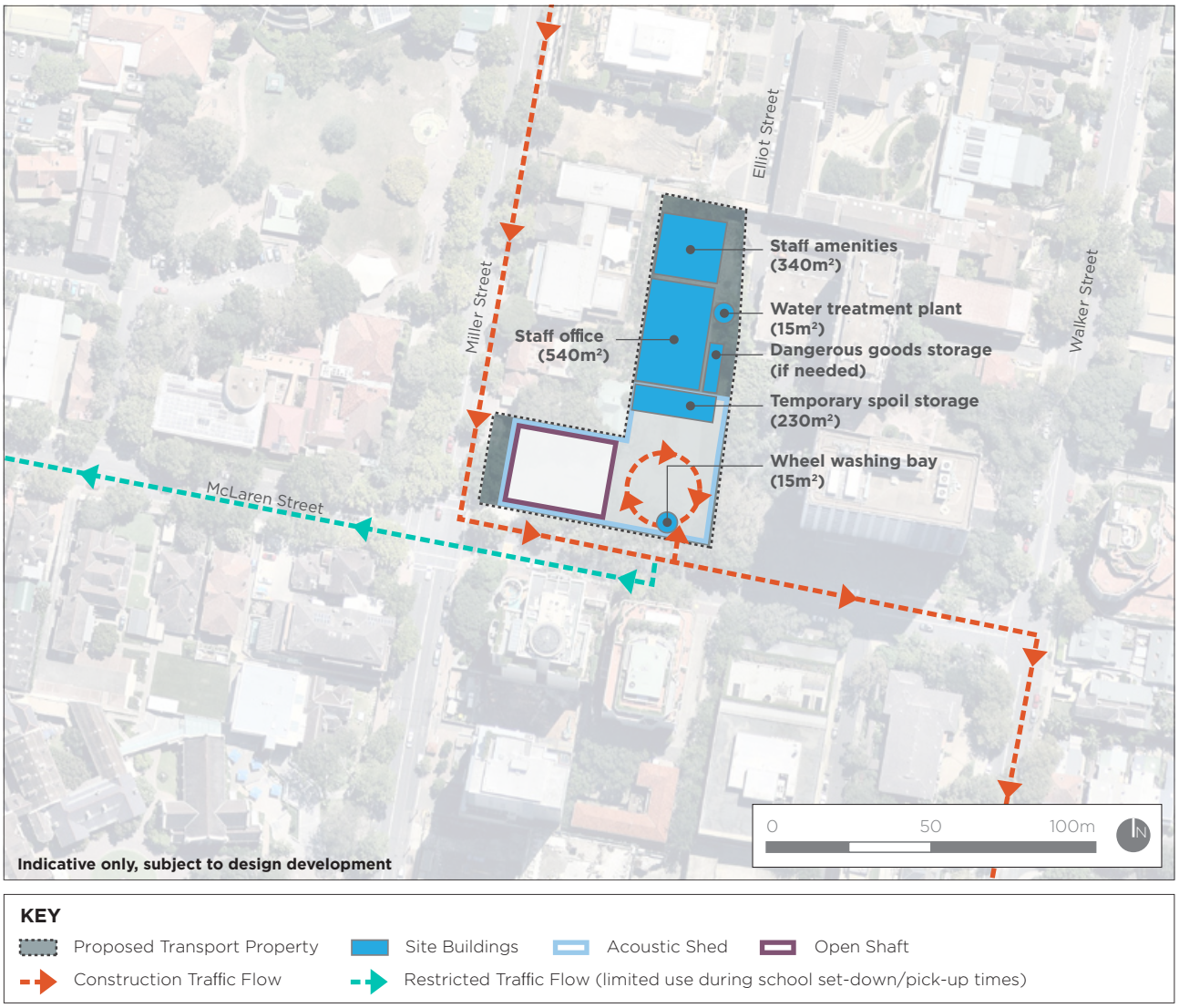

Figure 7-1 Victoria Cross Station northern station entrance and services building construction site

Testing and commissioning

Testing and commissioning works would be consistent with those identified for the approved project. Once all services are installed, testing and commissioning of the power, communications and other systems would occur in three stages:

- Collection of safety and quality assurance documentation and commissioning of readiness checks
- Installation and operation tests and checks
- Final inspection, site acceptance tests, commissioning and validation of individual systems.

Construction hours

Construction hours for the proposed modification would be consistent with those described for the approved project.

Indicative construction program

An indicative construction program for the works at Victoria Cross Station is consistent with the approved project and is shown in Table 7-1.

Table 7-1 Indicative construction program – Victoria Cross Station

Construction activity	Indicative construction timeframe																											
	2017				2018				2019				2020				2021				2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling works and site establishment	●				●																											
Station excavation					●				●																							
TBM pass through station									●			●																				
Station structural works									●				●																			
Station fit out																	●				●											
Station testing and commissioning																					●			●								

Subject to approval, site establishment is expected from December 2017 and excavation is expected to commence in February 2018 or sooner, with the northern station and services building scheduled to open at the same time as broader Sydney Metro City & Southwest Chatswood to Sydenham in 2024.

7.2 Artarmon substation

7.2.1 Overview

The construction activities required for the Artarmon substation component of the proposed modification are generally consistent with the approved project. Construction activities for the approved project and proposed modification are described below.

The construction site for the proposed Artarmon substation at 98-104 Reserve Road, within the Artarmon industrial area, is shown on Figure 7-2.

Approved Sydney Metro works at Artarmon substation

The key construction activities as described as part of the approved project for the Artarmon substation are:

- Excavating a vertical shaft to the tunnels below. This is likely to be carried out using a large diameter piling rig or a raised bore; however, drill and blast or penetrating cone fracture techniques may also be used
- Lining and reinforcing the shaft
- Building aboveground components
- Installing electrical equipment

The indicative construction program was identified as extending between the second quarter of 2020 and the first quarter of 2022. Construction hours were described in section 7.11.3 of the Environmental Impact Statement and involve most of the facility fit-out and other aboveground construction activities being carried out during the standard construction hours:

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

Other activities were identified as being carried out up to 24 hours per day, seven days per week, including the following activities as relevant to the Artarmon modification site:

- Underground excavation
- Construction traffic (with restrictions during peak times) for material supply to, and spoil removal from, underground excavation).

Spoil generation was estimated to be 2,000 cubic metres, while the plant and equipment required for construction was varied as described in section 7.11.10 of the Environmental Impact Statement.

Access to the site was identified as being via Barton Lane to Reserve Road.

7.2.2 Artarmon substation modification

The Artarmon substation construction site would cover about 1,060 square metres at 98-104 Reserve Road, within the Artarmon industrial area. This contrasts with an approximate area of 3,500 square metres at the Butchers Lane / Barton Lane site included as part of the approved project.

The key construction activities for the Artarmon substation would be generally consistent with those described for the approved project, although demolition of two industrial / commercial buildings would also be required at the new site. Construction hours, spoil removal and required plant / equipment would also be similar to those described for the approved project, with additional demolition equipment and demolition waste generated as a result of the proposed modification. The construction site would include provision for rigid trucks to turn around before egress. Figure 7-2 shows the indicative construction site layout.

Access to the 98-104 Reserve Road site would be direct from Whiting Street. The inbound haulage route would be via the Pacific Highway and Whiting Street. The outbound haulage route would be via Whiting Street, Clarendon Street, Dickson Avenue and Reserve Road. Final access arrangements would be determined during the preparation of the Construction Traffic Management Plan in consultation with stakeholders and with reference to potential cumulative impacts associated with other construction projects.

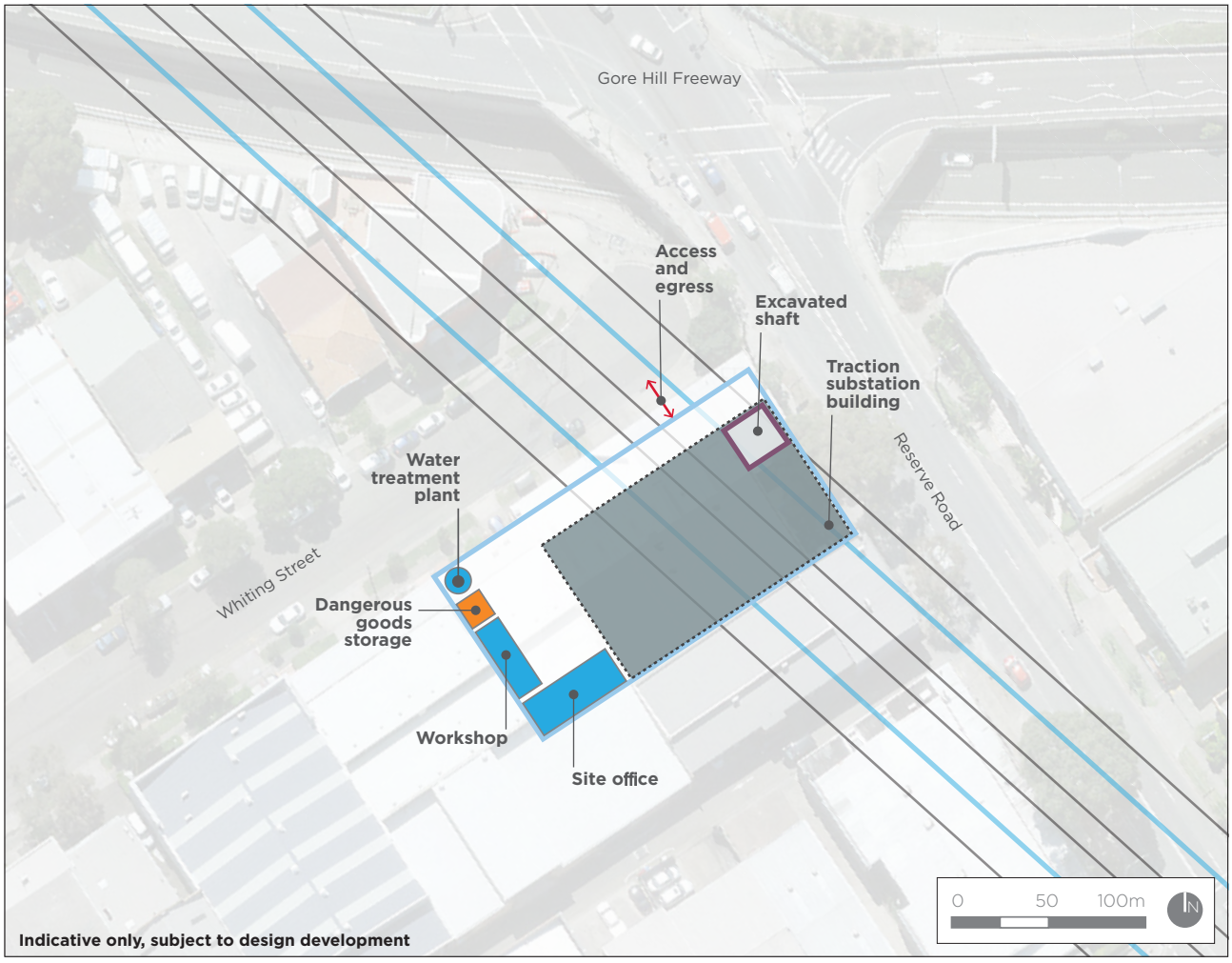

Figure 7-2 Artarmon substation construction site

The indicative construction program for the works at Artarmon is consistent with the approved project and is shown in Table 7-2.

Table 7-2 Indicative construction program – Artarmon substation

Construction activity	Indicative construction timeframe																											
	2017				2018				2019				2020				2021				2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling works and site establishment																																
Shaft excavation and structural works																																
Aboveground building works																																
Traction substation fitout																																
Traction substation testing and commissioning																																

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ENVIRONMENTAL SCREENING ASSESSMENT

CHAPTER EIGHT

8 Environmental screening assessment

This chapter considers the potential for change to the impacts assessed for the approved project and whether further assessment of each issue is required.

Consideration of each environmental issue as assessed for the approved project was carried out to determine the potential for change to the impacts and, therefore, whether further assessment of the potential impacts of the proposed modifications is required. The following sections provide a screening assessment for proposed change in impacts at Victoria Cross Station and Artarmon substation respectively.

8.1 Victoria Cross Station

A screening assessment of the potential change in impacts for Victoria Cross Station is provided in Table 8-1.

Table 8-1 Environmental screening assessment – Victoria Cross Station

Issue	Potential change in impact?	Description
Traffic and transport	Yes	The proposed modification would change the location of the northern construction site for Victoria Cross Station, which would require new left-in / left-out access to McLaren Street (and provision for some right-turn movements outside of school pick-up and drop-off times). With a more even distribution of construction activity (including spoil removal) between the northern and southern Victoria Cross construction sites, there would also be a change to construction traffic, including an increase in overall and peak construction vehicle movements at the northern site. There would be some impact to pedestrians using the footpath adjacent to the site during construction; however these footpaths are less heavily used when compared to those on Miller Street as assessed for the approved project. This site would have no impact on bus stops or services, but would affect motorcycle parking and car share parking. The proposed modification would change the location of the services building for the Victoria Cross Station and would also introduce a new station entry at this location. This would change the way some customers move in and out of the station, increase the reach of the station catchment to include additional regional attractors and improve transfer opportunities for customers using nearby bus services on Miller Street. An assessment of potential changes to construction and operational traffic and transport impacts associated with the proposed modification is provided in Chapter 9.
Noise and vibration	Yes	The proposed modification would change the location of construction activities for the northern construction site which would introduce new noise and vibration impacts to receivers. The site is currently a vacant lot therefore there would be no impacts from above ground demolition works. The proposed modification would introduce new fixed infrastructure (mechanical and electrical) at the new location along McLaren Street, including additional infrastructure associated with the proposed northern station entry. An assessment of potential changes to noise and vibration impacts associated with the proposed modification is provided in Chapter 10.

Issue	Potential change in impact?	Description
Land use and property	Yes	The proposed modification would require additional property acquisition, however the proposed site is currently a vacant lot therefore there would be no disruption associated with relocation of existing property occupiers. In 2011, development consent was granted by North Sydney Council for demolition of existing structures, tree removal, installation of drainage infrastructure and Stage 1 concept approval for an aged care housing development and associated non-residential uses at the site. The land use of the site would change as a result of the proposed modification, if approved. The proposed northern station entry would also provide additional opportunities to integrate with surrounding land use and provide potential opportunities for future redevelopment of a portion of the site at 52 McLaren Street (Lot 2 DP218407). An assessment of potential changes to land use and property impacts associated with the proposed modification is provided in Chapter 11.
Business impacts	No	The proposed modification would not directly impact any businesses as the site is currently a vacant lot. Any potential types of indirect impacts to nearby businesses would be similar to those assessed for the approved project in relation to the Victoria Cross Station. The psychology practice at 243 Miller Street, immediately to the north of the proposed site, would remain accessible from Miller Street but be more affected by construction activities (and associated noise) than under the approved project. There would be a reduction in impact for the restaurant at 198 Miller Street, which is adjacent to the northern services building site included as part of the approved project. An additional assessment of potential changes to business impacts associated with the proposed modification is not considered necessary.
Non-Aboriginal heritage	Yes	The proposed modification would not directly impact any additional heritage items; however there is potential for indirect impacts as the site is located immediately adjacent to the locally significant 'Shop' at 243 Miller Street (Lot 1, DP 561413). An assessment of potential changes to non-Aboriginal heritage impacts associated with the proposed modification is provided in Chapter 12.
Aboriginal heritage	Yes	There are no previously recorded Aboriginal heritage items on the site. The proposed modification would require excavation in new areas which may have Aboriginal heritage potential. An assessment of potential changes to Aboriginal heritage impacts associated with the proposed modification is provided in Chapter 13.
Landscape character and visual amenity	Yes	The proposed modification would require construction activities in the new location proposed for the northern services building and would introduce new built infrastructure at this location. An assessment of potential changes to landscape character and visual amenity impacts associated with the proposed modification is provided in Chapter 14.
Groundwater and geology	Yes	The proposed modification would involve underground excavation including a shaft extending downwards to the depth of Victoria Cross Station platforms and an underground services adit to connect the new services building and station entry to the northern end of the station mezzanine and platforms. These underground excavation works may intercept groundwater. An assessment of potential changes to groundwater and geology impacts associated with the proposed modification is provided in Chapter 15.

Issue	Potential change in impact?	Description
Soils, contamination and water quality	Yes	As the construction activities for the proposed modification are generally consistent with the types of construction activities for the approved project, there would not be any additional soil or water quality risks. The mitigation measures identified in the Environmental Impact Statement would be applied to the proposed modification. An additional assessment of potential changes to soil and water quality impact associated with the proposed modification is not considered necessary. The proposed modification would involve excavation in new areas which may have increased or new contamination risks. An assessment of potential contamination impacts associated with the proposed modification is provided in Chapter 16.
Social impacts and community infrastructure	No	The Environmental Impact Statement for the approved project identified community infrastructure surrounding the Victoria Cross Station site, including those in and around the proposed modification site. The Uniting Care aged care facility approved for development on this site would be directly impacted as the land would be developed for the purpose of the project. Additionally social infrastructure surrounding the proposed modification would be subject to potential additional local amenity, community health and safety and access and connectivity impacts being located within closer proximity to site. This includes Wenona High School located to the north and north west of the site. Potential impacts are addressed through the relevant chapters including Chapter 9 (Traffic and transport), Chapter 10 (Noise and vibration) and Chapter 11 (Land use and property). An additional assessment of potential changes to social impacts and community infrastructure impacts associated with the proposed modification is not considered necessary.
Biodiversity	Yes	The proposed modification would involve construction activities on vacant lots which have previously been cleared. Some minor clearing of exotic vegetation and potential weeds would be required as part of the proposed modification. There may be potential impacts to fauna habitat in and or immediately adjacent to the site if not appropriately managed. It is proposed to retain existing mature trees within the site and the surrounding streetscapes of Miller Street and McLaren Street. An assessment of potential changes to biodiversity impacts associated with the proposed modification is provided in Chapter 17.
Flooding and hydrology	No	The Environmental Impact Statement for the approved project identified the drainage catchment, drainage infrastructure and receiving waters, and existing flood behaviours associated with the Victoria Cross Station. The proposed modification works would be located upstream of the station, with overland flow paths down Miller Street and McLaren Street. The majority of the eastern portion of the site contains impervious surfaces, with some unsealed surfaces across the eastern portion of the site. As the construction and operational activities for the proposed modification are generally consistent with the types of construction activities and operational facilities for the approved project, the proposed modification would not introduce any new flooding and hydrology impacts and the mitigation measures identified for the approved project would be applied to the proposed modification. An assessment of potential changes to flooding and hydrology impacts associated with the proposed modification is not considered necessary.

Issue	Potential change in impact?	Description
Air quality	No	The Environmental Impact Statement for the approved project identified potential air quality impacts associated with the generation of dust and exhaust emissions during construction and operational greenhouse gas emissions. As the construction and operational activities for the proposed modification are generally consistent with the types of construction activities and operational facilities for the approved project, the proposed modification would not introduce any new air quality impacts and the mitigation measures identified for the approved project would be applied to the proposed modification. An assessment of potential changes to air quality impacts associated with the proposed modification is not considered necessary.
Hazard and risk	No	The Environmental Impact Statement for the approved project identified potential hazard and risk impacts associated with the storage, use and transport of dangerous goods and hazardous substances, the rupture or interference of underground utilities, and damage to adjacent buildings due to ground movement. The proposed modification would not introduce any new hazard and risk impacts and the mitigation measures identified for the approved project would be applied to the proposed modification. An assessment of potential changes to hazard and risk impacts associated with the proposed modification is not considered necessary.
Waste management	No	The Environmental Impact Statement for the approved project identified potential waste management impacts associated with the handling and disposal of waste (including spoil) generated during construction and operation. The proposed modification would not introduce any new waste streams, although it would result in some minor additions to the volume of waste (including spoil and potential contaminated waste) generated. The mitigation measures identified for the approved project would be applied to the proposed modification and would be sufficient to manage the minor increase in waste volumes. During operation, waste would be managed in accordance with waste management procedures for the Victoria Cross Station. An assessment of potential changes to waste management impacts associated with the proposed modification is not considered necessary.
Sustainability	No	The Environmental Impact Statement for the approved project identified potential sustainability impacts associated with climate change adaptation, construction resource use and greenhouse gas emissions. The proposed modification would not introduce any new sustainability impacts, although there would be some minor increases in the volumes of materials used and the greenhouse gas emissions. These increases are not considered to make a material change to the assessment. The mitigation measures identified for the approved project would be applied to the proposed modification and would be sufficient to manage these minor increases In addition, the Environmental Impact Statement for the approved project provided the sustainability strategy, objectives and initiatives for Sydney Metro City & Southwest. These would also apply to the proposed modification. An assessment of potential changes to sustainability impacts associated with the proposed modification is not considered necessary.

Issue	Potential change in impact?	Description
Cumulative impacts	No	The Environmental Impact Statement for the approved project identified potential cumulative impacts at the proposed Victoria Cross Station associated with the proposed over station development, and if approved, cumulative impacts with projects associated with the North Sydney Centre Traffic and Pedestrian Study and Brett Whiteley Place redevelopment. The proposed modification is not expected to have any additional cumulative impacts associated with these projects. Opportunity for redevelopment of 52 McLaren Street (Lot 2 DP218407) would be retained, including the opportunity for a north-south pedestrian connection between Elliot Street and McLaren Street. This would be subject to a separate approval process and if approved may have potential cumulative impacts. An assessment of potential changes to cumulative impacts associated with the proposed modification is not considered necessary.

8.2 Artarmon substation

A screening assessment for the Artarmon substation modification is provided in Table 8-2.

Table 8-2 Environmental screening assessment – Artarmon substation

Issue	Potential change in impact?	Description
Traffic and transport	Yes	The proposed modification would change the location of the Artarmon substation construction site, resulting in a new site access to Whiting Street and changes to haulage routes. Construction traffic numbers would be the same as for the approved project. An assessment of potential changes to construction and operational traffic and transport impacts associated with the proposed modification is provided in Chapter 9.
Noise and vibration	Yes	The proposed modification would change the location of construction activities for the Artarmon substation, which would introduce potential noise and vibration impacts to new receivers. The proposed modification would introduce new noise generating fixed infrastructure (mechanical and electrical) at the new location on Reserve Road. An assessment of potential changes to noise and vibration impacts associated with the proposed modification, including traffic noise associated with changed haulage routes, is provided in Chapter 10.
Land use and property	Yes	The proposed modification requires additional property acquisition from that identified for the approved project, which has already occurred. It would result in a change of land use from commercial / industrial (motorcycle sales / service, car repairs / detailing) to an ancillary facility supporting metro operations. An assessment of potential changes to land use and property impacts associated with the proposed modification is provided in Chapter 11.

Issue	Potential change in impact?	Description
Business impacts	No	The proposal would result in property acquisition resulting in relocation of the occupying businesses, or other negotiated arrangements. Customer, servicing and delivery access to nearby businesses would be maintained and there is not expected to be any loss of on-street parking. Construction work, including excavation, could disturb adjacent businesses and the work environment due to increased noise, traffic and dust impacts, however mitigation measures would be implemented during construction to manage any negative impacts to nearby businesses. For example, expected noise impacts would be substantially reduced through the use of an acoustic shed at the construction site. Nearby businesses are also predominantly industrial and less sensitive to amenity impacts. Traffic and transport and noise and vibration impacts are assessed in Chapters 9 and 10 respectively. As noted below, potential air quality impacts to nearby receivers and associated mitigation measures would be implemented as identified for the approved project as applicable to the proposed modification. Food and beverage businesses within the Artarmon industrial area may benefit from increased demand during the construction period. An additional assessment of potential changes to business impacts associated with the proposed modification is not considered necessary.
Non-Aboriginal heritage	Yes	There are no heritage items at or near the 98-104 Reserve Road site. The proposed modification would require excavation in new areas which may have archaeological potential. An assessment of potential changes to non-Aboriginal heritage impacts associated with the proposed modification is provided in Chapter 12.
Aboriginal heritage	Yes	There are no previously recorded Aboriginal heritage items on the site. The proposed modification would require excavation in new areas which may have Aboriginal heritage potential. An assessment of potential changes to Aboriginal heritage impacts associated with the proposed modification is provided in Chapter 13.
Landscape character and visual amenity	Yes	The proposed modification would require construction activities in the new location proposed for the Artarmon substation and would introduce new built infrastructure at this location. An assessment of potential changes to landscape character and visual amenity impacts associated with the proposed modification is provided in Chapter 14.
Groundwater and geology	Yes	The proposed modification would involve underground excavation including a shaft extending downwards to the metro tunnels. These underground excavation works may intercept groundwater. An assessment of potential changes to groundwater and geology impacts associated with the proposed modification is provided in Chapter 15.

Issue	Potential change in impact?	Description
Soils, contamination and water quality	Yes	As the construction activities for the proposed modification are generally consistent with the approved project, there would not be any additional soil or water quality risks. The mitigation measures identified for the approved project would be applied to the proposed modification. An additional assessment of potential soil and water quality impact associated with the proposed modification is not considered necessary. The proposed modification would involve excavation in new areas used for industrial purposes which may have increased or new contamination risks. An assessment of potential changes to contamination impacts associated with the proposed modification is provided in Chapter 16.
Social impacts and community infrastructure	No	There is no community infrastructure in the immediate vicinity of the 98-104 Reserve Road site. Potential amenity impacts are addressed through the relevant chapters including Chapter 9 (Traffic and transport), Chapter 10 (Noise and vibration) and Chapter 11 (Land use and property). An additional assessment of potential changes to social impacts and community infrastructure impacts associated with the proposed modification is not considered necessary. The detailed design of electrical infrastructure for the project would ensure that the exposure limits for the local community suggested by the *Draft Radiation Standard – Exposure Limits for Magnetic Fields* (Draft Radiation Standard) (Australian Radiation Protection and Nuclear Safety Agency, 2006) would not be exceeded within public areas. This would be achieved through positioning of infrastructure within the site to direct electric and magnetic fields away from residences and other public areas.
Biodiversity	No	The proposed modification would not require removal of trees or other vegetation and would not affect the habitat of native fauna, including threatened species. The buildings at the 98-104 Reserve Road site which would be impacted by the proposed modification were considered for their potential to provide fauna habitat. These buildings and structures are unlikely to provide potential habitat due to their location within a busy industrial area and lack of available water and native vegetation in proximity to the site. An additional assessment of potential changes to biodiversity impacts associated with the proposed modification is not considered necessary.
Flooding and hydrology	No	The 98-104 Reserve Road construction site is currently impervious to infiltration and well-established drainage systems are already in place to cater for stormwater flows. Construction activities would not result in any major increase in stormwater volumes or peak flow rates. The site is within the Flat Rock Creek catchment, which flows to Middle Harbour. The site is not flood prone. An additional assessment of potential changes to flooding and hydrology impacts associated with the proposed modification is not considered necessary.

Issue	Potential change in impact?	Description
Air quality	No	The Environmental Impact Statement for the approved project identified potential air quality impacts associated with the generation of dust and exhaust emissions during construction and operational greenhouse gas emissions. As the construction and operational activities for the proposed modification are generally consistent with the types of construction activities and operational facilities for the approved project, the proposed modification would not introduce any new air quality impacts and the mitigation measures identified for the approved project would be applied to the proposed modification. An assessment of potential changes to air quality impacts associated with the proposed modification is not considered necessary.
Hazard and risk	No	The Environmental Impact Statement for the approved project identified potential hazard and risk impacts associated with the storage, use and transport of dangerous goods and hazardous substances, the rupture or interference of underground utilities, and damage to adjacent buildings due to ground movement. The proposed modification would not introduce any new hazard and risk impacts and the mitigation measures identified for the approved project would be applied to the proposed modification. An assessment of potential changes to hazard and risk impacts associated with the proposed modification is not considered necessary.
Waste management	No	The Environmental Impact Statement for the approved project identified potential waste management impacts associated with the handling and disposal of waste (including spoil) generated during construction and operation. The proposed modification would not introduce any new waste streams and would not result in significant changes to the volume of waste generated. The mitigation measures identified for the approved project would be applied to the proposed modification and would be sufficient to manage the minor increase in waste volumes. An additional assessment of potential changes to waste management impacts associated with the proposed modification is not considered necessary.
Sustainability	No	The Environmental Impact Statement for the approved project identified potential sustainability impacts associated with climate change adaptation, construction resource use and greenhouse gas emissions. The proposed modification would not introduce any new sustainability impacts, although there would be some minor increases in the volumes of materials used and the greenhouse gas emissions. These increases are not considered to make a material change to the assessment. The mitigation measures identified for the approved project would be applied to the proposed modification and would be sufficient to manage these minor increases In addition, the Environmental Impact Statement for the approved project provided the sustainability strategy, objectives and initiatives for Sydney Metro City & Southwest. These would also apply to the proposed modification. An assessment of potential changes to sustainability impacts associated with the proposed modification is not considered necessary.
Cumulative impacts	No	There would be no interactions that are expected to result in cumulative impacts between construction of the Artarmon substation at the 98-104 Reserve Road site and the projects described in Table 26-2 or Table 26-3 of the Environmental Impact Statement. An assessment of potential changes to cumulative impacts associated with the proposed modification is not considered necessary.

TRAFFIC AND TRANSPORT

CHAPTER NINE

9 Traffic and transport

This chapter provides an assessment of the potential changes to impacts on construction and operational traffic and transport, as a result of the proposed modifications, and identifies any changes to mitigation measures to address these impacts.

9.1 Assessment methodology and assumptions

9.1.1 Construction traffic and transport assessment

The construction traffic impact assessment is consistent that the method used for the assessment of the approved project. This is based on the analysis of existing traffic movements on the road network near the construction sites to determine the current operational performance. Construction traffic from the project was added to the existing network and analysed to identify potential impacts. The approach to traffic modelling carried out for this assessment aligns with the *Traffic Modelling Guidelines* (Roads and Maritime, 2013).

Consistent with the standard approach for traffic assessments on major infrastructure projects, the traffic modelling carried out is of the AM and PM peak periods only. These peak traffic periods represent a 'worst case scenario' as during these periods the road network experiences the maximum background traffic demand and the available spare capacity of the road network is at its most limited. In order to minimise impacts to the road network, construction vehicle volumes have been planned to be higher outside the AM and PM weekday peak periods; however, the number movements would remain relatively low and would be within the range of daily variations in traffic volumes on the road network when compared to background traffic.

To assess the impact of the construction activities on the road network performance, intersections along the proposed construction routes between construction sites and the arterial road network have been assessed using Linsig 3.2 modelling software. Linsig 3.2 is used for the analysis of a corridor or a small transport network. The main performance indicators for Linsig 3.2 include:

- Degree of Saturation (DoS) – the ratio between traffic volumes and capacity (v/c) of the intersection, used to measure how close to capacity an intersection is operating. The DoS is a direct measure of the congestion level at the intersection. As DoS approaches 1.0, both queue length and delays increase rapidly. Satisfactory operations usually occur with a DoS range between 0.8-0.9 or below
- Average Delay – duration, in seconds, of the average vehicle waiting time at an intersection
- Level of Service (LoS) – a measure of the overall performance of the intersection. For this purpose, average delay from Roads and Maritime Services LoS calculations has been used. Criteria for these performance indicators are provided in Table 9-1.

Table 9-1 Level of Service criteria

Level of service	Average delay (seconds per vehicle)	Traffic signals and roundabout operations
A	Less than 14	Good operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity; at signals incidents will cause excessive delays
F	Greater than 70	Exceeds capacity; roundabouts require other control mode

9.1.2 Transport assessment

Consistent with the approach for the approved project, a qualitative assessment has been carried out on the potential impacts to transport services during construction. This includes consideration of the active transport network (pedestrian and cyclist facilities) and public transport services (suburban rail, buses and ferries) as relevant to the proposed modifications.

9.1.3 Spoil transport options

The traffic and transport assessment for the approved project assumed that all spoil would be transported by road, however that assessment also identified that further consideration of rail and barge options would be carried out during the detailed design phase of the approved project. These options would not be applicable to the proposed modifications to Victoria Cross Station and Artarmon substation therefore this assessment assumes that all spoil would be transported by road.

9.1.4 Hours of truck operation

As identified for the approved project, excavation of underground station caverns and associated activities would be carried out up to 24 hours per day and seven days per week. These activities would require support construction vehicles for material supply and spoil removal, to also occur up to 24 hours per day and seven days per week. In accordance with the approved project, the development of truck movements for the proposed modifications aims to minimise movements during the AM and PM peak traffic periods and during the night-time period. Further detail is provided in the respective sections of this chapter.

9.1.5 Haul routes

The proposed haul routes for each of the proposed modification construction sites are provided in the respective sections of this chapter.

9.1.6 Spoil generation

Based on the concept design of the approved project, it was envisaged that excavation would generate about 2.4 million cubic metres of spoil in total. This included the expected spoil volumes and truck types for the Artarmon substation and Victoria Cross Station sites as outlined in Table 9.2. This is expected to change for the proposed modifications in line with changed excavation requirements as also outlined in Table 9-2.

Table 9-2 Anticipated spoil generation and likely truck type for the proposed modifications

Site	Approved project		Proposed modifications	
	Volume of spoil (m^3)	Truck type	Volume of spoil (m^3)	Truck type
Artarmon substation	2,000	Tipper truck	2,000	Tipper truck
Victoria Cross Station	175,000	Tipper truck	200,000	Tipper truck

9.1.7 Operational traffic and transport assessment

A qualitative assessment of the operation of the approved project was carried out, including a description of the transport integration of each station and assessment of the potential traffic and transport impacts. The same approach has been used for the operational traffic and transport assessment for the proposed modifications.

Two patronage forecast models were configured and run to produce preliminary forecast passenger demand and their anticipated mode of arrival / departure from each station:

- The Public Transport Project Model (PTPM) is informed by a number of assumptions regarding future land and transport use and operations
- The Enhanced Train Crowding Model (ETCM) provides detailed rail modelling analysis for station entries and exits, line loading and platform crowding. Inputs to the ETCM are based on the outputs generated from the PTPM.

Cycling forecasts at each station were determined using the outputs of the patronage modelling and the Transport for NSW Bike and Ride initiative, identified in *Sydney's Cycling Future* (Transport for NSW, 2013c).

The patronage forecasts were produced for 2036 based on land use planning projections available from the Department of Planning and Environment. However, the design year adopted for the project is 2056 to ensure the design of the stations would be able to accommodate future growth.

This information was reviewed as part of the assessments for each of the proposed modifications and the outcomes updated as per the relevant sections below.

9.2 Victoria Cross Station

9.2.1 Existing environment

The regional transport environment and road network in relation to the approved project and the local traffic and transport environment around Victoria Cross Station was described in the assessment for the approved project. This remains applicable to the proposed Victoria Cross component of the proposed modification.

This section provides further details relevant to the proposed Victoria Cross Station modification.

Active transport network

The Miller Street / McLaren Street intersection has signalised pedestrian crossings on all four legs of intersection. There is no specific provision for pedestrian movements at the McLaren Street / Walker Street intersection. Miller Street is a defined cycle route.

Public transport services

Public transport services in and around the site would be similar to that outlined for the approved project, with North Sydney identified as a major thoroughfare for buses, including bus stops located on Miller Street.

North Sydney is also served by the existing North Sydney Station located on Blue Street south of the proposed Victoria Cross Station. North Sydney Station is on the T1 North Shore Rail Line, currently providing connections towards Hornsby, Chatswood and Macquarie Park in the north, the Sydney CBD to the south, and Parramatta, Blacktown and Penrith to the west.

Existing traffic volumes and patterns

Eastbound traffic volumes on McLaren Street between the Pacific Highway and Miller Street are 240 and 190 vehicles per hour in the morning and evening peak hour, respectively. Similarly, westbound traffic volumes on McLaren Street between the Pacific Highway and Miller Street are 290 and 250 vehicles per hour in the morning and evening peak hour, respectively.

Peak hour traffic volumes in both directions along McLaren Street are heavily influenced by the pick-up / drop off activities associated with the schools in the area. However, during the remainder of the day traffic volumes along McLaren Street are significantly lower than peak hour volumes.

Southbound traffic volumes on Walker Street between McLaren Street and Miller Street are 250 and 270 vehicles per hour in the morning and evening peak hour, respectively.

Approximate peak hour link volumes on key access roads are shown in Table 9-3.

Table 9-3 Victoria Cross Station existing peak hour traffic volumes by direction (2015)

Road	Location	AM peak volume (vehicles per hour)	PM peak volume (vehicles per hour)
Pacific Highway	Between McLaren Street and Berry Street (southbound)	1,390	1,060
	Between McLaren Street and Berry Street (northbound)	1,000	790
Pacific Highway	Between Berry Street and Miller Street (southbound)	520	620
	Between Berry Street and Miller Street (northbound)	1,210	1,160
Miller Street	Between McLaren Street and Berry Street (southbound)	630	530
	Between McLaren Street and Berry Street (northbound)	470	500
Miller Street	Between Berry Street and Pacific Highway (southbound)	540	370
	Between Berry Street and Pacific Highway (northbound)	550	640
McLaren Street	Between Pacific Highway and Miller Street (eastbound)	240	190
	Between Pacific Highway and Miller Street (westbound)	290	250
Berry Street	Between Pacific Highway and Miller Street (eastbound)	1,220	940
	Between Miller Street and Walker Street (eastbound)	1,280	1,700
Walker Street	Between Arthur Street and Mount Street (southbound)	160	100
	Between Arthur Street and Mount Street (northbound)	1,170	940
	Between McLaren Street and Berry Street (southbound)	250	270
	Between McLaren Street and Berry Street (northbound)	500	460

9.2.2 Potential impacts – construction

Construction vehicle movements

Construction vehicle access for the proposed modification (including light vehicles and rigid trucks) would be left in / left out movements via McLaren Street. The access driveway would likely be located at the eastern end of the site as the geographical low point of the proposed construction site. The haulage route involves arrivals from Miller Street and departures via Walker Street as shown in Figure 9-1. Outside school pick-up and drop-off times, right turn from the site to travel west along McLaren Street to the Pacific Highway may occur. Final access arrangements would be determined during the preparation of the Construction Traffic Management Plan in consultation with stakeholders and with reference to potential cumulative impacts associated with other construction projects.

The reasons for using Walker Street as opposed to Miller Street for outbound movements are as follows:

- The McLaren Street westbound approach to Miller Street is very steep and would result in poor operational performance for fully laden vehicles accelerating from a stationary state
- Walker Street southbound between McLaren Street and Berry Street is regulated with 'No Stopping' signage resulting in adequate lane widths to accommodate haulage vehicles
- Walker Street southbound experienced relatively light traffic, making the right turn from McLaren Street feasible
- Berry Street provides direct access to the Warringah Freeway via the northbound entry ramp.

The proposed modification would result in an increase in the number of construction vehicles required and a change in vehicle movement forecasts compared to the approved project. This is because the larger site allows a more even distribution of construction vehicle movements between the southern and northern construction sites and provides more opportunity to support station cavern excavation and spoil removal activities.

The difference in construction vehicle movements and the Victoria Cross Station northern construction site between the approved project and that required for the proposed modification is shown in Table 9-4.

Table 9-4 Victoria Cross Station – construction traffic volumes

Construction site	Vehicle type	6am to 10am (vehicle movements/h)	10am to 3pm (vehicle movements/h)	3pm to 7pm (vehicle movements/h)	7pm to 6am (vehicle movements/h)
Approved project[1]	Heavy	0.9	3.6	0.9	0.9
	Light	0.3	1.5	0.3	0.3
Proposed modification	Heavy	6	24	6	24
	Light	2	10	2	2

1 *The assessment for the approved project assumed construction traffic split of 85% / 15% between the northern and southern construction sites. For the proposed modification, an equal construction traffic split between the northern and southern construction sites is proposed.*

The proposed modification would remove construction traffic associated with the approved northern station services building on Miller Street between Berry and McLaren Streets. However, there would be additional impacts on Walker Street for southbound traffic. Traffic impacts on Walker Street would be managed in accordance with the Sydney Metro Construction Environmental Management Framework with the conditions of approval. This includes the Construction Traffic Management Plan (required by Condition C2) and the Construction Traffic Management Framework (required by Condition E81).

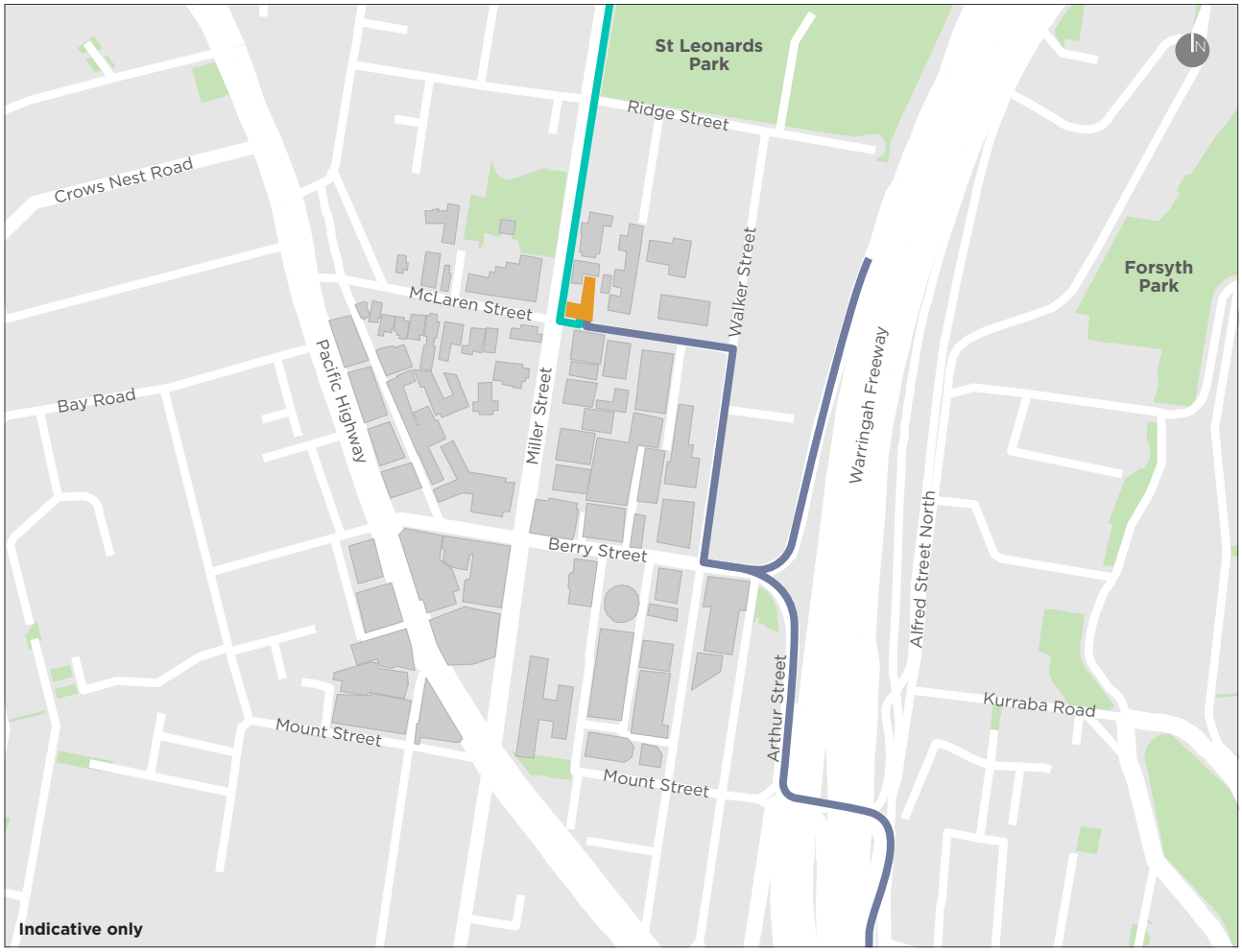

Figure 9-1 Victoria Cross Station proposed modification northern construction site haulage routes

Road network performance

Table 9-5 shows the impacts of construction of the proposed modification on nearby key intersections. The impact of the proposed modification is compared with both the existing traffic conditions and the traffic conditions of the approved project. In summary, this shows that the level of service at each intersection modelled would not deteriorate with the addition of construction vehicles. The impacts of the proposed modification on key intersections would be the same as the approved project.

One additional intersection at McLaren Street / Walker Street would be impacted by the proposed modification compared to the approved project. As shown in Table 9-5, construction vehicles associated with the proposed modification would not deteriorate the level of service at this intersection.

Overall, the proposed modification would not significantly impact the road network performance around Victoria Cross Station.

Table 9-5 Victoria Cross Station modification construction site intersection performance

Intersection / peak period	Base			With approved project			With proposed modification		
	Average delay (seconds per vehicle)	Level of Service	Degree of saturation	Average delay (seconds per vehicle)	Level of Service	Degree of saturation	Average delay (seconds per vehicle)	Level of Service	Degree of saturation
Falcon Street / Warringah Freeway ramps (signalised)									
AM peak	32	C	0.90	32	C	0.90	32	C	0.90
PM peak	31	C	0.92	31	C	0.92	30	C	0.92
Falcon Street / Miller Street (signalised)									
AM peak	30	C	0.93	31	C	0.82	30	C	0.82
PM peak	32	C	0.95	32	C	0.95	31	C	0.95
Miller Street / Carlow Street (signalised)									
AM peak	27	B	0.79	26	B	0.79	27	B	0.79
PM peak	28	B	0.72	28	B	0.72	28	B	0.72
Miller Street / Ridge Street (signalised)									
AM peak	15	B	0.44	16	B	0.50	15	B	0.43
PM peak	19	B	0.45	19	B	0.45	19	B	0.47
McLaren Street / Miller Street (signalised)									
AM peak	25	B	0.75	25	B	0.78	23	B	0.75
PM peak	26	B	0.84	26	B	0.84	26	B	0.84
McLaren Street / Walker Street (priority controlled)									
AM peak	6	A	0.53	–	–	–	6	A	0.57
PM peak	4	A	0.43	–	–	–	5	A	0.46
Berry Street / Walker Street (signalised)									
AM peak	31	C	0.84	31	C	0.85	31	C	0.85
PM peak	27	B	0.75	27	B	0.75	27	B	0.79
Mount Street / Arthur Street (signalised)									
AM peak	10	A	0.68	10	A	0.66	10	A	0.67
PM peak	25	B	0.78	25	B	0.78	25	B	0.80

Active transport network

The location of the northern services building in the approved project is adjacent to the Monte Sant' Angelo Mercy College on Miller Street. School children currently use footpaths around the site to travel between public transport services and the school. School drop off areas are also located close to the site on Berry Street and Miller Street.

The location of the proposed modification is fronted by a footpath on McLaren Street that carries lower numbers of pedestrians than the footpaths on Miller Street south of McLaren Street. While there is currently an informal pedestrian route used by Wenona Students that extends from Elliot Street along the eastern boundary of 52 McLaren Street, this connectivity would be retained (in conjunction with suitable pedestrian management measures along the McLaren Street frontage). As such, the proposed modification is expected to have a reduced impact on the active transport network compared to the approved project.

Impacts on the footpaths around the proposed modification site would be managed in accordance with the Sydney Metro Construction Environmental Management Framework, the mitigation measures identified for the approved project and the conditions of approval. This includes the Construction Traffic Management Plan (required by Condition C2) and the Construction Traffic Management Framework (required by Condition E81). As the proposed modification site would remain near local schools, haulage of construction materials would be scheduled to minimise movements during school pick up ad drop off times consistent with the approved project.

Public transport services

The proposed modification would not impact on public transport services. The proposed modification would reduce the impact of the approved project, as the bus stop at 194 Miller Street would no longer need to be temporarily located during construction.

9.2.3 Potential impacts – operation

Passenger demand and pedestrian integration

The existing Victoria Cross Station 10-minute catchment has the potential to serve around 51,000 workers and up to 5,900 dwellings by 2036. The station would also serve some of the estimated 10,000 school students in the wider precinct.

An estimated 20 per cent of customers using Victoria Cross Station have a destination to the north of Berry Street. The proposed additional entry would increase the reach of the station catchment to include additional regional attractors such as the Mater Hospital, North Sydney Oval, North Sydney Boys High School and the residential and mixed use area to Falcon Street and Neutral Bay via the footbridge over the Warringah Freeway (refer to Figure 2-1).

For 2036, the potential northern entry usage is estimated to be around 2,300 trips during the AM peak hour, representing about 17 per cent of all peak rail entries and exits at Victoria Cross Station. An increase in patronage of five per cent (over the approved project) is expected due to the additional walking catchment serviced by the northern entry.

Footpaths fronting the proposed modification would be designed to an appropriate width and standard to accommodate the anticipated pedestrian demand generated by the proposed modification. The existing signalised pedestrian crossings across all four legs of the Miller Street / McLaren Street intersection are suitable to address the additional demand for pedestrian crossing as a result of the proposed modification.

Cyclist integration

The proposed modification would be located adjacent to the existing Miller Street on road bicycle route. The proposed modification may include limited additional cycle parking to complement existing facilities and proposed facilities on Miller Street as part of the approved project.

Public transport integration

Approximately 1,600 customers are expected to board or alight bus services on Miller Street at Victoria Cross Station during the 3.5 hour AM peak under the conditions of the approved project. The proposed modification would benefit these customers by providing a northern entry that would improve transfer opportunities. The proposed modification would especially benefit mobility impaired customers by reducing the walking distance between stops and enabling transfer to the station before reaching the busy North Sydney CBD.

A northern station entry would also enable the transfer between modes to be segmented, with transfers to car based modes such as taxis, point to point transport and kiss and ride relocated to the northern entry, and transfers to mass transit, such as buses, retained at the southern entry. This has the potential to improve lessen demand on kerb space in the busiest, most constrained part of the interchange as well as reduce demand on the surrounding roads by distributing demand to other parts of the local road network. It would provide operational flexibility for buses (accommodation of future routes / additional kerb space for bus stands) and improve the customer interchange experience for car based transfers.

Parking and taxis

The proposed modification would permanently affect motorcycle parking and car share parking located on the McLaren Street frontage. This represents a small reduction in the context of the broader supply of parking in the locality.

Kiss-and-ride and taxi facilities are proposed. Refer to Chapter 6 (Modification description – operation).

9.2.4 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified. This includes measures to address potential cumulative impacts (see measures T21 and CU1 in Chapter 18).

The proposed modification would also be constructed and operated in accordance with relevant conditions of approval including:

- Condition C2 – Construction Traffic Management Plan
- Condition D3 – Operational Management Plan Traffic and Transport Sub Plan
- Conditions E75 to E96 – various traffic and transport conditions including the requirement for the development and implementation of a Construction Traffic Management Framework.

No additional traffic and transport mitigation measures are proposed for the Victoria Cross Station component of the proposed modification, although additional measures may be developed as part of the Construction Traffic Management Framework.

9.3 Artarmon substation

9.3.1 Existing environment

The regional transport environment and road network in relation to the approved project and the local traffic and transport environment around the approved Artarmon substation site was described in the assessment for the approved project. This is no longer applicable to the Artarmon component of the proposed modification due to the proposed relocation of the site.

This section provides further details relevant to the proposed Artarmon substation modification.

Active transport network

Footpaths are located on both sides of Reserve Road and Whiting Street within the immediate vicinity of the 98-104 Reserve Road site. Although Whiting Street is a cul de sac at its eastern end, connectivity between Whiting Street and Reserve Road is maintained for pedestrians adjacent to the north-eastern corner of the site. Signalised pedestrian crossings are available on all four legs of the Reserve Road / Dickson Avenue intersection and the Reserve Road / Gore Hill Freeway interchange.

A shared path runs along the southern side of the Gore Hill Freeway and provides facilities for cyclists. There is also an on-road marked bicycle path on the Pacific Highway in the southbound direction between Hotham Parade and Whiting Street. This is connected to a shared path between Whiting Street and Carlotta Street.

Public transport services

Public transport services operating near the proposed site include the Artarmon Loop, which is a free, weekday bus shuttle service operated by Willoughby City Council. During the morning (6am to 10am) and evening (3pm to 7pm) peak period, services operate every seven to 15 minutes along Clarendon Street, Hotham Parade and the Pacific Highway. Interpeak services are less frequent, operating every 30 minutes and with an extended route via Reserve Road. Near the site, customers may access the Artarmon Loop from stops on Clarendon Street south of Whiting Street and south of Dickson Avenue, and on Reserve Road near Whiting Street (interpeak only).

All other bus services are at least 600 metres from the site and operate along the Pacific Highway towards destinations such as Chatswood, Manly and the Sydney CBD. The N90 NightRide bus service is only accessible from Hampden Road, around 800 metres from the site.

The nearest rail service is the T1 North Shore, Northern and Western Line accessible from Artarmon Station, around 800 metres from the site.

Existing traffic volumes and patterns

Traffic volumes on Dickson Avenue and Clarendon Street are similar, generally between 350 and 410 vehicles per hour in the peak direction during both peak hours. Dickson Avenue traffic volumes are higher in the westbound direction during the morning peak hour and in the eastbound direction during the evening peak hour. Traffic volumes on Clarendon Street are higher during the evening peak hour compared to the morning peak hour in both directions.

Low traffic volumes occur on Whiting Street particularly between Clarendon Street and Reserve Road. During the morning peak hour, there are around 20 vehicles in the eastbound direction and 40 vehicles in the westbound direction. Traffic volumes double during the evening peak hour however are still low, with around 40 vehicles per hour in the eastbound direction and 80 vehicles per hour in the westbound direction.

Traffic volumes are slightly higher on Whiting Street between the Pacific Highway and Clarendon Street. Eastbound traffic volumes are 80 and 150 vehicles per hour during the morning and evening peak hour, respectively, while westbound traffic volumes are 80 and 120 vehicles per hour during the morning and evening peak hour, respectively.

Approximate peak hour link volumes on key access roads are shown below in Table 9-6.

Table 9-6 Artarmon substation existing peak hour traffic volumes by direction (2015)

Road	Location	AM peak volume (vehicles per hour)	PM peak volume (vehicles per hour)
Pacific Highway	South of the Gore Hill Freeway (southbound)	1,940	1,240
	South of the Gore Hill Freeway (northbound)	910	1,430
Whiting Street	Between the Pacific Highway and Clarendon Street (eastbound)	80	150
	Between the Pacific Highway and Clarendon Street (westbound)	80	120
	Between Clarendon Street and Reserve Road (eastbound)	20	40
	Between Clarendon Street and Reserve Road (westbound)	40	80
Clarendon Street	Between Whiting Street and Dickson Avenue (southbound)	180	350
	Between Whiting Street and Dickson Avenue (northbound)	350	410
Dickson Avenue	Between Clarendon Street and Reserve Road (eastbound)	200	390
	Between Clarendon Street and Reserve Road (westbound)	360	280
Reserve Road	South of the Gore Hill Freeway (southbound)	1,270	520
	South of the Gore Hill Freeway (northbound)	530	1,170

9.3.2 Potential impacts – construction

Construction vehicle movements

Construction vehicle access for the proposed modification would be left in / left out movements via Whiting Street, with the access driveway located on the northern boundary of the site. The haulage route involves arrivals via the Pacific Highway and Whiting Street and departures via Whiting Street, Clarendon Street, Dickson Avenue and Reserve Road as shown in Figure 9-2. There would be no direct access / egress between the site and Reserve Road. Final access arrangements would be determined during the preparation of the Construction Traffic Management Plan in consultation with stakeholders and with reference to potential cumulative impacts associated with other construction projects.

Peak heavy vehicle movements for the Artarmon substation construction site would be as described for the approved project. In the AM peak period (7am to 10am) there would be four heavy vehicles per hour during the site establishment and excavation phases.

The proposed modification would remove construction traffic associated with the approved Artarmon substation site using Barton Lane.

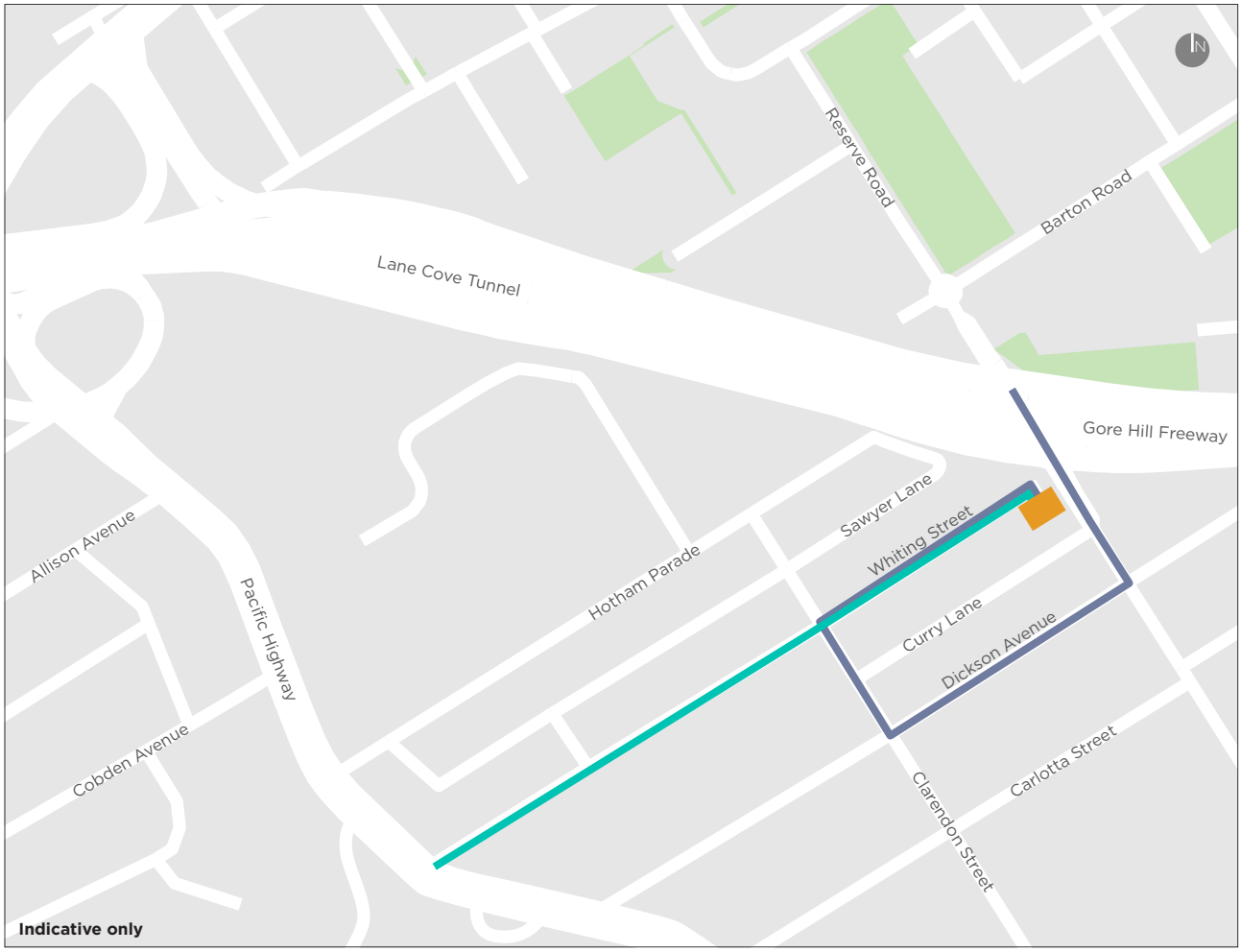

Figure 9-2 Artarmon substation proposed modification haulage routes

Road network performance

Table 9-7 shows the impacts of construction of the proposed modification on nearby intersections. The impact of the proposed modification is compared with both the existing traffic conditions and the traffic conditions of the approved project. The approved project and proposed modification both impact the intersection of Reserve Road and the Gore Hill Freeway ramps. The impacts of the proposed modification would be the same as the approved project with LoS B during the morning peak hour and LoS C during the evening peak hour.

Four additional intersections would be impacted by the proposed modification compared to the approved project. As shown in Table 9-7, construction vehicles associated with the proposed modification would not deteriorate the LoS at these intersections.

Overall, the proposed modification would not significantly impact the road network performance around the Artarmon substation.

Table 9-7 Artarmon substation modification construction site intersection performance

Intersection / peak period	Base			With approved project			With proposed modification		
	Average delay (seconds per vehicle)	Level of Service	Degree of saturation	Average delay (seconds per vehicle)	Level of Service	Degree of saturation	Average delay (seconds per vehicle)	Level of Service	Degree of saturation
Whiting Street / Clarendon Street									
AM peak	3	A	0.21	–	–	–	3	A	0.21
PM peak	4	A	0.27	–	–	–	5	A	0.30
Whiting Street / Pacific Highway									
AM peak	7	A	0.48	–	–	–	7	A	0.49
PM peak	6	A	0.42	–	–	–	6	A	0.42
Clarendon Street / Dickson Street									
AM peak	23	B	0.79	–	–	–	23	B	0.79
PM peak	17	B	0.69	–	–	–	17	B	0.69
Reserve Road / Dickson Street									
AM peak	15	A	0.60	–	–	–	15	A	0.60
PM peak	23	B	0.62	–	–	–	24	B	0.66
Reserve Road / Gore Hill Freeway ramps									
AM peak	25	B	0.93	25	B	0.93	25	B	0.94
PM peak	28	B	0.93	31	C	0.98	29	C	0.93

Active transport network

The Artarmon substation construction site is not anticipated to result in any impacts to nearby pedestrian footpaths, crossings, or cyclist facilities.

Public transport services

As the Artarmon Loop provides services every 30 minutes during the interpeak period when construction volumes are at their highest, and the impact of construction vehicles at Artarmon substation is anticipated to be minor, any impacts to this service would be negligible.

Parking and taxis

The Artarmon substation construction site is not anticipated to result in any loss of parking or impacts to taxi facilities.

9.3.3 Potential impacts – operation

Consistent with the approved project, the limited number of vehicles and the expected frequency of access for maintenance of the Artarmon substation is not expected to result in any impacts to the surrounding road network. Maintenance access would be from Whiting Street and access requirements would be as per Table 9-6 of the Environmental Impact Statement.

9.3.4 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The proposed modification would also be constructed and operated in accordance with relevant conditions of approval including:

- Condition C2 – Construction Traffic Management Plan
- Condition D3 – Operational Management Plan Traffic and Transport Sub Plan
- Conditions E75 to E96 – various traffic and transport conditions including the requirement for the development and implementation of a Construction Traffic Management Framework.

No additional mitigation measures are required for the Artarmon substation component of the proposed modification.

NOISE AND VIBRATION

CHAPTER TEN

10 Noise and vibration

This chapter assesses the potential changes to impacts of noise and vibration during the construction and operational phases of the proposed modifications. It describes the existing noise and vibration environment and identifies the potential significance of impacts to sensitive receivers. Changes to mitigation measures to address the potential impacts are also identified.

10.1 Assessment methodology

The assessment of potential changes to construction and operational noise and vibration impacts followed the same approach as was carried out for the approved project and involved:

- Identifying and classifying sensitive receivers
- Characterising the existing noise environment based on attended and unattended noise measurements at nearby receiver locations
- Determining noise and vibration management levels in accordance with relevant guidelines.

10.1.1 Construction

The assessment methodology for the construction noise and vibration assessment generally involved:

- Modelling to quantify the potential construction noise and vibration impacts from the construction activities for the proposed modifications in isolation, and modelling of the project as proposed to be modified (that is modelling the combined impacts of the construction activities for the approved project and the proposed modifications)
- Identifying the potential changes to the impacts from the approved project and assessing the significance of potential impacts identified
- Examining the proposed construction methodologies and identifying mitigation measures that are likely to be required to minimise construction noise and vibration impacts
- Preparing and documenting any changes to the mitigation measures identified for the approved project that would be implemented during construction.

The assessment provides a 'worst-case' scenario based on the proposed works within a 15 minute period which is typically associated with works located within the nearest site area to a particular receiver. However, in reality at any particular location, the potential construction noise impacts can vary greatly depending on factors including the following:

- The position of the construction works within the site and distance to the nearest sensitive receiver
- The overall duration of the construction works
- The intensity of the noise levels
- The time at which the construction works are undertaken
- The character of the noise.

In response to feedback received on the assessment carried out for the approved project and to present a more refined assessment of the potential variance in noise impacts over the duration of works activity, this assessment refers to the $L_{Aeq(15minute)}$ 'typical range' to describe the range of impacts likely to be experienced by a receiver.

The 'worst-case' and 'typical range' are defined as:

- The **'worst-case'** $L_{Aeq(15minute)}$ noise level corresponds to the worst case noise level expected during construction works for a given activity. This is consistent with the requirements of the ICNG. The 'worst-case' noise prediction denotes a scenario where all works are located at the closest construction boundary to the receiver and that all equipment is running simultaneously within each works area. The upper noise level is expected to occur on occasion, typically only over several days corresponding to each scenario activity and would typically occur for a short period only during those days
- The **'typical range'** of $L_{Aeq(15minute)}$ noise level expected during construction works for a given activity is representative of the construction noise levels likely to be experienced by a receiver as works progress through other areas of the site and cater for the likely variability in the intensity of the works and utilisation rate of the plant and equipment. This approach represents a typical worst case prediction for the works which is expected to occur on a regular basis, typically occurring several times per day corresponding to each scenario and it is the levels which is likely to correlate to the ongoing level of disturbance experienced by the surrounding sensitive receivers.

A figure showing the indicative work locations of the 'worst-case', 'typical upper' and 'typical lower' range assessment locations is provided in Figure 10-1.

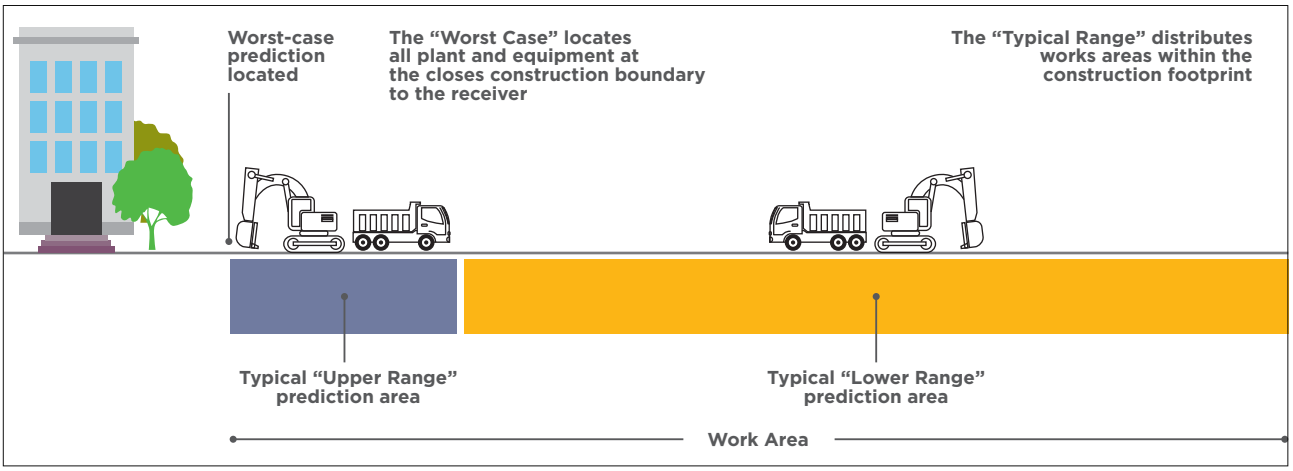

Figure 10-1 Illustration of relative equipment location for worst-case, typical upper and lower range assessments

To further quantify the range of levels that may be experienced throughout a typical work day, detailed information surrounding the composition of equipment for each activity has been included. A works activity within a construction scenario is comprised of a number of individual items of plant that make up the activity. Generally, one item of plant dominates the noise emissions from that particular works activity. The use of and location of the dominant item of plant generally controls the worst-case noise level from the site. To represent periods of construction where the dominant items of plant are not working, a 'Supporting Works Only' scenario has been included for each activity. The 'Supporting Works Only' prediction includes all items of plant for a given activity, except for the dominant noise source.

10.1.2 Operation

The assessment methodology for the operational noise assessment involved determining the allowable airborne noise emissions from mechanical plant and ventilation systems in accordance with criteria derived from the *New South Wales Industrial Noise Policy* (Department of Environment and Conservation, 2006a).

10.1.3 Terminology

Noise parameters most relevant to the noise assessment are described below:

- Rating Background Level (RBL) or L_{A90} – the background noise level in the absence of proposed construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods and is used to set the L_{Aeq}(15 minute) Noise Management Levels (NMLs) for residential receivers
- $L_{Aeq(15minute)}$ – the "energy average noise level" evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.
- $L_{Aeq(period)}$ – the Energy Average Noise Level evaluated over a defined measurement period (typically 15 minutes for construction noise or the relevant daytime, evening or night-time period for ambient noise monitoring)
- L_{Amax} or $L_{A1(1min)}$ – the 'typical maximum noise level' for an event, used in the assessment of potential sleep disturbance during night-time periods.

10.1.4 Sensitive receivers

The sensitivity of occupants to noise and vibration varies according to the nature of the occupancy and the activities performed within the affected premises. For example, recording studios are more sensitive to vibration and ground-borne noise than residential premises, which in turn are more sensitive than typical commercial and industrial premises.

Properties surrounding the site have been classified into one of the following receiver categories:

- Commercial
- Educational
- Industrial
- Mixed commercial/residential
- Residential
- Place of Worship
- Child care
- Special Sensitive (eg hospital, precision laboratories, recording studios)

The receivers surrounding the site are predominantly residential, educational and commercial with some of the other receiver types near the site.

10.1.5 Operational noise assessment methodology

The modelling of the mechanical and electrical services airborne noise presented in this assessment is based on the current project design. The approach to the assessment of noise impacts presented is to calculate the maximum total allowable emitted sound power level (SWL) at each location, thus specifying the acoustic emission limit for all equipment (combined operation) at each location.

The noise sources have been assumed to operate without noticeable tonal, impulsive or intermittent components, unless otherwise stated, and the assessment therefore does not require the application of modifying factors, as defined in the *NSW Industrial Noise Policy* (INP).

10.2 Assessment criteria

10.2.1 Construction noise management levels

Airborne construction noise

Airborne noise would occur from all construction activities and would primarily be associated with surface activities or underground activities where there is an airborne noise path between the source and receiver (ie not fully shielded).

The *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change, 2009) sets out ways to deal with the impacts of construction noise on residential receivers and other sensitive land uses by presenting assessment approaches that are tailored to the scale of construction projects.

The ICNG sets out a quantitative assessment method involving predicting noise levels at sensitive receivers and comparing them with the project-specific NMLs established for noise affected receivers. If construction noise levels are predicted to be above the NMLs, all feasible and reasonable mitigation and work practices are required to be investigated to minimise noise emissions.

Residential receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at residential receivers by applying the measured $L_{A90(15minute)}$ background noise levels, as described in Table 10-1.

Table 10-1 Determination of noise management levels for residential receivers

Time of Day	Noise Management Level $L_{Aeq(15minute)}$	How to apply
Recommended standard hours: **Monday to Friday 7 am to 6 pm** **Saturday 8 am to 1 pm** **No work on Sundays or public holidays**	Noise affected RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dBA	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practice have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Other sensitive land uses

The project-specific $L_{Aeq(15minute)}$ NMLs for other non-residential noise sensitive receivers from the ICNG are provided in Table 10-2.

Table 10-2 Noise management levels for other sensitive receivers

Land use	NML $L_{Aeq(15minute)}$ (Applied when the land use is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of worship	Internal noise level 45 dBA
Active recreation areas	
(characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. reading, meditation)	External noise level 60 dBA
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in *Australian Standard 2107 – Acoustics – Recommended design sound levels and reverberation times for building interiors* for specific uses.

For sensitive receivers such as schools, hospitals and places of worship, the NMLs presented in Table 10-2 are based on internal noise levels. For the purposes of this assessment, it is assumed that all schools, hospitals and places of worship have openable windows. On the basis that external noise levels are typically 10 dB higher than internal noise levels when windows are open, an external $L_{Aeq(15minute)}$ NML of 55 dBA has been adopted.

Other noise-sensitive businesses require separate project-specific noise goals. The ICNG recommends that the internal construction noise levels at these premises are determined based on the 'maximum' internal levels presented in *AS 2107*. These recommended 'maximum' internal noise levels are provided in Table 10-3.

Table 10-3 Noise management levels for other receivers

Description	Time period	AS 2107 Classification	Recommended 'Maximum' Internal L_{Aeq} (dBA)
Hotel	Daytime and evening	Bars and lounges	50
	Night-time	Sleeping areas (hotels near major roads)	40
Café	When in use	Coffee bar	50
Bar / Restaurant	When in use	Bars and lounges / restaurant	50
Library	When in use	Reading areas	45
Recording Studio	When in use	Music Recording Studios	25
Theatre / Auditorium	When in use	Drama Theatres	30

Commercial and industrial premises

NMLs for commercial and industrial premises have been set based on the ICNG. For commercial premises, including offices, retail outlets and small commercial premises an external NML of $L_{Aeq(15minute)}$ 70 dBA has been adopted. An external NML of $L_{Aeq(15minute)}$ 75 dBA has been adopted for industrial premises. For both land use types, the external noise levels should be assessed at the most affected occupied point on the premises.

Ground-borne construction noise

Ground-borne noise during construction may be experienced by sensitive receivers located close to underground excavation. Whilst ground-borne noise may also be audible during construction activities on the surface, the airborne noise levels are likely to be higher and more prominent.

Ground-borne NMLs for residential receivers, based on levels provided in the ICNG, are presented in Table 10-4. These would be applicable when ground-borne noise levels are higher than the corresponding airborne noise levels. The ICNG provides ground-borne noise levels at residential receivers for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

Table 10-4 Ground-borne noise management levels for residential receivers

Time of day	Ground-borne NMLs $L_{Aeq(15\ minute)}$
Daytime 7 am to 6 pm	45 dBA – internal
Evening 6 pm to 10 pm	40 dBA – internal
Night-time 10 pm to 7 am	35 dBA – internal

At locations where the construction noise levels are predicted to exceed the NMLs, consideration must be given to applying all feasible and reasonable work practices for each site and activity to minimise potential noise impacts.

For other sensitive receivers such as education institutions, hospital wards and operating theatres and places of worship the ICNG does not provide guidance in relation to acceptable ground-borne noise levels. However, the internal NML's provided in the ICNG for these receivers have been adopted in order to assist in identifying potential impacts.

For commercial receivers, such as offices and retail areas, the ICNG does not provide guidance in relation to acceptable ground-borne noise levels. However an internal NML of $L_{Aeq(15minute)}$ 50 dBA has been adopted in order to assist in identifying potential impacts, and is based on the ICNG external NML of 70 dBA and that when commercial premises have windows closed this would provide typically 20 dB of noise reduction from outside to inside. Therefore, the internal ground-borne NML of $L_{Aeq(15minute)}$ 50 dBA equals the expected internal noise level resulting from the external airborne NML of $L_{Aeq(15minute)}$ 70 dBA.

Construction ground-borne vibration

The EPAs "Assessing Vibration: a technical guideline" (DEC, 2006) recommends the use of British Standard BS 6472-1992 *Guide to evaluation of human exposure to vibration in building* (BS6472-1992) for the purpose of assessing vibration in relation to human comfort. BS6472-1992 nominates guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV), rather than a continuous vibration level. The vibration dose values recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in Table 10-5.

Table 10-5 BS 7385 Vibration Dose Value Ranges for human comfort

Place and Time	Low Probability of Adverse Comment ($m/s^{1.75}$)	Adverse Comment Possible ($m/s^{1.75}$)	Adverse Comment Probable ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

In relation to structural and cosmetic damage, Australian Standard AS 2187:2 – 2006 recommends use of the guidelines values and assessment methods provided in *British Standard BS 7385:2 – 1993*. The guidelines values for minimal risk of cosmetic damage from the *BS 7385*:2 – 1993 are provided in Table 10-6.

Table 10-6 BS 7385 cosmetic damage guideline values

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Where dynamic loading caused by continuous vibration may result in magnification of vibration through a building structure the guideline values may need to be reduced by up to 50 per cent. Rock breaking, rock hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (eg residences).

For construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, and consistent with the guidance from *BS 7385*, the following conservative cosmetic vibration damage screening level per receiver type have been adopted for the project:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s.

Heritage items

Heritage listed structures should not be assumed to be more sensitive to vibration. Notwithstanding, a conservative vibration screening criterion of 7.5 mm/s has been adopted for heritage structures. Where a historic building is deemed to be sensitive to damage from vibration, more conservative superficial cosmetic damage criterion of 2.5 mm/s peak component particle velocity (from German Standard DIN 4150) should be considered.

Blasting

The ICNG recommends that vibration and overpressure from blasting be assessed against the levels presented in the *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (Australia and New Zealand Environment Council, 1990).

The criteria set by this standard are targeted for operations that occur for long periods of time such as those at mining sites and hence are targeted to protect human comfort from vibration. As a result the vibration levels are conservative and can introduce unnecessary constraints when applied to construction projects which typically occur for much shorter time periods.

Recent NSW infrastructure project approvals have recognised the restrictive nature of these blasting criteria when applied to construction projects and have allowed higher limits. Consistent with condition E54 of the planning approval, the vibration and overpressure limits for blasting applied to this project are:

- Vibration (PPV): 25 mm/s or 7.5mm/s for heritage structures
- Overpressure: 125 dBL.

These upper limits of vibration and overpressure are intended to target the protection of building structures from cosmetic damage rather than human comfort criteria as construction works are considered short-term. Since these criteria are analogous to the cosmetic damage screening criteria it is appropriate to add an additional conservative criteria which is specific to heritage buildings. As noted above, a vibration (PPV) of 7.5 mm/s would be used to screen potential vibration impacts from blasting at heritage buildings.

The blasting scenarios developed for consideration in this assessment have been designed (based on preliminary information) to comply with the above criteria. The assessment then considers the potential reduction in periods of ground-borne noise impacts associated with the adoption of blasting as an excavation method.

Construction traffic noise

During construction, spoil removal and product deliveries would result in additional heavy vehicle movements on public roads. Whilst specific guidance on acceptable noise levels associated with construction traffic is not provided by the Environment Protection Authority, the potential noise impacts have been identified using guidance in the *NSW Road Noise Policy* (RNP) (Department of Environment, Climate Change and Water, 2011a).

One of the objectives of the RNP is to protect against excessive reduction in amenity as the result of a project by comparing traffic noise levels to the following relevant road traffic noise criteria:

- Existing freeway / arterial / sub-arterial roads:
  - $L_{Aeq(15hour)}$ 60 dBA day
  - $L_{Aeq(9hour)}$) 55 dBA night
- Existing local roads:
  - $L_{Aeq(1hour)}$ 55 dBA day
  - $L_{Aeq(1hour)}$ 50 dBA night.

Where traffic noise levels from the existing traffic plus the additional traffic generated by the project exceeds the above criteria, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no project option'.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2 dB, consideration is also given to the actual noise levels associated with construction traffic.

Sleep disturbance

Sleep disturbance is considered as the emergence of the maximum level ($L_{A1(1minute)}$ or L_{Amax}) above the $L_{A90(15minute)}$ background level at the time. The appropriate screening criterion for sleep disturbance is determined to be a maximum level 15 dB above the RBL, normally during the night-time period (10 pm to 7 am). Where this criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

Additional guidance is provided in the RNP which concludes that:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to cause awakening reactions
- One or two events per night, with maximum internal noise levels of 65 dBA to 70 dBA, are not likely to affect health and wellbeing significantly.

On the basis of the above guidance, a sleep disturbance NML of 55 dBA (internal) has been adopted, which equates to an external noise level of 65 dBA (assuming open windows).

Operational noise criteria

The INP sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. These criteria are to be met at the most-affected boundary of the receiver property. The more stringent of the criteria usually defines the proposal specific noise levels. For both amenity and intrusiveness, night-time criteria are more stringent than daytime or evening criteria.

In addition to intrusiveness and amenity, the risk of sleep disturbance must be assessed. Sleep disturbance is assessed in accordance with the screening criterion described in the online Application Notes to the INP and the more detailed review of sleep disturbance contained in the Road Noise Policy (RNP) (Department of Environment, Climate Change and Water, 2011a).

To provide for protection against intrusive noise, the INP states that the L_{Aeq} noise level of the source, measured over a period of 15 minutes, should not be more than five decibels above the ambient (background) L_{A90} noise level (or RBL), measured during the daytime, evening and night-time periods at the nearest sensitive residential receiver. In this case, the intrusiveness criteria are determined from the rating background levels at sensitive receiver locations nearest to the facility.

To provide protection against impacts on amenity, the INP specifies suitable maximum noise levels for particular land uses and activities during the daytime, evening and night-time periods. For this assessment, the existing residences in the vicinity of the proposed modification are considered to be 'Urban'.

According to the INP, where existing transportation L_{Aeq} noise levels exceed the 'Acceptable' noise level by 10 dB or more, and the existing noise level is unlikely to decrease in future, the noise criteria should be taken to be the existing noise level minus 10 dB. This approach is also applicable to areas with high traffic noise. The relevant INP external amenity noise criteria are presented in Table 10-7.

Table 10-7 Industrial Noise Policy (INP) amenity criteria

Type of receiver	Indicative noise amenity area	Time of day	Recommended L_{Aeq} noise level (dBA)	
			Acceptable	Recommended maximum
Residence	Urban[1]	Day	60	65
		Evening	50	55
		Night	45	50
Commercial	All	When in use	65	70
Active recreation area	All	When in use	55	60
Educational	All	When in use	551	601
Place of worship	All	When in use	601	651

1 *External levels, based on the internal levels specified in the INP plus 20 dB (assuming open windows).*

The modelling of the mechanical and electrical services airborne noise presented throughout this assessment is based on the current proposed modification design. The approach to the assessment of noise impacts is to calculate the maximum total allowable emitted sound power level (SWL) at each location, thus specifying the acoustic emission limit for all equipment (combined operation) at each location. The noise sources have been assumed to operate without noticeable tonal, impulsive or intermittent components, unless otherwise stated, and the assessment therefore does not require the application of modifying factors, as defined in the INP.

Sleep disturbance

The current approach to assessing potential sleep disturbance is to apply an initial screening criterion of background plus 15 dB (as described in the Application Notes to the INP), and to undertake further analysis if the screening criterion cannot be achieved. The sleep disturbance screening criterion applies outside bedroom windows during the night-time period. Where the screening criterion cannot be met, the additional analysis should consider the level of exceedance as well as factors such as:

- How often high noise events would occur
- The time of day (normally between 10:00 pm and 7:00 am)
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

Other guidelines that contain additional advice relating to potential sleep disturbance impacts should also be considered, including the RNP. The RNP provides a review of research into sleep disturbance. From the research to date, the RNP concludes that:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep
- One or two events per night, with maximum internal noise levels of 65 dBA to 70 dBA, are not likely to affect health and wellbeing significantly.

It is generally accepted that internal noise levels in a dwelling, with the windows open are 10 dB lower than external noise levels. Based on a worst case minimum attenuation, with windows open, of 10 dB, the first conclusion above suggests that short term external noises of 60 dBA to 65 dBA are unlikely to cause awakening reactions. The second conclusion suggests that one or two noise events per night with maximum external noise levels of 75 dBA to 80 dBA are not likely to affect health and wellbeing significantly.

10.3 Victoria Cross Station

10.3.1 Existing environment

The local noise and vibration environment around Victoria Cross Station was described in the assessment for the approved project. This remains applicable to the Victoria Cross Station component of the proposed modification. This section provides further details relevant to the proposed modification.

Noise catchment areas

The study area for the Victoria Cross Station component of the proposed modification has been divided into multiple noise catchment areas (NCAs) as shown in Figure 10-2. These NCAs reflect the changing land uses and ambient noise environments adjacent to the site, and extends approximately 200 metres from the site. The NCAs are labelled alphanumerically for reference and are presented in Table 10-8.

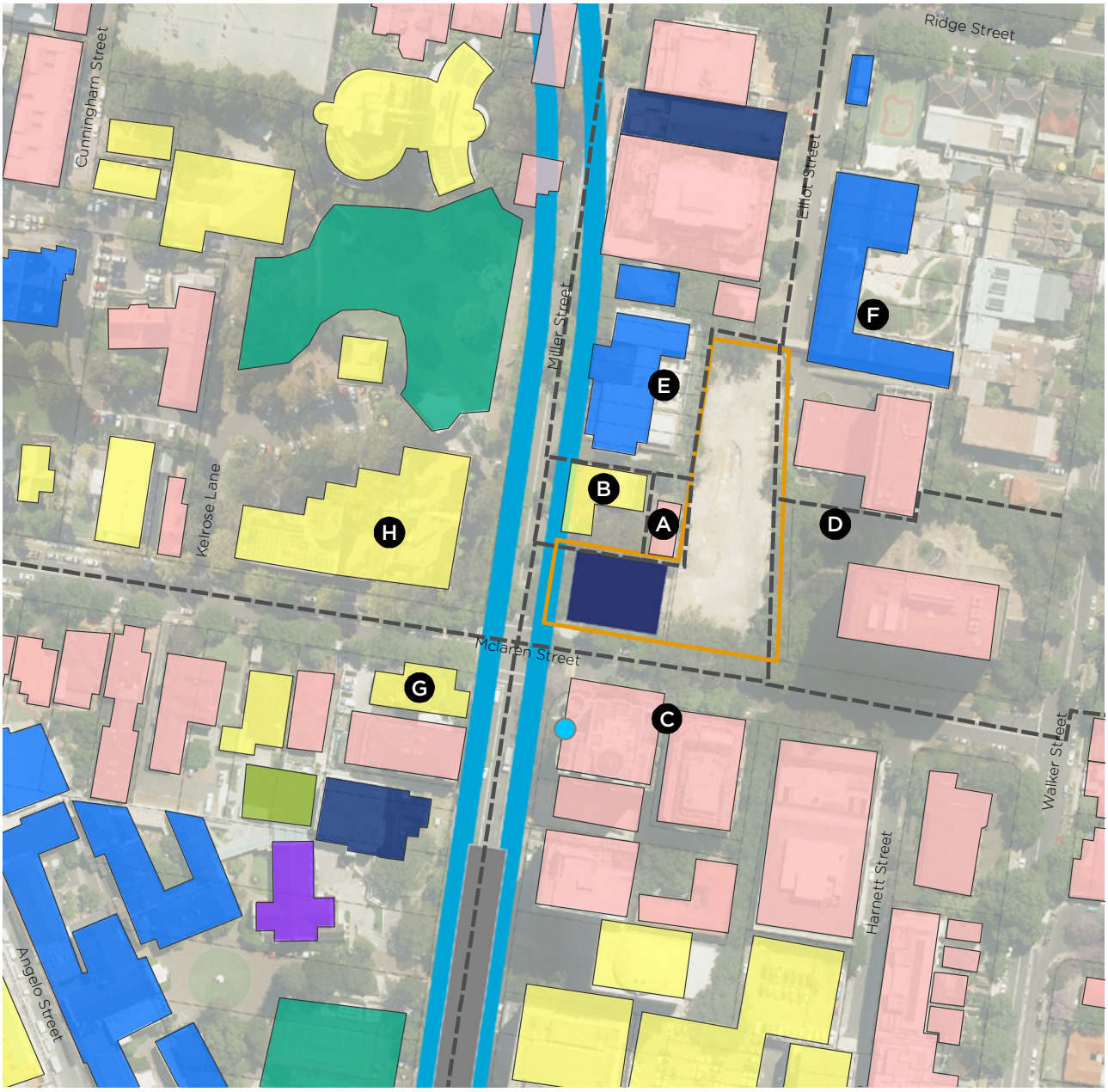

Figure 10-2 Victoria Cross Station noise catchment areas

Table 10-8 Victoria Cross Station summary of noise catchment areas (NCAs)

NCA	Receiver Specification	Approximate distance to proposed station entry / services building (m)
A	Residential	5
B	Commercial	7
C	Residential	20
D	Residential	70
E	Other sensitive – Educational	40
E	Other sensitive – Theatre	165
E	Residential	100
F	Other sensitive – Educational	100
G	Other sensitive – Café/bar	60
G	Residential	65
G	Other sensitive – Theatre	95
G	Other sensitive – Educational	170
G	Other sensitive – Place of Worship	140
H	Commercial	60
H	Other sensitive – Outdoor Passive Recreation	75
H	Residential	150

Ambient noise surveys and monitoring locations

The dominant noise sources that are likely to influence background noise levels at the site and surrounds include:

- Road traffic noise
- Other construction activities (such as the building redevelopments, road and housing construction).

In order to characterise the existing ambient noise environment across the proposed modification area to establish ambient noise levels on which to base the construction NMLs, environmental noise monitoring was carried out at a representative location during September 2015.

The location of unattended and attended noise survey (monitoring location B.18) is shown in Figure 10-2. The results of the unattended noise survey are summarised in Table 10-9.

Table 10-9 Victoria Cross Station summary of unattended noise monitoring results

Location ID	Noise Level (dBA)[1]					
	Daytime 7 am to 6 pm		Evening 6 pm to 10 pm		Night-time 10 pm to 7 am	
	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
B.18	65	74	57	71	51	66

1 The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the INP.

10.3.2 Site-specific assessment criteria

Construction noise management levels

Table 10-10 summarises the NMLs which are relevant for each NCA and receiver types for the proposed modification.

Table 10-10 NMLs for the Victoria Cross Station component of the proposed modification

NCA	Receiver Type	Relevant monitoring location	Standard Construction (RBL + 10dB)	Out of Hours (RBL + 5dBA)[1]			Sleep Disturbance screening (RBL + 15)
			Daytime	Daytime	Evening	Night	
A	Residential	B.18	75	70	62	56	66
B	Commercial	n/a	70	70	n/a	n/a	n/a
C	Residential	B.18	75	70	62	56	66
D	Residential	B.18	75	70	62	56	66
E	Other sensitive – Educational	n/a	55	n/a	n/a	n/a	n/a
E	Other sensitive – Theatre	n/a	50	50	50	n/a	n/a
E	Residential	B.18	75	70	62	56	66
F	Other sensitive – Educational	n/a	55	n/a	n/a	n/a	n/a
G	Other sensitive – Café/bar	n/a	60	60	60	60	n/a
G	Residential	B.18	75	70	62	56	66
G	Other sensitive – Theatre	n/a	50	50	50	n/a	n/a
G	Other sensitive – Educational	n/a	55	n/a	n/a	n/a	n/a
G	Other sensitive – Place of Worship	n/a	55	55	n/a	n/a	n/a
H	Commercial	n/a	70	70	n/a	n/a	n/a
H	Other sensitive – Outdoor Passive Recreation	n/a	60	60	60	n/a	n/a
H	Residential	B.18	75	70	62	56	66

1 *Out of hours construction hours: Evening hours are 6-10pm, night time hours are 10pm-7am Sunday to Saturday and 10pm Saturday to 8am Sunday.*

Operational noise goals

Noise emissions from mechanical and electrical services are normally of a continuous nature and do not change unless operational conditions vary. As a result of the general reduction in existing ambient noise levels during the latter periods of the day, the night-time INP intrusive noise criteria are in general the most stringent for residential receivers and are therefore the controlling design criteria at most residential locations.

The locations of sensitive receivers and their corresponding industrial noise criteria, determined using the procedures defined within the INP are presented in Table 10-11.

Table 10-11 Victoria Cross Station operational noise criteria for sensitive receivers

Receiver Area	Type	Address	Distance to nearest boundary or facade (metres)	Reference[2]	External Noise Criteria (dBA)[1]
A	RES	243 Miller Street, North Sydney	5	B18	56
B	COM	243 Miller Street, North Sydney	14	n/a	65
C	RES	37 McLaren Street, North Sydney	20	B18	56
D	RES	54 McLaren Street, North Sydney	55	B18	56
E	EDU	245-261 Miller Street, North Sydney	35	n/a	55

1 *The night-time intrusive noise criteria are adopted for the design criteria presented in this table. The criteria for commercial and educational premises are absolute levels and are not relative to existing background noise levels in accordance INP.*

2 *The reference location refers to the nearest unattended noise logging location (where applicable).*

10.3.3 Potential impacts

Consistent with the approach adopted for the assessment of the approved project, the noise modelling results presented below assumes standard attenuation acoustic sheds and noise barriers (indicatively three metres high) around the construction site.

The assessment of the proposed modification includes a 'worst-case' scenario based on the proposed works within a 15 minute period, which is typically associated with works located within the nearest area of the site to a particular receiver. However, as this 'worst-case' scenario would typically occur for a short period of time only, the assessment also provides a 'typical range' noise level (in Appendix B), which is considered to be a more realistic scenario.

Construction noise levels have been predicted at all receiver locations in the vicinity of the proposed modification. A summary of these results is provided below in relation to the number of receivers which have the potential to exceed the NMLs during each activity, based on typical upper range results for the proposed modification site.

A comparative assessment of the predicted worst-case exceedances for proposed modification site against the results of the assessment for the approved project is also provided below.

Airborne noise

Table 10-12 provides a summary of the predicted airborne noise level exceedances during construction at the proposed modification site. Detailed noise modelling results are included in Appendix B.

Table 10-12 Victoria Cross Station summary of predicted airborne noise level exceedances

Activity		Number of receivers with NML exceedances		
		0-10 dB	10-20 dB	> 20 dB
Enabling works				
Clearance and diversion of services	Main activity	3	2	0
	Support works	2	2	0
Establishment of site compounds	Main activity	2	2	0
	Support works	2	2	0

Activity		Number of receivers with NML exceedances		
		0-10 dB	10-20 dB	> 20 dB
Earthworks				
Piling works	Main activity	6	0	0
	Support works	5	0	0
Construction of working platform	Main activity	6	0	0
	Support works	2	0	0
Construction of Acoustic Shed[1]				
Construction of Acoustic Shed		3	0	0
Shaft excavation[2]				
Excavation of rippable material	Main activity	0	0	0
Excavation using rockbreakers	Main activity	3	0	0
Excavation using drill and blast	Main activity	5	0	0
All activities	Support works	0	0	0
Building Construction / Fitout				
Inside acoustic shed	Activity	0	0	0
	Support works	0	0	0
Without acoustic shed	Activity	7	1	0
	Support works	6	0	0

1 *As the construction of the acoustic shed is a specific task, this scenario is addressed within one activity. In addition, as the plant and equipment are predicted to emit a similar level of noise, no "supporting works" predictions have been included for this activity.*

2 *This activity has been based on worst case predicted construction noise levels.*

A summary of the findings is presented below:

- For enabling works, NML exceedances of less than 10 dB account for approximately half of the overall impacted receiver count during this scenario with the remainder of the exceedances less than 20 dB. For this scenario, the number of receivers with predicted NML exceedances during the main activity works are not significantly reduced by the supporting works due to the similar sound power levels
- For earthworks, all NML exceedances would be less than 10 dB. NML exceedances during the piling works main activity works are not significantly reduced by the supporting works due to the similar sound power levels. NML exceedances during the construction of working platform main activity works are 4 dB higher than the supporting works
- For the construction of the acoustic shed, all NML exceedances are expected to be less than 10 dB
- For excavation of the shaft, there would be no exceedance of the NMLs at any receivers during excavation of rippable material. For excavation using rockbreakers as well as excavation using drill and blast technique, all NML exceedances would be less than 10 dB. However, almost double the amount of receivers would be impacted by drill and blast works when compared to the use of rockbreakers. Predicted noise levels for supporting works comply with NMLs at all locations for these activities, indicating that supporting works can be undertaken during out-of-hours periods for this activity without generating NML exceedances

- For construction of the services building, there would be no exceedances for any works undertaken inside the acoustic shed. For works undertaken outside the acoustic shed, the majority of NML exceedances would be less than 10 dB account, with the exception of one receiver predicted to have exceedances in the range of 10-20 dB. The number of receivers with predicted NML exceedances during the main activity are reduced slightly during the supporting works and the NML exceedance greater than 10 dB would be eliminated

Table 10-13 provides a summary comparison of predicted worst-case airborne noise level exceedances for the proposed modification site in comparison to the approved project. This assessment is based on a comparison of exceedance categories for each construction activity as opposed to the number of receivers within each exceedance category. As outlined above, this comparative assessment is based on the worst-case predictions for both sites as opposed to the upper level predictions as presented above.

Table 10-13 Victoria Cross Station comparison of predicted airborne noise level exceedances with the approved project

Activity	Receiver category	NML (Day)	NML exceedance category[1]	
			Approved project	Proposed modification
Enabling Works	Commercial	70	3	1
	Residential	75	2	0
	Educational	55	3	2
	Place of Worship	55	-	0
	Theatre/Recording Studio	45	3	1
Earthworks	Commercial	70	2	2
	Residential	75	2	1
	Educational	55	3	2
	Place of Worship	55	-	0
	Theatre/Recording Studio	45	3	1
Construction of Acoustic Shed	Commercial	70	1	1
	Residential	75	0	1
	Educational	55	2	2
	Place of Worship	55	-	0
	Theatre/Recording Studio	45	3	1
Excavation	Commercial	70	0	0
	Residential	75	1	0
	Educational	55	1	1
	Place of Worship	55	-	0
	Theatre/Recording Studio	45	3	0

Activity	Receiver category	NML (Day)	NML exceedance category[1]	
			Approved project	Proposed modification
Building Construction / Fitout	Commercial	70	2	1
	Residential	75	1	1
	Educational	55	2	2
	Place of Worship	55	–	1
	Theatre/Recording Studio	45	3	1

1 *NML exceedance categories: 0 = NML compliance, 1 = NML exceedance of less than 10dB, 2 = NML exceedance between 10dB and 20dB, 3 = NML exceedance of more than 20dB*

The results presented above show that construction at this site would result in lower level exceedances of NMLs for airborne noise when compared to the approved project site. Key results are as follows

- No predicted exceedances of airborne NMLs greater than 20 dBA for the proposed modification compared with exceedances for the approved project during the enabling works and earthworks phases for nearby educational and commercial receivers, and at the recording studio / theatre within the grounds of the Monte Sant' Angelo Mercy College site. For the approved project greater than 20 dBA exceedances for the recording studio would persist for all remaining phases of construction
- Predicted exceedances of NMLs for the proposed modification of between 10 dBA and 20 dBA for adjacent educational receivers during the enabling works, earthworks and building construction / fit out phases.
- Predicted exceedances of NMLs for the proposed modification of between 10 dBA and 20 dBA for adjacent commercial receivers during the earthworks phase
- Predicted exceedances of NMLs of less than 10 dBA for nearby residential receivers during all earthworks, acoustic shed construction and building construction / fit out phases. This is compared with exceedances of between 10 dBA and 20 dBA for nearby residential receivers during the enabling works and earthworks phases for the approved project and exceedances of less than 10 dBA during the excavation and building construction / fit out phases.

Ground-borne noise

Table 10-14 provides a summary of the predicted ground-borne noise level exceedances at potentially impacted receivers in relation to shaft excavation works at the proposed modification site. These results are based on predicted worst-case levels.

No other activities are expected to have the potential to result in ground-borne noise impacts.

Table 10-14 Victoria Cross Station predicted ground-borne noise level exceedance in relation to shaft excavation works

Receiver area	Type	Shortest distance to vibration intensive works (m)	NML				Ground-borne noise[1]		NML exceedance[1]							
			Day	DOOH	EVE	Night	L_{Aeq}(15min) (dBA)		Day		DOOH		EVE		NIGHT	
							A	B	A	B	A	B	A	B	A	B
A	RES	5	45	45	40	35	37	75	0	30	0	30	0	n/a	2	n/a
B	COM	14	50	50	n/a	n/a	28	65	0	15	0	15	n/a	n/a	n/a	n/a
C	RES	20	45	45	40	35	25	60	0	15	0	15	0	n/a	0	n/a
D	Res															
E	EDU	35	45	n/a	n/a	n/a	19	50	0	5	n/a	n/a	n/a	n/a	n/a	n/a

1 *Activities relate to the following: A. Rock drilling with non-percussive rock drill, B. Excavation and trimming with rockbreaker*

A summary of the results is outlined below:

- Works requiring the use of rock-drilling do not generate ground-borne noise exceedances at the most potentially affected receivers during any day-time or evening period, with only minor ground-borne noise exceedances of up to 2 dB at the most potentially affected residential receiver in NCA A during the night-time period. Therefore excavation activities using non-percussive rock drills could operate 24/7 without generating ground-borne NML exceedances, subject to verification of the ground-borne noise predictions
- Worst-case ground-borne noise levels associated with the use of medium rockbreakers are predicted to exceed the NMLs at the closest commercial building by 15 dB and residential receivers by 15 to 30 dB. This is due to the close proximity of the building to the works
- Commercial and residential receivers located in NCAs B and C respectively are predicted to exceed the NMLs by up to 15 dB during the use of medium rockbreakers
- Educational receivers located in NCA E are predicted to exceed the NMLs by up to 5 dB during the use of medium rockbreakers
- Internal ground-borne noise levels in excess of 60 dBA would be highly intrusive for building occupants and should therefore be mitigated as far as reasonable and feasible.

Table 10-15 provides a summary comparison of predicted worst-case ground-borne noise level exceedances (as a result of excavation activities) for the proposed modification in comparison to the approved project.

Table 10-15 Victoria Cross Station comparison of predicted ground-borne noise level exceedances with the approved project

Activity	Receiver category	NML exceedance category[1]	
		Approved project	Proposed modification
All Works Activities	Commercial	- (3)[2]	3
	Residential	- (3)[2]	3
	Educational	- (3)[2]	2
	Theatre/Recording Studio	3	0

1 *NML exceedance categories: 0 = NML compliance, 1 = NML exceedance of less than 10dB, 2 = NML exceedance between 10dB and 20dB, 3 = NML exceedance of more than 20dB*

2 *Results not presented in the Environmental Impact Statement are denoted with a '-'. Results presented in (parentheses) represent assumed noise level exceedance categories based on the assumptions presented in the Environmental Impact Statement.*

The comparison presented above shows that ground borne noise levels are predicted to exceed NMLs by more than 20 dBA at adjacent commercial and residential receivers and by between 10 dBA and 20 dBA at adjacent educational receivers, with no predicted exceedances for the recording studio / theatre receiver category. In contrast, for the approved project there are predicted exceedances of more than 20 dBA for all receiver categories.

Ground-borne vibration

The assessment for the approved project identified that during excavation of the shaft associated with the services building, vibration levels were anticipated to exceed the cosmetic damage vibration screening criteria for the three buildings immediately adjacent to the site.

During construction of the proposed modification, vibration levels are expected to exceed the cosmetic damage vibration screening criteria for one commercial building immediately adjacent to the site (in NCA B) during construction of the shaft using a medium rockbreaker. This is the local heritage item ("Shop") identified in Chapter 3 – Modification development and alternatives and in Chapter 12 (Non-Aboriginal heritage). This would be a reduced impact from what was assessed as part of the approved project, with fewer receivers potentially impacted.

Consistent with the management approach identified for the approved project, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for this structure.

Construction traffic noise

The predicted L_{Aeq} increase and sleep disturbance noise levels have been assessed for the access routes to the site and are presented in Table 10-16.

Traffic noise levels have been predicted for residential receivers located on the proposed access route to the proposed modification site. In this instance, the access to the site is via McLaren Street and Miller Street which are sub-arterial roads with significant daytime flows. The RNP base criteria, predicted L_{Aeq}(15hr) daytime and L_{Aeq}(9hr) night-time noise levels with the development, and the L_{Aeq} increase and sleep disturbance noise levels have been assessed in Table 10-16.

On McLaren Street and Miller Street the base criteria is expected to be exceeded and the predicted noise level increase (L_{Aeq}) of night time criteria associated with construction traffic is expected to be greater than 2 dB. While the levels above the 2 dB allowance are small, sensitive receivers may notice an increase in the average road traffic noise levels during construction. This would be an increase on what was assessed for the approved project, however given the minimal exceedance above the 2 dB allowance (up to 2.5 dB on McLaren Street), the impact is not expected to be significant. A similar outcome is expected for Walker Street.

There are expected to be up to 24 heavy vehicle and 10 light vehicle movements or events per hour during the night (in contrast with 6 heavy vehicle and no light vehicle movements at the northern site for the approved project) and while there is an exceedance of the sleep disturbance screening criterion (of up to 13 dB) and external sleep disturbance NML of 65 dBA (by up to 14 dB), the L_{Amax} levels would be similar to other heavy vehicles using McLaren Street and Miller Street.

Opportunities to minimise noise from heavy vehicles while on site, such as consideration of site layouts and screening, would be considered during detailed construction site planning. Where compliance with the road traffic noise criteria cannot be achieved on Walker Street, an alternative route for night time heavy vehicle movements would be investigated.

Table 10-16 Victoria Cross Station road traffic noise

Road	Base criteria (dB) day / night (L_{Aeq}(15hr/9hr))	Predicted road traffic noise (dB) day / night	Predicted road traffic noise increase (dB) day / night	RBL + 15 dB screening criterion (dBA)	External L_{Amax} NML level (dBA)	Predicted L_{Amax} noise level (dBA)
McLaren Street	60 / 55	62 / 64	0.8 / 2.5	66	65	79
Miller Street	60 / 55	62 / 64	0.4 / 2.2	66	65	79

Operational noise

In accordance with the approved project, the approach to assessment of noise from services at station and ancillary facilities is to calculate the maximum acceptable sound power level at each location based on the location of the proposed facility and the location of the nearest receivers. These maximum acceptable sound power levels would be used to guide the detailed design to ensure compliance with the applicable criteria from the *Industrial Noise Policy* (EPA, 2000).

The design of station mechanical and electrical services for the proposed modification site is yet to be finalised and plant and equipment selection is subject to change. Notwithstanding this, a maximum allowable mechanical and electrical services sound power level of 80 dBA has been calculated for the purpose of detailed design of the proposed modification site.

The nearest receiver type and relevant external noise criteria for the proposed modification site is the same as that assessed for the approved project in relation to the norther services building, as outlined in Table 10-17. It is expected that these levels can be achieved through the use of appropriate noise attenuation measures such as equipment selection, positioning of plant and ventilation discharges, in-duct attenuators, and acoustic enclosures.

Table 10-17 Victoria Cross Station external noise criteria applicable to the proposed modification

Nearest receiver type	External noise criteria (dBA)
Residential	56
Commercial	65

10.3.4 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The proposed modification would also be constructed and operated in accordance with relevant conditions of approval including:

- Condition C3 – Construction Noise and Vibration Sub Plan
- Condition C11 – Noise and Vibration and Blast Monitoring Plan
- Condition D3 – Operational Management Plan Noise and Vibration Sub Plan
- Conditions E28 to E31 – Vibration
- Conditions E32 to E35 – Construction Noise and Vibration Strategy

- Condition E36 – Standard construction hours
- Conditions E37 to E40 – Respite for receivers
- Condition E41 – Mitigation – Non residential zones
- Condition E42 – Mitigation – Residential receivers in residential zones
- Condition E43 – Workplace health and safety for nearby workers
- Conditions E44 to E46 – Variation to standard construction hours
- Condition E47 – Out of Hours Work Protocol
- Conditions E48 and E49 – 24 Hour Construction
- Conditions E50 to E56 – Blast management

The construction and operational noise and vibration assessment did not identify any new mitigation measures required in relation to the proposed modification.

10.4 Artarmon substation

10.4.1 Existing environment

The local noise and vibration environment around the Artarmon substation site was described in the assessment for the approved project. This remains applicable to the Artarmon substation component of the proposed modification. This section provides further details relevant to the proposed modification.

Noise catchment areas

The study area for the Artarmon substation component of the proposed modification has been divided into multiple NCAs as shown in Figure 10-2. These NCAs reflect the changing land uses and ambient noise environments adjacent to the site, and extends approximately 200 metres from the site. The NCAs are labelled alphanumerically for reference and are presented in Table 10-18.

Figure 10-3 Noise catchment areas – Artarmon substation

Table 10-18 Artarmon sustation summary of noise catchment areas (NCAs)

NCA	Receiver specification	Approximate distance to substation site1
A	Residential	146
B	Residential	300
C	Residential	151
C	Educational	270
D	Commercial	<5
D	Child Care	175
D	Industrial	219

Ambient noise surveys and monitoring locations

The dominant noise sources that are likely to influence background noise levels at the site and surrounds include:

- Road traffic noise
- Industrial activities occurring within the Artarmon industrial area.

In order to characterise the existing ambient noise environment across the proposed modification area to establish ambient noise levels on which to base the construction NMLs, environmental noise monitoring was carried out at a representative location during September 2015.

The location of unattended and attended noise survey (monitoring location B.21) is shown in Figure 10-3. The results of the unattended noise survey are summarised in Table 10-19.

Table 10-19 Artarmon substation summary of unattended noise monitoring results

	Noise Level (dBA)[1]					
	Daytime 7 am to 6 pm		Evening 6 pm to 10 pm		Night-time 10 pm to 7 am	
Location ID	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
B.21	49	55	46	50	41	48

1 The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the INP.

10.4.2 Site-specific assessment criteria

Construction noise management levels

Table 10-20 summarises the NMLs which are relevant for each NCA and receiver types for the proposed modification based on the relevant assessment criteria outlined in section 10.2.

Table 10-20 NMLs for the Artarmon substation component of the proposed modification

NCA	Receiver Type	Relevant monitoring location	Standard Construction (RBL + 10dB)	Out of Hours (RBL + 5dBA)1			Sleep Disturbance screening (RBL + 15)
			Daytime	Daytime	Evening	Night	
A	Residential	B.21	59	54	51	46	56
B	Residential	B.21	59	54	51	46	56
C	Residential	B.21	59	54	51	46	56
C	Other sensitive – Educational	n/a	55	n/a	n/a	n/a	n/a
C	Commercial	n/a	70	70	n/a	n/a	n/a
D	Other sensitive – Child Care	n/a	50	n/a	n/a	n/a	n/a
D	Industrial	n/a	75	75	n/a	n/a	n/a

1 *Out of hours construction hours: Evening hours are 6-10pm, night time hours are 10pm-7am Sunday to Saturday and 10pm Saturday to 8am Sunday.*

Operational noise goals

Noise emissions from mechanical and electrical services are normally of a continuous nature and do not change unless operational conditions vary. As a result of the general reduction in existing ambient noise levels during the latter periods of the day, the night-time INP intrusive noise criteria are in general the most stringent for residential receivers and are therefore the controlling design criteria at most residential locations.

The locations of sensitive receivers and their corresponding industrial noise criteria, determined using the procedures defined within the INP are presented in Table 10-21.

Table 10-21 Artarmon substation operational noise criteria for sensitive receivers

Receiver Area	Type	Address	Distance to nearest boundary or facade (metres)	Reference[1]	External noise criteria (dBA)[2]
A	RES	23 Barton Road, Artarmon	145	B.21	45
B	RES	110 Reserve Road, Artarmon	280	B.21	45
C	RES	15 Barton Road, Artarmon	140	B.21	45
C	OED	Artarmon Public School	270	n/a	45
D	COM	96 Reserve Road, Artarmon	2	n/a	65

1 *The reference location refers to the nearest unattended noise logging location (where applicable).*

2 *The night-time intrusive noise criteria are adopted for the design criteria presented in this table. The criteria for commercial and educational premises are absolute levels and are not relative to existing background noise levels in accordance INP.*

10.4.3 Potential impacts

Consistent with the approach adopted for the assessment of the approved project, the noise modelling results presented below assumes standard attenuation acoustic sheds and noise barriers (indicatively three metre high hoarding) around the construction site.

The assessment of the proposed modification includes a 'worst-case' scenario based on the proposed works within a 15 minute period, which is typically associated with works located within the nearest area of the site to a particular receiver. However, as this 'worst-case' scenario would typically occur for a short period of time only, the assessment also provides a 'typical range' of results (in Appendix A), the upper level of which is considered to be a more realistic scenario.

Construction noise levels have been predicted at all receiver locations in the vicinity of the proposed modification. A summary of these results is provided below in relation to the number of receivers which have the potential to exceed the NMLs during each activity, based on typical upper range results for the proposed modification site.

A comparative assessment of the predicted worst-case exceedances for the proposed modification site against assessment results for the approved project is also provided below.

Airborne noise

Table 10-22 provides a summary of the predicted airborne noise level exceedances during construction at the proposed modification site. Detailed noise modelling results are included in Appendix B.

Table 10-22 Artarmon susbstation summary of predicted airborne noise level exceedances

Activity		Number of receivers with NML exceedances		
		0-10 dB	10-20 dB	> 20 dB
Enabling works				
Vegetation clearing	Main activity	37	3	0
	Support works	3	0	0
Demolition of acquisition buildings and other structures	Main activity	40	3	2
	Support works	2	0	0
Clearance and diversion of services	Main activity	2	0	0
	Support works	2	0	0
Establishment of site compounds	Main activity	2	0	0
	Support works	2	0	0
Earthworks				
Piling works	Main activity	3	2	0
	Support works	3	2	0
Construction of working platform	Main activity	3	2	0
	Support works	2	0	0

Activity		Number of receivers with NML exceedances		
		0-10 dB	10-20 dB	> 20 dB
Shaft excavation[2]				
Excavation of rippable material	Main activity	7	2	0
	Support works	3	0	0
Excavation using rockbreakers	Main activity	40	3	2
	Support works	4	0	0
Building Construction / Fitout				
Construction of new buildings and fitout	Activity	13	2	0
	Support works	3	2	0

1 *As the construction of the acoustic shed is a specific task, this scenario is addressed within one activity. In addition, as the plant and equipment are predicted to emit a similar level of noise, no "supporting works" predictions have been included for this activity.*

2 *This activity has been based on worst case predicted construction noise levels.*

A summary of the findings is presented below:

- For enabling works, minor worst-case NML exceedances of less than 10 dB are predicted at the most potentially affected surrounding residential, educational, and child care receivers. This is mostly attributed to vegetation clearing (if required) and demolition works at the site. The use of highly noise intensive construction plant (rockbreakers) results in worst-case NML exceedances of greater than 20 dB at the closest two commercial receivers which are located immediately adjacent the site. When only supporting activities are performed, there would not be a significant reduction in construction noise levels compared with the main works activities
- For earthworks, worst-case NML exceedances of between 10 dB and 20 dB are predicted at two commercial receivers located immediately adjacent the site. Lower impacts are predicted for three other commercial receivers located within close proximity to the site. No change in impacts is expected as a result of supporting activities for piling works due to similar sound power levels of these activities. When support activities only are undertaken for construction of the working platform, noise levels are expected to decrease marginally by up to 5 dB
- For excavation of the shaft, there would be some minor exceedance of the NMLs at seven receivers during excavation of rippable material, and exceedances of between 10-20 dB at two receivers during main activity works. When support activities only are undertaken, noise levels are expected to decrease marginally. For excavation using rockbreakers, the majority of NML exceedances would be less than 10 dB, however worst-case NML exceedances of greater than 20 dB would occur at the closest two commercial receivers which are located immediately adjacent the site. Predicted noise levels would be significantly reduced during supporting works with no NML exceedance of greater than 10 dB
- For construction of the substation building and fit out, the majority of worst-case NML exceedances would be less than 10 dB at the most potentially affected surrounding receivers. Worst-case NML exceedances of between 10 dB and 20 dB are expected at the two commercial buildings located immediately adjacent the site. This would be significantly reduced during support activities only, with the exception of the two commercial receivers immediately adjacent to the site for which worst-case NML exceedances of between 10 dB and 20 dB are expected to remain.

Table 10-23 provides a summary comparison of predicted worst-case airborne noise level exceedances for the proposed modification site in comparison to the approved project. This assessment is based on a comparison of exceedance categories for each construction activity as opposed to the number of receivers within each exceedance category. As outlined above, this comparative assessment is based on the worst-case predictions for both sites as opposed to the upper level predictions as presented above.

Table 10-23 Artarmon substation comparison of predicted airborne noise level exceedances with the approved project

Activity	Receiver category	NML (Day)	NML exceedance category[1]	
			Approved project	Proposed modification
Enabling Works	Residential	59	3	1
	Commercial	70	1	3
	Educational[2]	55	(2)	1
	Child care[2]	50	(0)	1
Earthworks	Residential	59	3	0
	Commercial	70	1	2
	Educational[2]	55	(1)	0
	Child care[2]	50	(0)	0
Excavation	Residential	59	3	1
	Commercial	70	1	3
	Educational[2]	55	(1)	1
	Child care[2]	50	(0)	1
Building Construction / Fitout	Residential	59	2	1
	Commercial	70	0	2
	Educational[2]	55	(1)	0
	Child care[2]	50	(0)	1

1 *NML exceedance categories: 0 = NML compliance, 1 = NML exceedance of less than 10dB, 2 = NML exceedance between 10dB and 20dB, 3 = NML exceedance of more than 20dB*

2 *Construction noise impacts for childcare and educational receivers were not presented in the EIS. The results are denoted in parentheses and represent assumed noise level exceedance categories based on the assumptions presented in the EIS.*

The results presented above show that construction at the proposed modification site would generally result in a reduction of NML exceedances for airborne noise levels, in particular in relation to residential receivers when compared to the approved project site. Impacts to commercial receivers would increase due to the proximity of the site to adjacent commercial receivers. Key results are summarised below:

- Increased NML exceedances at commercial receivers, ranging from between 10dB and 20dB during earthworks and building construction and fitout and greater than 20dB during noisier activities associated with enabling works and excavation
- Reduced NML exceedances of between 10dB and 20dB at residential and educational receivers during all activities, with NML compliance achieved during earthworks and in the case of educational receivers also during building construction and fitout
- NML exceedances of less than 10dB at child care receiver during most activities, with the exception of earthworks during which no NML exceedance is expected.

Ground-borne noise

Table 10-24 provides a summary of predicted worst-case ground-borne noise level exceedances (as a result of excavation activities) for the proposed modification in comparison to the approved project. The activities expected to result in ground-borne noise impacts are:

- Enabling works – the most vibration intensive plant associated with this work method would include medium rockbreakers associated with the demolition of existing structures and the hammering of slab and/or footing elements of the existing structures.
- Earthworks –piling activity has been assessed for the worst case scenario construction scenario during this activity
- Excavation – the most vibration intensive plant associated with this work method would include medium rockbreakers associated with excavation of the shaft.

Table 10-24 Artarmon substation comparison of predicted ground-borne noise level exceedances with the approved project

Receiver	Receiver category	NML exceedance category[1]	
		Approved project	Proposed modification
Enabling works			
A	RES	0	0
B	RES	1	0
C	RES	0	0
C	OED	0	0
D	COM	0	3
D	OCC	0	0
D	IND	0	0
Earthworks			
A	RES	0	0
B	RES	0	0
C	RES	0	0
C	OED	0	0
D	COM	0	1
D	OCC	0	0
D	IND	0	0
Excavation			
A	RES	0	0
B	RES	1	0
C	RES	0	0
C	OED	0	0
D	COM	0	3
D	OCC	0	0
D	IND	0	0

1 *NML exceedance categories: 0 = NML compliance, 1 = NML exceedance of less than 10dB, 2 = NML exceedance between 10dB and 20dB, 3 = NML exceedance of more than 20dB*

2 *Results presented in (parentheses) represent assumed noise level exceedance categories based on the assumptions presented in the Environmental Impact Statement.*

A summary of the results is outlined below:

- Worst-case ground-borne noise levels associated with the use of medium rockbreakers are predicted to exceed the NMLs at the closest commercial receiver building by over 20 dB. These impacts would be restricted to the buildings closest to the site due to their proximity. Construction ground-borne noise impacts associated with enabling works at residential receivers would be eliminated as a result of the proposed modification location when compared to the project site
- Worst-case ground-borne noise levels associated with earthworks are expected to comply with most NMLs at nearby receivers, with the exception of the adjacent commercial receivers where minor exceedances of the internal ground-borne NMLS of less than 10 dB are predicted
- Similar to the use of rockbreakers during the enabling works, worst-case ground-borne noise levels associated with the use of medium rockbreakers are predicted to exceed the NMLs at the closest commercial receiver building by over 20 dB due to proximity to the site. Construction ground-borne noise impacts associated with enabling works at residential receivers would be eliminated by the proposed modification when compared to the approved project site.

Ground-borne vibration

The assessment for the approved project identified that during rock breaker activities at the approved site, vibration levels would potentially be perceptible at the nearest residential receivers adjacent to the site, however as the nearest buildings are around 25 metres from the approved shaft location, vibration levels were anticipated to remain below the vibration screening levels associated with minor cosmetic building damage.

During construction of the proposed modification, vibration levels are expected to exceed the cosmetic damage vibration screening criteria for one commercial building immediately adjacent to the site (in NCA D) during construction of the shaft using a medium rockbreaker. This would be an increased impact from what was assessed as part of the approved project, with one receiver potentially impacted as opposed to none.

Consistent with the management approach identified for the approved project, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for this structure.

Construction traffic noise

The construction road traffic access and egress routes for the relocated site do not traverse any residential receiver areas between the arterial road source (Pacific Highway) and the proposed site. A quantitative road traffic noise impact assessment is therefore not presented in this assessment for residential receivers.

One child care receiver in NCA D is located adjacent to the proposed construction traffic access route at address 41 Dickson Avenue, Artarmon. There is potential for construction traffic noise to impact this child care receiver and as such, a quantitative construction road traffic noise impact assessment should be undertaken during the detailed design stage of the project when construction traffic volumes, existing traffic volumes and percentage of heavy vehicles, and the child care receiver building facade noise performance are confirmed.

Operational noise

In accordance with the approved project, the approach to assessment of noise from services at station and ancillary facilities is to calculate the maximum acceptable sound power level at each location based on the location of the proposed facility and the location of the nearest receivers. These maximum acceptable sound power levels would be used to guide the detailed design to ensure compliance with the applicable criteria from the *Industrial Noise Policy* (EPA, 2000).

The design of station mechanical and electrical services for the proposed modification site is yet to be finalised and plant and equipment selection is subject to change. Notwithstanding this, a maximum allowable mechanical and electrical services sound power level of 69 dBA has been calculated for the purpose of detailed design of the proposed modification site.

The nearest receiver type and relevant external noise criteria for the proposed modification site has changed to that assessed for the approved project, with the nearest receivers being adjacent commercial receivers as opposed to residential receivers. The associated external noise criteria are outlined in Table 10-25. It is expected that these levels can be achieved through the use of appropriate noise attenuation measures such as equipment selection, in-duct attenuators, acoustic enclosures and the strategic positioning of critical plant and vent discharges away from sensitive receivers.

Table 10-25 Artarmon substation external noise criteria applicable to the proposed modification

Nearest receiver type	External noise criteria (dBA)
Commercial	65

10.4.4 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The proposed modification would also be constructed and operated in accordance with relevant conditions of approval including:

- Condition C3 – Construction Noise and Vibration Sub Plan
- Condition C11 – Noise and Vibration and Blast Monitoring Plan
- Condition D3 – Operational Management Plan Noise and Vibration Sub Plan
- Conditions E28 to E31 – Vibration
- Conditions E32 to E35 – Construction Noise and Vibration Strategy
- Condition E36 – Standard construction hours
- Conditions E37 to E40 – Respite for receivers
- Condition E41 – Mitigation – Trigger levels for additional mitigation measures for residential receivers in non-residential zones
- Condition E42 – Mitigation – Residential receivers in residential zones
- Condition E43 – Maximum noise level for workplace health and safety of nearby workers.
- Conditions E44 to E46 – Variation to standard construction hours
- Condition E47 – Out of Hours Work Protocol
- Conditions E48 and E49 – 24 Hour Construction
- Conditions E50 to E56 – Blast management

The construction and operational noise and vibration assessment did not identify any new mitigation measures required in relation to the proposed modification.

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LAND USE AND PROPERTY

CHAPTER ELEVEN

11 Land use and property

This chapter provides an assessment of the potential changes to land use and property impacts as a result of the construction and operation of the proposed modifications and identifies any changes to mitigation measures to minimise these impacts.

11.1 Victoria Cross Station

11.1.1 Existing environment

The existing land use and property environment in and around Victoria Cross Station was described in the assessment for the approved project. This section provides further details specific to the proposed modification.

Land use

The proposed modification would be located to the northeast of the approved Victoria Cross Station northern services building location. The proposed location of the northern station entry and services building would be on the corner of McLaren and Miller streets. The site is located within a mixed-use precinct to the north of the North Sydney commercial core comprising commercial, health, residential, community facilities and educational institutions. The site itself is currently a vacant lot, although Development Consent has been granted for development of an aged care facility. North Sydney Town Hall and Civic Park is located to the west of the site on Miller Street. Wenona School is located to the north and north-east of the site.

Land use surrounding the site is shown in Figure 11-1.

Planning controls

The *North Sydney Local Environmental Plan 2013* (North Sydney LEP 2013) defines the land use zoning relevant to the proposed modification as B4 Mixed Use. The aim of this zone is to provide a mixture of compatible land uses to integrate suitable business, office, residential, retail and other development in accessible locations to maximise public transport patronage and encourage walking and cycling. Clause 6.4 of the North Sydney LEP 2013 prescribes a 12 metre setback from Miller Street at the proposed modification site.

The *North Sydney Development Control Plan 2013* (North Sydney DCP 2013) is also relevant to the proposed modification site. Part C, Section 2 of the North Sydney DCP 2013 addresses setbacks to McLaren Street and provides that the setback of new buildings or alterations and additions to existing buildings on land fronting McLaren Street between Miller and Walker streets are to match that existing to protect the existing fig trees.

KEY

- Chatswood to Sydenham
- Proposed construction site area
- Proposed operational area at surface
- Proposed station platforms

Land use

- High density residential
- Low to medium density residential
- High density commercial
- Educational establishment
- Community facility
- Recreation
- Public Administration
- Transportation and infrastructure
- Mixed use

Indicative only, subject to design development

0 100 m

N

Figure 11-1 Victoria Cross Station modification – existing land use

11.1.2 Potential impacts

Property

The Victoria Cross Station component of the proposed modification would require the acquisition of two additional properties over and above that identified for the approved project, located at 50 and 52 McLaren Street. The combined land area required for acquisition is 4,180 square metres, comprising 1,080 square metres at 50 McLaren Street and 3,100 square metres at 52 McLaren Street. Both properties are zoned for mixed use and are currently vacant. The sites are subject to a current planning approval for the development of an aged care facility.

The site at 50 McLaren Street is proposed as the permanent location of the northern station entry and services building, while the adjacent site at 52 McLaren Street is proposed to be used as an ancillary construction site to provide site access, amenities, offices and stockpiling facilities. Therefore the site at 52 McLaren Street is unlikely to be required during operation of the metro system. On completion of construction works, 52 McLaren Street and the airspace above the services building may be used for future redevelopment in line with Council's Capacity Study (subject to separate planning approval).

While the acquisition of mixed use land at 194 and 196A Miller Street has already occurred, demolition of the buildings on these sites would no longer be required subject to approval of this modification. Transport for NSW will consider divestment or development of these sites separate from the approved project.

As described for the approved project, all property acquisition would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*. Every effort would be made to acquire the affected property through negotiated purchase. The changes made to the land acquisition process as a result of the Russell Review would be implemented.

Land use

The approved project includes a change in the use of the land at 194 and196A Miller Street from commercial to infrastructure due to the construction of the northern station services building on the site. With the relocation of the services facility to 50 McLaren Street, this change in the use of the land would no longer be required.

The proposed modification would result in a change in land use at 50 and 52 McLaren Street from the existing vacant land (and approved aged care facility) to infrastructure.

Given the small scale of the change, the land use impacts would be minor and consistent with the approved project. Additionally there is potential for the existing mixed use zoning to be realised again in the future following potential future over station development (subject to separate approval). As the proposed construction site is currently vacant, no existing facilities or businesses would be required to be relocated or impacted by the proposed modification works.

The proposed inclusion of an additional northern station entry for Victoria Cross Station would further support State and local strategic priorities and planning controls by increasing the pedestrian catchment of the station and improving connectivity to employment, residential properties, services, cultural and recreational activities. The proposed northern station entry would provide more direct access to Mater Hospital, North Sydney Oval, North Sydney Boys High School North Sydney Girls High School, Marist College North Shore, North Sydney Demonstration School, St Mary's Primary School, and to mixed use and residential precincts on the periphery of the North Sydney commercial core.

11.1.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

No additional mitigation measures are required for the Victoria Cross Station component of the proposed modification.

11.2 Artarmon substation

11.2.1 Existing environment

Land use

The site of the Artarmon substation component of the proposed modification is located within the Artarmon industrial area, with surrounding development predominantly industrial in character. Opposite the site, on the eastern side of Reserve Road, is the Freeway Hotel (food, beverage and entertainment uses).

The Artarmon industrial area forms part of the approximately 94 hectares of industrial zoned land in the Willoughby Local Government Area that provide a range of activities from traditional uses such as manufacturing, warehouses and concrete batching plants to high technology developments.

Land use surrounding the site is shown in Figure 11-2.

Planning controls

The *Willoughby Local Environmental Plan 2012* (Willoughby LEP 2012) defines the land use zoning relevant to the proposed modification as IN1 General Industrial. The objectives of this zone are:

- To provide a wide range of industrial and warehouse land uses
- To encourage employment opportunities
- To minimise any adverse effect of industry on other land uses
- To support and protect industrial land for industrial uses
- To identify and preserve industrial land to meet the current and future general industrial needs of Willoughby and the wider region
- To accommodate industrial development that provides employment and a range of goods and services without adversely affecting the amenity, health or safety of residents in adjacent areas
- To permit land uses that serve the daily convenience needs of workers employed in the industrial area
- To protect the viability of business zones in Willoughby by enabling development for the purpose of offices if they are ancillary to, and used in conjunction with, industrial, manufacturing, warehousing or other permitted uses on the same land
- To improve the environmental quality of Willoughby by ensuring that land uses conform to land, air and water quality pollution standards and environmental and hazard reduction guidelines
- To accommodate uses that, because of demonstrated special building or site requirements or operational characteristics, cannot be, or are inappropriate to be, located in other zones.

The assessment of potential impacts of the proposed Artarmon substation modification has occurred in the context of these objectives.

Figure 11-2 Artarmon substation modification – existing land use

11.2.2 Potential impacts

Property

The Artarmon component of the proposed modification would require the acquisition of one additional property from that identified for the approved project, located at 98-104 Reserve Road (Lot 1 DP605751) with an area of 1,055 square metres. This contrasts with three parcels (with a combined area of 3,164 square metres) required at the approved project site. The property required for the modification is zoned for general industrial and is currently occupied by two businesses (motorcycle sales / service and car repair / detailing).

With the proposed modification, acquisition of the site at Butchers Lane would no longer be required.

Land use

The approved project includes a change in the use of the land at Butchers Lane from land zoned for medium density residential (but which is being used for educational purposes) to infrastructure. With the relocation of the substation to the Artarmon industrial area, this change in the land use would no longer be required. Therefore this land would be available to be maintained for its current use or developed in the future based on the relevant zoning provisions.

The proposed modification would result in a change in land use at 98-104 Reserve Road from industrial purposes (motorcycle sales / service and car repair / detailing) to infrastructure. While there would be a small reduction in the supply of land available for industrial purposes, there are currently other areas of industrial land locally and a change from its current use to use for a substation would have a minor land use impact. Additionally, this location in terms of its industrial setting would be more suitable for the development of a substation site than the residential location identified for the approved project. This would have benefits to the local community in terms of reducing potential impacts on surrounding residential receivers.

11.2.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

No additional mitigation measures are required for the Artarmon substation component of the proposed modification.

NON-ABORIGINAL HERITAGE

CHAPTER TWELVE

12 Non-Aboriginal heritage

This chapter provides an assessment of the potential changes to impact on non-Aboriginal heritage items and archaeological remains as a result of the proposed modifications, and identifies any changes to mitigation measures to address these impacts.

12.1 Assessment methodology

The assessment of non-Aboriginal heritage in relation to the proposed modifications is the same as the methodology used in the assessment for the approved project as summarised below.

12.1.1 Study area

Consistent with the approach used for the assessment of the approved project, the study area includes the site that would be directly impacted by the proposed modifications, plus a buffer zone of 25 metres. The study area also incorporates the construction sites and underground works. The application of a buffer helps to identify heritage items that may be within the visual catchment of the project and where potential visual impacts on that item may occur. It also supports assessment of other potential indirect impacts on heritage fabric of heritage items that may be in the vicinity of the site (eg as a result of vibration). Any reference to the study area in this chapter includes reference to the 25 metre buffer, unless otherwise stated.

12.1.2 Identification, significance and assessment of heritage items

Identification of heritage items

This chapter considers potential changes to impacts of the proposed modifications on:

- Heritage listed items – buildings or other structures, places, items, areas or cultural landscapes that are located aboveground
- Archaeological heritage – significant physical remains of the past, including relics and artefacts that are located underground.

Heritage listed items within the study area have been identified through a search of various heritage registers. These listed heritage items have been previously assessed against the NSW Heritage Office guideline *Assessing Heritage Significance* (2001). Statements of heritage significance identified in this chapter are consistent with those included in relevant heritage inventory sheets and are based on the 2001 guideline.

Historic archaeological potential is defined as the potential of a site to contain historical archaeological relics, as classified under the *NSW Heritage Act 1977*. Preliminary assessment of the archaeological potential was considered based on a review of several historical archaeological investigations within or close to the study area. This provides evidence that helps to evaluate the potential historical archaeological resource of the study area.

Significance of heritage items

Determining the significance of heritage items or a potential archaeological resource generally follows the evaluation criteria set out in the NSW Heritage Office guideline *Assessing Heritage Significance* (2001). The level of heritage significance in relation to a place, building, work, relic, moveable object or precinct, can be considered to be at a local or State level of significance – that is, important in a local context or in a NSW State context – if it meets one or more of the following criteria:

- Criterion (a): Historic significance
- Criterion (b): Associative significance
- Criterion (c): Aesthetic significance
- Criterion (d): Social significance
- Criterion (e): Research potential
- Criterion (f): Rarity
- Criterion (g): Representativeness.

Assessment of heritage impact

Impacts on heritage are identified as either:

- Direct impacts, resulting in the demolition or alteration of fabric of heritage significance
- Indirect impacts, resulting in changes to the setting or curtilage of heritage items or places, historic streetscapes or views
- Potential direct impact, resulting in impacts from vibration and demolition of adjoining structures.

The vibration modelling referenced in this heritage assessment considers a reasonable 'worst case' construction vibration scenario, being excavation by rock breakers at surface level. Vibration levels have been calculated at the closest façade of buildings or structures adjacent to this construction activity. Vibration impacts have also been considered with respect to demolition of structures adjacent to heritage items.

Specific terminology and corresponding definitions are used in this assessment to consistently identify the magnitude of the project's direct, indirect or potentially direct impacts on heritage items or archaeological remains. The terminology and definitions are based on those contained in guidelines produced by the International Council on Monuments and Sites (ICOMOS) and are shown in Table 12-1.

Table 12-1 Terminology for assessing the magnitude of heritage impact

Magnitude	Definition
Major	Actions that would have a long term and substantial impact on the significance of a heritage item. Actions that would remove key historic building elements, key historic landscape features, or significant archaeological materials, thereby resulting in a change of historic character, or altering of a historical resource. These actions cannot be fully mitigated.
Moderate	Actions involving the modification of a heritage, including altering the setting of a heritage item or landscape, partially removing archaeological remains, or the alteration of significant elements of fabric from historic structures. The impacts arising from such actions may be able to be partially mitigated.
Minor	Actions that would result in the slight alteration of heritage buildings, archaeological remains, or the setting of an historical item. The impacts arising from such actions can usually be mitigated.
Negligible	Actions that would result in very minor changes to heritage items.

Magnitude	Definition
Neutral	Actions that would have no heritage impact.

Vibration screening levels

A conservative vibration damage screening level of 7.5 millimetres per second peak particle velocity has been adopted for all heritage items for the approved project, and would be applicable to the proposed modifications sites. This screening level has been established with reference to the minor cosmetic damage criteria for unreinforced or light framed structures in *British Standard BS 7385:2* – 1993. The vibration levels specified in this standard are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

Archaeological assessment

The assessment of historical archaeological potential is based on the identification of former land uses and evaluating whether subsequent actions (either natural or human) may have impacted on archaeological evidence for these former land uses.

The archaeological potential is presented in terms of the likelihood of the presence of archaeological remains considering the land use history and previous impacts at the site. This is presented using the grades of archaeological potential listed in Table 12-2.

Table 12-2 Grades of archaeological potential

Magnitude	Definition
Nil	No evidence of historical development or use, or where previous impacts such as deep basement structures would have removed all archaeological potential
Low	Research indicates little or low intensity historical development, or where there have been substantial previous impacts, disturbance and truncation in locations where some archaeological remains such as deep subsurface features may survive
Moderate	Analysis demonstrates known historical development and some previous impacts, but it is likely that archaeological remains survive with some localised truncation and disturbance
High	Evidence of multiple phases of historical development and structures with minimal or localised twentieth century development impacts, and it is likely the archaeological resource would be largely intact

The potential archaeological remains are then assessed against the NSW heritage assessment criteria and identified as either being of:

- No significance
- Local significance
- State significance.

The significance assessment is informed by the NSW Heritage Division's 2009 guidelines *Assessing Significance for Historical Archaeological Sites and Relics* (the 2009 guidelines).

12.2 Victoria Cross Station

12.2.1 Historical context

A historical background assessment for the lower North Shore, and land surrounding Victoria Cross Station, was previously prepared as part of the assessment for the approved project. The following historical background assessment focuses on the Victoria Cross Station component of the proposed modification. The majority of background information within this section has been based on a previous Heritage Impact Statement for the site, prepared by Godden Mackay Logan (GML) in 2011 for Uniting Care Ageing.

Phase 1: 1788 – 1869

Land associated with the study area at 50-52 McLaren Street, North Sydney was originally occupied by small grants given to Charles William Roemer in 1840, Didier Numa Joubert in 1852 and William Tucker in 1853. It is unlikely that the men resided on their grants.

In the 1850s, the town was sold and divided into 35 additional sections. The study area is located in Lots 1 to 7, Section 10, to the south of the St Leonards township. Prior to this, land is likely to have been cleared of timber, although no development is known to have taken place.

Phase 2: 1869 – 1960

The study area remained vacant until the late-1860s, when the Charles Palmer (Secretary of the Bank of New South Wales) purchased Lots 2, 3, 4, 5, 6 and 7 and constructed his home Kedron along the northeast side of McLaren Street between Miller and Walker Streets. This was a large property that covered three acres. Kedron itself was a substantial residence, with a tennis court and large gardens. Remnants of the gardens still exist today. The study area is located in Lot 2, to the west of the residence. An 1890 Metropolitan Detail Series plan of the block between Miller, McLaren, Walker and Ridge streets does not include any structures within the study area, although unrecorded outbuildings, wells or cisterns may have occupied the area.

The property was sold to Dr Erasmus Bligh in 1930. Bligh was a descendant of Admiral John Bligh, Governor Bligh's cousin. Dr Bligh renamed the home Cobham House and the family remained on the property until 1963.

In 1895, Edward Amphlett (a former member of the Royal Navy) built his family home Clent on a smaller allotment at the corner of Miller and McLaren Streets (today's 50 McLaren Street). This was a modest residence compared to Kedron, although also relatively substantial. The 1890 plan shows various outbuildings located along its northern boundary, in line with a boundary fence. These may be outbuildings (privies, sheds), cisterns or wells.

A 1943 aerial photograph shows that each property remained intact during this period.

Phase 3: 1960 – present

Both properties remained occupied and intact until the 1960s, when developers purchased the land and demolished Clent in 1963 and Kedron 1970. The three-acre allotment originally occupied by Kedron is now occupied by Rydges North Sydney (which covers the entire footprint of the residence) and SAP Australia (which is located near the earlier tennis court).

The smaller allotment once associated with Clent is part of a former Assisted Care development. A green space replaced the site of the earlier dwelling when the Assisted Care home was established. This property was purchased by the Methodist Church (NSW) Property Trust in 1976, now the Uniting Church in Australia Property Trust (NSW). The facility was demolished in 2016 and remains unoccupied as of March 2017.

12.2.2 Identification of heritage items and assessments of significance

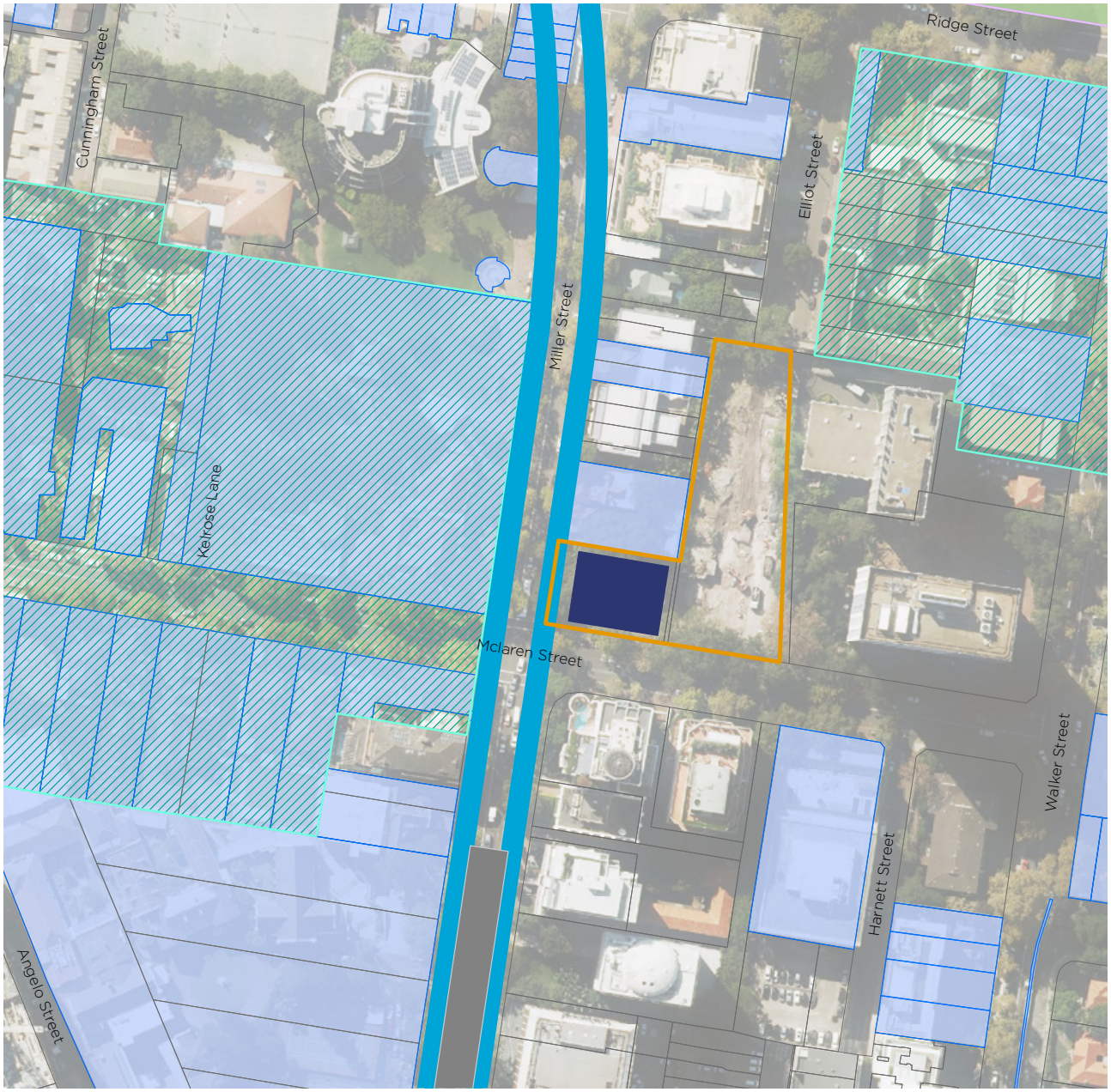
There are a number of heritage listed items within the study area, as summarised in Table 12-3. This includes the heritage significance of the item and associated Statement of significance for each of the items.

Table 12-3 Victoria Cross Station – heritage listed items and Statement of significance

Heritage item name / location	Register listings	Significance	Statement of Significance
McLaren Street Heritage Conservation Area (HCA) West of project site, small section of HCA encompassed by 25m buffer	North Sydney LEP 2013 (CA19)	Local	The statement of significance for the McLaren Street Conservation Area identifies its key significant characteristics as: • An area close to the centre of North Sydney that retains representative details from its development in the late 19th and early 20th centuries • Having landmark qualities and associations with St Thomas' Church and the Council buildings • Having buildings with an intact character on the southern side of McLaren Street which provide a strong edge to the church and civic precinct.
Walker and Ridge Streets Heritage Conservation Area (HCA) Located north-east of project site, small section of HCA encompassed by 25m buffer	North Sydney LEP 2013 (CA20)	Local	The statement of significance for the Walker and Ridge Streets Conservation Area identifies its key significant characteristics as: • Its substantial late 19th and early 20th century character, which is essentially intact and containing a high number of heritage items • Being a largely intact area retaining much of the urban detail and fabric seen in gardens and fencing with original front fences and retaining walls which create a strong sense of streetscape and define views • Having mature public and private vegetation that unifies the area and frames the buildings • The variety in scale of the buildings accentuated by random setbacks but controlled by common colouring, materials, pitched roofs and vegetation.
North Sydney Council Chambers (including fountain in park adjacent to Council Chambers) Located west of project site, small section of curtilage encompassed by 25m buffer	North Sydney LEP 2013 (I0902)	Local	Important example of its style in a prominent corner location. Associated with early medical practice and was significant local hospital at one stage. Later associations as Council Chambers and generally an important local public building. Work of significant local architect.
***Shop (243 Miller Street also known as "Garston")** Located immediately adjacent to project site within 25m buffer	North Sydney LEP 2013 (I0908)	Local	Fine, restrained example of Arts and Crafts style house in prominent location in area dominated by buildings of the same period. Example of local architects work. Important stylistic and physical relationship to Council Chambers and McLaren Street Group.

Heritage item name / location	Register listings	Significance	Statement of Significance
House (255–257 Miller Street) Located immediately adjacent to project site within 25m buffer	North Sydney LEP 2013 (I0912)	Local	Two storey brick house with a hipped half round tile roof. Asymmetrical façade with gable to one side, triple arch colonnade to the ground floor with brick decoration to the arches with roughcast render above and a tessellated tile floor. Gable bay infilled with timber framed window with decorative leadlight and multi-paned upper lights. Open verandah to upper floor under the main roof supported on turned timber columns on a low decorated brick balustrade. Steel windows to the upper gable. Two storey brick house with hipped and gabled roof of half-round tiles. Panels of rough-cast render, shingled gable ends, circular windows, semi-eliptical arches, dichromatic brickwork and leadlight windows are features. This building is designed in the Federation Arts and Crafts style.
Simsmetal House Located south of project site, small section of curtilage encompassed by 25m buffer	North Sydney LEP 2013 (I0889)	Local	A most interesting office building which, by means of a concrete framed structure and clever set-backs, achieves a sense of modest scale and streetscape while in fact being a most commodious structure. Almost every horizontal structural member features planting troughs and the resulting plane material screens and softens the building. Walling and spandrels are of pale brickwork and one is indented to accommodate a large branch of a weeping willow in the front garden. Dense landscaping makes an effective architectural foil. The slope of the McLaren Street is such that the open, large entrance foyer is below street level, producing an interesting spatial effect. The five storey concrete framed office building has a flat roof, concrete floor plates with white brick walls and blades with aluminium framed glazing. Planting troughs to most levels with terraces to the street with dense landscaping makes an effective architectural foil. The open, large entrance foyer is below street level in an undercroft. This building is designed in the Late Twentieth century international style.

** This site is listed as "Shop" but also referred to as "Garston". "Garston" will be used when referring to the site.*



KEY

- Chatswood to Sydenham
- Proposed construction site area
- Proposed operational area at surface
- Proposed station platforms
- State Heritage Register
- LEP Conservation Area - General
- LEP heritage item - General
- LEP heritage item - Landscape

Indicative only, subject to design development

0 100 m

N

Figure 12-1 Victoria Cross Station – location of heritage listed items

12.2.3 Heritage impact assessment

Heritage items

The assessment of impacts to heritage listed items within the study area (including buffer zone) for the approved project in relation to the northern services building only, and the changed impacts to heritage listed items within the study area for the proposed modification are summarised in Table 12.4. This shows the change in impact between the approved project and the proposed modification with six items no longer impacted, one item where impacts would be reduced, and five new items potentially impacted as a result of the proposed modification.

Table 12-4 Victoria Cross Station – impacts on heritage items

Description	Listing[1]	Heritage significance	Heritage impact assessment for the approved project	Changed heritage impact associated with the proposed modification
Restaurant (196 Miller Street)	LEP	Local	• Indirect impact: Neutral (views and vistas) • Potential direct impact: Minor (vibration)	• No impact
House (31 McLaren Street)	LEP	Local	• Indirect impact: Neutral (views and vistas) • Potential direct impact: Minor (vibration)	• No impact
Fairhaven (33 McLaren Street)	LEP	Local	• Indirect impact: Neutral (views and vistas) • Potential direct impact: Minor (vibration)	• No impact
O'Regan (192 Miller Street)	LEP	Local	• Indirect impact: Minor (views and vistas) • Potential direct impact: Minor (vibration)	• No impact
Monte Sant' Angelo Group	LEP	Local	• Indirect impact: Negligible (views and vistas)	• No impact
North Sydney bus shelters	LEP	Local	• Direct physical impact: Moderate (removal and re-location)	• No impact
McLaren Street Conservation Area	LEP	Local	• Indirect impact: Minor (views and vistas)	• Indirect impact: Negligible (views and vistas)

Description	Listing[1]	Heritage significance	Heritage impact assessment for the approved project	Changed heritage impact associated with the proposed modification
Walker and Ridge Streets HCA	LEP	Local	• No impact	• Indirect impact: Negligible (views and vistas)
North Sydney Council Chambers (including fountain in park adjacent to Council Chambers)	LEP	Local	• No impact	• Indirect impact: Minor (views and vistas)
***Shop (243 Miller Street also known as "Garston")**	LEP	Local	• No impact	• Indirect impact Minor (views and vistas) • Potential direct impacts: Minor (vibration)
House (255-257 Miller Street)	LEP	Local	• No impact	• Indirect impact: Minor (views and vistas)
Simsmetal House	LEP	Local	• No impact	• Indirect impact: Negligible (views and vistas)

In summary, the magnitude of impacts to heritage items as a result of the proposed modification would range from minor to negligible in relation to indirect impacts to views and vistas, as well as minor direct impacts from vibration. Impacts would be mitigated through the implementation of relevant mitigation measures.

Although the previously proposed services building assessed as part of the approved project would impact different heritage items than those impacted by the proposed modification, the magnitude of these impacts can be compared as outlined below:

- For the most part, the magnitude of impacts for the proposed modification would be similar to those assessed for the approved project which identified a range of impacts from neutral to minor indirect impacts to views and vistas, and minor direct impacts from vibration
- The proposed modification would result in fewer heritage items being affected by a potential exceedance of the 7.5 mm/s screening level for cosmetic damage due to construction vibration
- Both the proposed modification and the approved project would impact views and vistas related to the McLaren Street HCA, however the proposed modification would only indirectly affect this area, reducing the impact from moderate as per the approved project to negligible
- The proposed modification would eliminate the moderate impact identified for the approved project in relation to direct impacts the North Sydney bus shelters – near the Victoria Cross Station.

Archaeological remains

The assessment of archaeological impact for the approved project concluded that any archaeological resource at the approved location at 194 Miller Street is assumed to have been removed due to the two basement levels on the existing property. This includes basement level 2 (the lowest) ranging between 4.94 metres below ground level fronting Miller Street and 8.94 metres below ground level towards the rear of the property (74.16 metres AHD). This site would no longer be impacted due to the proposed modification.

The proposed modification would introduce potential new impacts as a result of excavation proposed at the site as assessed below.

The assessment of archaeological potential is based on the Archaeological Research Design prepared for the approved project, and a previous Heritage Impact Statement for the site, prepared by Godden Mackay Logan (GML) in 2011 for Uniting Care Ageing.

Subsurface impacts associated with former or current land uses have the potential to remove or damage potential archaeological remains. Based on the initial literature review and site inspection undertaken as part of this assessment, the following assumptions regarding archaeology at the proposed modification site can be made:

- Development that took place in the 1960s and 1970s on land once occupied by Clent and Kedron are likely to have impacted archaeological remains of the residences and associated structures
- Archaeological remains associated with Kedron are likely to have been significantly impacted by the construction of the Rydges Hotel, which occupied its former footprint. The footprint of Kedron is outside the proposed modification site
- Archaeological remains associated with Clent (and associated outbuildings that occupied the northern boundary of the property), which appears to have been demolished and replaced with a landscaped green area in 1963, may exist within the study area, depending on impacts associated with the greenspace's development.

In summary, the study area has low potential to contain remains associated with Kedron and moderate archaeological potential to contain remains associated with Clent. These have the potential to contain an archaeological resource with the potential to reach the local significance threshold, as summarised in Table 12-5.

The extent of excavation at the site of the proposed modification would vary from discrete areas of minor excavation (construction compound area and access routes) through to areas of major excavation works associated with excavations for a shaft. Therefore, works in this location are likely to have a minor to major impact on potential archaeological resources, dependent on the location and extent of excavation. Potential impacts of the proposed modification on these archaeological resources is also summarised in Table 12-5.

Table 12-5 Victoria Cross Station – summary of archaeological potential within study area

Potential archaeological resource	Potential impacts
Evidence of pre-1860 occupation of the study area – for example, evidence of land clearance and cultivation, outbuildings, postholes associated with fencing: • Significance: Local • Archaeological potential: Nil-low	Excavation works within the study area have nil-low potential to impact on archaeological remains.
Mid-to-late 19th century residential development: • Significance: Local • Archaeological potential: Low (Kedron) – Moderate (Clent)	Excavation works within the study area have low-moderate potential to impact on archaeological remains. If archaeological remains associated with Clent, including footings and occupations deposits remain, these are likely to be impacted by excavation of the services shaft and station access.
Mid-20th commercial development: • Significance: Remains of mid-20th century development are unlikely to provide information not readily available through documentary resources. Therefore, they are unlikely to reach the local significance threshold. • Archaeological potential: Moderate-high	Excavation works within the study area have moderate to high potential to impact on archaeological remains. However, these would reach the threshold of local significance.

In summary, the proposed modification would have potential for low to moderate level impacts on a locally significant archaeological resource (should it be present).

12.2.4 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The heritage assessment did not identify any new mitigation measures required in relation to the Victoria Cross Station component of the proposed modification.

12.3 Artarmon substation

12.3.1 Historical context

A historical background assessment for the lower North Shore, and land surrounding the Artarmon substation, was previously prepared as part of the assessment for the approved project. The following historical background assessment focuses on the Artarmon substation component of the proposed modification. The following historical background assessment focuses on the current study area.

Phase 1: 1788 – 1869

The majority of the lower North Shore, and land surrounding the study area, is associated with large land grants given to soldiers, convicts and free settlers in the early 19th century.

Land associated with the study area at 96-98 Reserve Road and 2 Whiting Street Artarmon, was originally occupied by a 25-acre grant given to Daniel Curry in the early 1800s. These grants adjoined the larger grant of William Gore, Provost-Marshall of the Colony of NSW, to the north east, which was known as Artarmon and granted to Gore in 1810. Gore purchased additional neighbouring properties before his financial difficulties in 1818, however, it is not clear if Curry grant was one of those purchased.

There is no indication within the historic records of Daniel Curry building a residence within the study area.

Phase 2: 1869 – 1960

Residential development in Artarmon was supported by the introduction of public utilities for gas (1898), water (1888), and electricity (1914). Much of the development in the study are occurred after 1910 and into the 1920s, therefore it is unlikely occupation deposits such as rubbish dumps would be present. Wells would not have been necessary after water provision in 1888 and as the study area is located near a second order stream wells would not have been necessary in any case.

The development of brickmaking in the area, which was a major employer within Artarmon, with its close proximity to the railway, drove the redevelopment of the area into a working-class neighbourhood. Aerial images from 1943, show much of the area occupied by working class housing, including the study area, which was occupied by a large semi-detached pair of residences.

The residences identified in the 1943 aerial of the study area occupied the northern two thirds of the study area, being 98 Reserve Road and 2 Whiting Street. It is unlikely that 96 Reserve Road was built upon prior to the construction of the light industrial and commercial premises which now occupy the 96 Reserve Road.

Phase 3: 1960 – present

The three lots of the study area were later purchased and converted to light industrial/commercial allotments and the original structure demolished. The current structures date from the latter half of the twentieth century and occupy the full allotments.

12.3.2 Identification of heritage items and assessments of significance

There are no heritage listed items within the study area (Figure 12-2). This is consistent with the assessment for the approved project.

The nearest heritage listed items are the “Industrial building (including surviving industrial elements)” listed as item I1 on the Willoughby LEP 375 metres to the south-west at 80 Reserve Road, and “Artarmon Conservation Area”, listed as item C1 on the Willoughby LEP 600 metres to the north east (Figure 12-2).

Figure 12-2 Artarmon substation location of heritage listed items

12.3.3 Heritage impact assessment

Heritage items

The Artarmon substation component of the proposed modification would not affect any heritage item and would not occur within or adjacent to any HCA. This is consistent with the assessment for the approved project.

Archaeological remains

The assessment of archaeological impact for the approved project identified minor impact on potential archaeological resources of local significance within the study area, associated with evidence of early occupation and evidence of mid-19th century development with nil to moderate potential of occurrence. Additionally the approved project was identified as having potential minor impact on archaeological potential associated with evidence of late 19th and early 20th century residential development, with low to moderate potential for occurrence, however these items would be unlikely to be of local significance. These potential archaeological resources would no longer be impacted due to the proposed modification.

The proposed modification would introduce potential new impacts as a result of excavation proposed at the site as assessed below.

Subsurface impacts associated with former or current land uses have the potential to remove or damage potential archaeological remains. Based on the initial literature review and site inspection undertaken as part of this assessment, the following assumptions regarding archaeology of the study area can be made:

- Archaeological remains associated with early agricultural land grants (Phase 1) are likely to have been impacted by two subsequent periods of development, in the early twentieth century (Phase 2) and late twentieth century (Phase 3)
- Development that took place in the 1960s and 1970s on land once occupied by early twentieth century dwellings are likely to have impacted archaeological remains of the early nineteenth century residences and associated structures
- Archaeological remains associated with Phases 1 may be present on site; however, the nature of the remains of Phase 1, being likely limited to agricultural infrastructure, such as fence lines, would be limited, unless a built structure was present on site. However, there is no clear evidence of built structures form this phase.
- Remains of Phase 2 structures may be present at deeper levels, as building footings and foundations, though archaeological materials associated with occupation from this period is likely minimal, as utility and municipal services limit the available archaeological record.

In summary, the study area has low potential to contain remains associated with Phase 1 and moderate potential for remains associated with Phase 2. The archaeological resource is unlikely to meet the local significance threshold.

Therefore, works in this location are unlikely to impact potential archaeological resources. Potential impacts of the proposed modification on these archaeological resources is also summarised in Table 12.6.

Table 12-6 Artarmon substation summary of archaeological potential within study area

Potential archaeological resource	Potential impacts
Evidence of pre-1860 occupation of the study area – for example, evidence of land clearance and cultivation, outbuildings, postholes associated with fencing: • Significance: Local • Archaeological potential: Nil-low	Excavation works within the study area have nil-low potential to impact on archaeological remains.
Early 20th century residential development: • Significance: Remains of early nineteenth century residential development are unlikely to provide information not readily available through documentary resources. Therefore, they are unlikely to reach the local significance threshold. • Archaeological potential: Moderate	Excavation works within the study area have moderate potential to impact on archaeological remains. If archaeological remains associated with footings and occupations deposits remain, these are likely to be impacted by excavation during construction of the substation.

In summary, the proposed modification would have potential for nil to moderate level impacts on a locally significant archaeological resource (should it be present). This is consistent with the magnitude of impact identified for the approved project, with different areas of potential archaeological resources impacted.

12.3.4 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The heritage assessment did not identify any new mitigation measures required in relation to the Artarmon substation component of the proposed modification.

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ABORIGINAL HERITAGE

CHAPTER THIRTEEN

13 Aboriginal heritage

This chapter provides an assessment of the potential change in impacts on Aboriginal heritage sites and areas of archaeological potential as a result of the proposed modifications, and identifies any changes to mitigation measures to minimise these impacts.

13.1 Assessment methodology

The assessment of Aboriginal heritage in relation to the proposed modifications is the same as the methodology used in the assessment for the approved project as summarised below.

The Aboriginal heritage assessment identifies potential Aboriginal heritage impacts that could occur during construction and operation of the proposed modification, based on the locations of previously recorded Aboriginal heritage sites and the archaeological potential of the study area.

The scope of the Aboriginal heritage assessment for the proposed modifications comprised:

- A review of previous archaeological investigations and a search of the NSW Office of Environment and Heritage's (OEH) Aboriginal Heritage Information Management System (AHIMS) to determine whether Aboriginal heritage sites had previously been recorded near the proposed modifications. Information from the search was also used to determine the archaeological context of the study area
- Consideration of a predictive model for the study area to help determine archaeological potential
- A site inspection of the study area, in the presence of a representative from the Metropolitan Local Aboriginal Land Council
- Assessment of the potential of the proposed modifications to disturb Aboriginal heritage (sites, objects, remains, values, features or places) and, where this is the case:
  - Determine, in consultation with relevant stakeholders, the potential for Aboriginal heritage resources within the study area
  - Determine the extent and significance of impact on those resources as a result of construction and / or operation of the proposed modifications
  - Identify any requirements for in-situ conservation of items and / or areas (as appropriate), further archaeological testing and / or detailed archaeological excavations
- Identify the proposed scope of future Aboriginal heritage assessments for subsequent stages of the proposed modifications.

The following government guidelines were considered during the preparation of the Aboriginal heritage assessment for the proposed modifications:

- *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (Department of Environment, Climate Change and Water, 2011b)
- *Aboriginal Cultural Heritage Consultation requirements for proponents* (Department of Environment, Climate Change and Water, 2010a)
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (Department of Environment, Climate Change and Water, 2010b)
- *NSW Skeletal Remains: Guidelines for Management of Human Remains* (Heritage Office, 1998)
- *Criteria for the assessment of excavation directors* (NSW Heritage Council, 2011).

13.2 Victoria Cross Station

13.2.1 Existing environment

The existing Aboriginal heritage environment was described in assessment of the approved project. This section provides further details relevant to the proposed modification.

Previously registered Aboriginal heritage sites

Searches of AHIMS did not identify any previously recorded Aboriginal heritage site within 100 metres of the proposed modification site.

The closest recorded Aboriginal site is AHIMS site 45-6-0825, an art site recorded around 325 metres to the north-west of the proposed modification site.

Aboriginal heritage sites identified during site inspections

The Victoria Cross modification site was inspected on 25 May 2017 by Duncan Jones (Artefact Heritage) and Celina Timothy (Metropolitan LALC).

The western portion of the site (correlating with 50 McLaren Street) is located on a moderately steep hillslope to the east of the crest on the western side of Miller Street. The ground in this area has been terraced with brick and stone retaining walls throughout the property. This property is currently in use as a bitumen carpark, with grassed areas located on the western and northern sides. These grassed areas were former garden areas from a large two-storey residence that was present on the site in the 1940s. The terracing of the hillside for the development of housing and landscaped gardens has likely removed the original upper (artefact-bearing) soil horizons on the site. The eastern part of the site (correlating with 52 McLaren Street North Sydney) consists of a 100 metre long lot currently in use as a construction site access route and laydown area. Prior to the use of the property for construction works, a three-storey aged care facility was located on the lot. The demolition of the building and the laying of a new concrete roadway has caused significant ground disturbance throughout the property.

No Aboriginal objects were identified during the site inspection. Overall, the site has low archaeological potential.

Archaeological potential and significance

Limited archaeological investigation has occurred at North Sydney in the vicinity of Victoria Cross Station. The majority of recorded Aboriginal sites in the local area are associated with the Harbour foreshore zone, approximately 600 metres to the south of the site. The Aboriginal heritage assessment conducted for the Royal North Shore Hospital in a similar crest landform context to Victoria Cross Station identified that due to large-scale disturbance on shallow soils there was no assessed archaeological potential across that area.

The construction of the nineteenth century residence, twentieth century development and landscaping, and installation of underground services at the study area are likely to have impacted upon or removed archaeological deposits. The relatively shallow soils associated with Ashfield Shale and the crest context Hawkesbury Sandstone suggest that even minor surface disturbance associated with building or road construction is likely to have a significant impact or result in the removal of natural A horizon contexts.

The predictive model provided in the assessment for the approved project indicates that more frequently visited areas likely to demonstrate evidence of repeated and overlapping activities are likely to occur in close proximity to high order watercourses, raw material resources, or salient features in the landscape. The proposed modification is located on a crest landform context away from major watercourses, suggesting that the overall archaeological potential of the study area is likely to be low.

The archaeological significance of the proposed modification is assessed as low due to its low archaeological potential resulting shallow soil profiles and likely high levels of ground disturbance that would have impacted any surface or subsurface Aboriginal sites. No Aboriginal sites have been identified within the study area.

This is similar to the findings for the approved project for Victoria Cross Station, including the original proposed location for the services building, with this site assessed as having low archaeological potential and low archaeological significance.

13.2.2 Potential impacts

The potential impacts on Aboriginal heritage during construction of the Victoria Cross Station component of the proposed modification is provided in this section. Aboriginal heritage would not be impacted during the operation of the proposed modification as widespread ground disturbance and excavation would be restricted to the construction phase. This is the same for the approved project.

Aboriginal heritage sites

Construction of the proposed modification would not directly (ie damaged as a direct result of construction) or indirectly (ie damaged due to construction vibration) impact on any previously recorded Aboriginal heritage sites. As outlined above, the closest previously recorded Aboriginal heritage site is located about 325 metres to the north-west of the proposed modification. This is similar to the findings for the approved project at Victoria Cross Station, including the original proposed location for the services building, which found no direct or indirect impact to known Aboriginal heritage sites.

Archaeological potential and significance

Due to the largely modified nature of the proposed modification site and surrounding area, there are no identified areas of archaeological potential that would be impacted by the proposed works. This is similar to what was assessed for the approved project for Victoria Cross Station, including the original proposed location for the services building.

13.2.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The Aboriginal heritage assessment did not identify any new mitigation measure required in relation to the proposed modification.

13.3 Artarmon substation

13.3.1 Existing environment

The existing Aboriginal heritage environment was described in assessment of the approved project. This section provides further details relevant to the proposed modification.

Previously registered Aboriginal heritage sites

Searches of AHIMS did not identify any previously recorded Aboriginal heritage site within 100 meters of the proposed modification site.

The closest recorded Aboriginal site is AHIMS site 45-6-2938, an art site recorded by Michael Guider 950 metres to the south-east of the study area.

Aboriginal heritage sites identified during site inspections

The site was inspected on 25 May 2017 by Duncan Jones (Artefact Heritage) and Celina Timothy (Metropolitan LALC).

The site is located at 96 and 98 Reserve Road, Artarmon (Lots 1 through 3 DP 1022490 and Lot 1 DP 605751). The property is located at the base of a gentle hill-slope in a heavily developed area of industrial estate directly to the south of the Gore Hill Freeway cutting. Three separate light industrial buildings are located across the properties, which take up most each site except for a small area of street frontage on Reserve Road. The industrial buildings have sub-ground basement levels evident from both Curry Lane and Whiting Street business entrances.

No Aboriginal objects were identified during the site inspection. Overall, the site has low archaeological potential.

Archaeological potential and significance

The Aboriginal heritage assessment conducted for the Royal North Shore Hospital, located 900 metres south of the subject site identified that due to large-scale disturbance on shallow soils there was no assessed archaeological potential across that area.

The use of the land for farming, the construction of nineteenth century residences, later twentieth century development for light industry and commercial uses, and installation of underground services in the study area are likely to have impacted upon or removed archaeological deposits. The relatively shallow soils associated with Ashfield Shale and the crest context Hawkesbury Sandstone, suggest that even minor surface disturbance associated with building or road construction is likely to have a significant impact or result in the removal of natural A horizon contexts. Disturbance at the site has occurred in three distinct phases, likely heavily disturbing and removing the original soil surface layers.

The proposed sub-station is located on the lower slopes of a ridge landform away from major watercourses, though a second order creek appears, from documentary research, to have flowed through the north-east corner of 2 Whiting Street, suggesting that the overall archaeological potential of the study area is likely to be historically moderate before disturbance. However, due to the three successive stages of disturbance to the study area, the archaeological potential is considered overall to be low.

The predictive model provided in the assessment for the approved project indicates that more frequently visited areas likely to demonstrate evidence of repeated and overlapping activities are likely to occur in close proximity to high order watercourses, raw material resources, or salient features in the landscape. The proposed modification is located away from major watercourses, suggesting that the overall archaeological potential of the study area is likely to be low.

The archaeological significance of the proposed modification is assessed as low due to its low archaeological potential resulting shallow soil profiles and likely high levels of ground disturbance that would have impacted any surface or subsurface Aboriginal sites. No Aboriginal sites have been identified within the study area.

This is similar to the findings for the approved project for the Artarmon substation site at Butchers Lane, with that site assessed as having low archaeological potential and low archaeological significance.

13.3.2 Potential impacts

The potential impacts on Aboriginal heritage during construction of the Artarmon substation component of the proposed modification is provided in this section. Aboriginal heritage would not be impacted during the operation of the proposed modification as widespread ground disturbance and excavation would be restricted to the construction phase. This is the same for the approved project.

Aboriginal heritage sites

Construction of the proposed modification would not directly (ie damaged as a direct result of construction) or indirectly (ie damaged due to construction vibration) impact on any previously recorded Aboriginal heritage sites. As outlined above, the closest previously recorded Aboriginal heritage site is located about 950 metres to the south-east of the proposed modification site. This is similar to the findings of for the approved project for the Artarmon substation site at Butchers Lane, which found no direct or indirect impact to known Aboriginal heritage sites.

Archaeological potential and significance

Due to the largely modified nature of the proposed modification site and surrounding area, there are no identified areas of archaeological potential that would be impacted by the proposed works. This is similar to what was assessed for the approved project for the Artarmon substation site at Butchers Lane.

13.3.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The Aboriginal heritage assessment did not identify any new mitigation measure required in relation to the proposed modification.

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LANDSCAPE CHARACTER AND VISUAL AMENITY

CHAPTER FOURTEEN

14 Landscape character and visual amenity

This chapter provides an assessment of the potential change in impact on landscape character and visual amenity as a result of the proposed modifications, and identifies any changes to mitigation measures to minimise these impacts.

14.1 Assessment methodology

Landscape character and visual amenity were assessed to identify the likely impacts during construction and operation of the proposed modifications. The assessment methodology for the proposed modifications is the same as the methodology used in the assessment for the approved project as summarised below, including:

- A description of the existing environment
- Identification of potential landscapes and visual receivers and the sensitivity of those receivers
- Identification of potential landscape character and visual amenity impacts
- A general assessment of the potential improvement or reduction in landscape character and visual values
- Consideration of potential changed landscape character and visual amenity impacts with reference to the approved project
- Identification of any changes to mitigation measures.

14.1.1 Landscape impact assessment

Landscape in the urban context refers to the overall character and function of a place. It includes all elements within the public realm and the interrelationship between these elements and the people who use them.

A range of landscape elements may be directly or indirectly impacted by the proposed modification, particularly by the urban design elements. To identify these impacts, the assessment identified the sensitivity of the element to change and the magnitude of change expected as a result of the proposed modification, and then made an overall assessment of the level of impact expected.

The degree of sensitivity of each landscape element to change was identified as either neighbourhood, local, regional, State or National. Definitions are provided in Table 14-1.

The magnitude of modification to landscape quality of each landscape element was identified as considerable reduction, noticeable reduction, no perceived change, noticeable improvement, or considerable improvement. Definitions are provided in Table 14-2.

The assessed sensitivity and landscape modification changes were then combined for each element to identify a level of landscape impact based on the matrix in Table 14-3.

Table 14-1 Landscape sensitivity levels

Landscape sensitivity	Description
National	Landscape feature protected with national or international legislation, for example the Sydney Opera House.
State	Landscape feature or urban place that is heavily used and is iconic to the State, for example Martin Place and Hyde Park.
Regional	Landscape feature that is heavily used and valued by residents of a major portion of a city or a non-metropolitan region, Prince Alfred Park, Central Station and Belmore Park.
Local	Landscape feature valued and experienced by concentrations of residents, and / or local recreational users. Provides a considerable service to the community. For example, it provides a place for local gathering, recreation, sport, street use by cafes and / or shade and shelter in an exposed environment, Regent Street and Railway Square.
Neighbourhood	Landscape feature valued and appreciated primarily by a small number of local residents, for example street trees in a local street. Provides a noticeable service to the community. For example, it provides a seat or resting place, passive recreation, and / or some shade and shelter in a local street, Randle Lane, Surry Hills.

Table 14-2 Landscape modification change levels

Landscape change	Description
Considerable reduction or improvement	Substantial portion of the landscape is changed. This may include substantial changes to parkland function, footpath continuity, building access, permeability of local streets, and / or street tree cover for example. Substantial changes to the level of comfort, vibrancy, safety and walkability, enhancement, connectivity, diversity, and enduring legacy of the public realm.
Noticeable reduction or improvement	A portion of the landscape is changed. This may include the alteration of parkland function, footpath continuity, building access, permeability of local streets, and / or street tree cover for example. Some alteration to the level of comfort, vibrancy, safety and walkability, enhancement, connectivity, diversity, and enduring legacy of the public realm.
No perceived reduction or improvement	Either the landscape quality is unchanged or if it is, it is largely mitigated by proposed public realm improvements. Does not alter or not noticeably alter the level of comfort, vibrancy, safety and walkability, enhancement, connectivity, diversity, and enduring legacy of the public realm.

Table 14-3 Landscape impact matrix

Landscape change	Landscape sensitivity				
	National	State	Regional	Local	Neighbourhood
Considerable reduction	Very high adverse	Very high adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	Very high adverse	High adverse	Moderate adverse	Minor adverse	Negligible
No perceived change	Negligible	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Very high beneficial	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial

14.1.2 Visual impact assessment

Daytime

The daytime visual impact assessment considered visual amenity as experienced by the people (including rail customers, residents, workers, tourists, etc.) using the site surrounds. It aimed to identify the range of views to the sites that may be impacted, including views from public spaces, residential areas, offices and streets.

The assessment of these impacts involved identifying the existing visual conditions, views that are representative of these conditions, the sensitivity of the views (based on the definitions in Table 14-4), and the magnitude of change expected as a result of the proposed modifications (based on the definitions in Table 14-5). An overall assessment was then made of the level of impact expected (based on the matrix in Table 14-6).

The sensitivity levels incorporate a consideration of heritage values within a viewpoint; however the visual impact assessment is based on the potential change in views only.

Table 14-4 Visual sensitivity levels

Visual sensitivity	Description
National	Heavily experienced view to a national icon, for example view to Sydney Opera House from Circular Quay or Lady Macquarie's Chair, or a view to Parliament House Canberra along Anzac Parade.
State	Heavily experienced view to a feature or landscape that is iconic to the State, for example view along the main avenue in Hyde Park, or a view to Sydney Harbour from Observatory Hill.
Regional	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, for example views to Central Station from Belmore Park, a Sydney CBD skyline view from Prince Alfred Park.
Local	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, for example view from Chalmers Street.
Neighbourhood	Views where visual amenity is not particularly valued by the wider community

Table 14-5 Visual modification change levels

Visual change	Description
Considerable reduction or improvement	Substantial part of the view is altered. The project contrasts substantially with surrounding landscape.
Noticeable reduction or improvement	Alteration to the view is clearly visible. The project contrasts with surrounding landscape.
No perceived reduction or improvement	Either the view is unchanged or if it is, the change in the view is generally unlikely to be perceived by viewers. The project does not contrast with the surrounding landscape.

Table 14-6 Daytime visual impact matrix

Visual change	Daytime visual sensitivity				
	National	State	Regional	Local	Neighbourhood
Considerable reduction	Very high adverse	Very high adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	Very high adverse	High adverse	Moderate adverse	Minor adverse	Negligible

Visual change	Daytime visual sensitivity				
	National	State	Regional	Local	Neighbourhood
No perceived change	Negligible	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Very high beneficial	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial

Night-time

The assessment of night-time impacts was carried out with a similar methodology to the daytime assessment.

Australian Standard *AS4282 Control of the obtrusive effects of outdoor lighting* (1997) offers some useful terminology and principles for assessing night time impacts; however, this standard excludes 'public lighting', which is defined as 'lighting for the provision of all-night safety and security on public roads, cycle paths, footpaths, and pedestrian movement areas'. For this reason, the night-time assessment also drew on the *Guidance for the reduction of obtrusive light* (Institution of Lighting Engineers (UK), 2005).

The *Guidance for the reduction of obtrusive light* (Institution of Lighting Engineers (UK), 2005) identifies environmental zones, useful for the categorising of night-time landscape settings. It also defines a number of features of these environmental zones at night, including sky glow, glare and light trespass. The resulting impact levels are shown in Table 14-7.

Table 14-7 Night-time visual impact matrix

Visual change	Night-time visual sensitivity			
	E1: Intrinsically dark landscapes	E2: Low district brightness	E3: Medium district brightness	E4: High district brightness
Considerable reduction	Very high adverse	Very high adverse	High adverse	Moderate adverse
Noticeable reduction	Very high adverse	High adverse	Moderate adverse	Minor adverse
No perceived change	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial
Considerable improvement	Very high beneficial	Very high beneficial	High beneficial	Moderate beneficial

14.2 Victoria Cross Station

14.2.1 Existing environment

The existing landscape character and visual environment, including the areas in and around Victoria Cross Station and the original location of the services building was described in the assessment of the approved project. This section provides further details regarding the landscape character and visual environmental around the proposed modification site.

The proposed modification site is located at 50-52 McLaren Street, on the north-eastern corner of the Miller Street and McLaren Street intersection. This site was previously occupied by a three-storey assisted care apartment village with a car park and landscaped area; however these were demolished in mid-2016. Miller Street rises from the south, and McLaren Street rises steeply from the east, towards the site, at a local highpoint.

Several mature trees and shrubs are located within the site and along the adjacent streetscapes. This includes a large fig tree along the Miller Street boundary, and three mature fig trees on McLaren Street to the south, which contribute to the leafy character of this corner site. Mature London plane trees provide a canopy over Miller and McLaren streets, providing continuity with the wider streetscape.

Extending north and west from the site, the built form has a predominantly two-storey, heritage character. This includes the visually prominent state heritage listed North Sydney Council Chambers at 200 Miller Street opposite the site. To the north of this, Civic Park provides a visual setting for the Council Chambers and includes a number or heritage features. The park provides an elevated location from which views to the high-rise residential properties on McLaren Street are visible.

To the north of the site the building at 243 Miller Street ('Garston') is currently used as a wellness centre and for residential purposes, and is heritage listed. The heritage character continues north of this with the historic buildings of the Wenona School for Girls. The school is linked to the east via a pedestrian bridge, connecting to a group of buildings located on Ridge Street and Elliot Street, which back onto the site at 52 McLaren Street.

14.2.2 Potential impacts

One landscape character area, Miller and McLaren streets, and five representative viewpoints were selected to inform the landscape character and visual amenity assessment for the proposed modification. For the purposes of comparative assessment, impacts on the two viewpoints to the northern services site as part of the approved project are also reviewed. Representative viewpoints are shown in Figure 14-1.

Figure 6-4 in Chapter 6 (Modification description – operation) provides an indicative view of the proposed services building and station entry based on the preliminary concept design for the proposed modification.

KEY

1 Viewpoint location | Proposed transport property | Proposed station building

Figure 14-1 Victoria Cross Station representative viewpoints

Landscape character impacts

For the assessment of the approved project, potential landscape character impacts associated with the northern services building were assessed in the overall context of the Victoria Cross Station. A total of five landscape character areas were assessed, of which the most relevant to the location of the previously proposed services building would be the Berry and Miller streets and Monte Sant' Angelo Mercy College landscape character areas. These landscape character areas would no longer be impacted as a result of the proposed modification.

The proposed modification would result in new impacts to the Miller and McLaren streets landscape character area during construction and operation as summarised in Table 14-8.

During construction, there would be a minor adverse impact to the landscape quality of the Miller and McLaren streets landscape character area. This would be as a result of some localised impact on adjacent footpaths, resulting in a potential reduction east-west pedestrian connectivity at the McLaren Street / Miller Street intersection.

During operation, it is expected that there would be a noticeable improvement in landscape quality, producing an overall minor beneficial result. This would be as a result of improvements to footpaths in the vicinity of the station entry, creating an expanded public realm and plaza furnishings. The retention of existing mature trees and additional tree planting along McLaren Street would help integrate and soften the building's southern façade.

Table 14-8 Victoria Cross Station landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Change rating	Impact rating	Change rating	Impact rating
Miller and McLaren streets	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial

Visual impacts

Daytime visual impacts

The assessment for the approved project identified minor adverse daytime visual impacts on viewpoints from surrounding streets during construction due to the establishment of a construction compound and associated activities, as well as minor adverse impacts during operation due to the introduction of a utilitarian structure and the associated loss of visual interest and reduced visual compatibility. The specific viewpoints considered for the approved project are:

- Approved project viewpoint 01 – View west from corner of McLaren and Miller streets
- Approved project viewpoint 02 – View northwest along Miller Street.

These viewpoints would no longer be impacted as a result of the proposed modification and therefore the impact rating for each would be reduced to 'no impact' from 'minor adverse'.

The proposed modification would result in new daytime visual impacts during construction and operation of the proposed modification as summarised in Table 14-9 based on the five representative viewpoints as outlined above.

During construction, there would be minor adverse visual impacts on all views. These impacts would be primarily due to the establishment of a construction site, including an acoustic enclosure and site perimeter fencing and hoarding which would be visible along McLaren and Miller streets, and construction vehicles which would be seen travelling along these streets to access the site. There would also be some impact due to the loss of vegetation; however the retention of existing mature trees within the site and adjacent streetscapes would help to filter views to the site, especially during summer. This filtering effect would be somewhat reduced in winter as the deciduous London plane trees lose their leaves.

During operation, the majority of impacts would be either negligible due to building setbacks and the filtering effect of existing vegetation which would help to absorb the new station entry into the existing view, or minor beneficial as a result of the new visually open and transparent station entry and plaza. There would be minor adverse impacts to viewpoint 4 due to the sloping landform along McLaren Street would accentuate the eastern façade of the building from this location.

Table 14-9 Victoria Cross Station daytime visual impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Change rating	Impact rating	Change rating	Impact rating
Viewpoint 1: View northeast across intersection of McLaren and Miller Streets	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial
Viewpoint 2: View southwest from Civic Park	Local	Noticeable reduction	Minor adverse	No perceived change	Negligible
Viewpoint 3: View south along Miller Street	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial
Viewpoint 4: View west along McLaren Street	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Viewpoint 5: View from nearby high rise apartment and office buildings	Neighbourhood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible

Night-time visual impacts

The night-time visual impact identified during assessment of the approved project for the northern station site was negligible during both construction and operation. Due to the changed location of the proposed modification, these impacts would no longer apply in relation to the proposed modification.

As indicated in Table 14-10., there would be negligible night-time visual impacts at the proposed modification site during both construction and operation. The lighting associated with the station entry and services building at this location would generally be in character with the existing lighting levels of the area (assessed as being 'E4: High district brightness').

Table 14-10 Victoria Cross Station night-time visual impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Change rating	Impact rating	Change rating	Impact rating
Proposed modification site	E4: high district brightness	Noticeable reduction	Negligible	No perceived change	Negligible

14.2.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The proposed modification would be subject to relevant conditions of approval including the following which address urban design and visual amenity:

- Condition E99 – Visual amenity
- Condition E100 to E102 – Design Review Panel
- Condition E104 to E105 – Lighting and security.

It is also noted that Sydney Metro has developed design guidelines to guide the design development process and establish the aesthetic standards for the project. The Chatswood to Sydenham design guidelines were provided as part of the approved project.

14.3 Artarmon substation

14.3.1 Existing environment

The proposed Artarmon substation site is located at the southwestern corner of Reserve Road and Whiting Street, at the southern end of the Gore Hill Freeway overbridge. The site (98-104 Reserve Road) is located within an industrial precinct, including mostly light industrial, manufacturing and warehouse land uses, with some commercial and retail premises along Reserve Road, including the Freeway Hotel (opposite the proposed site on Reserve Road).

The site is currently occupied by two buildings, which are used for motor related service and retail. The northern part of the site consists of a single storey low set red brick building, with primary access (vehicular and pedestrian) from Whiting Street and secondary access (pedestrian only) from Reserve Road. The southern part of the site includes a double storey building used for motor vehicle servicing and office space, with primary access (vehicular and pedestrian) from Reserve Road. The building is set back from Reserve Road, with courtyard vehicular parking, enclosed by a low block wall and planting. A mature Eucalyptus tree outside the building along Reserve Road provides visual feature, shade and continuity with the wider streetscape character.

14.3.2 Potential impacts

One landscape character area, Reserve Road and Whiting Street, and three representative viewpoints were selected to inform the landscape character and visual amenity assessment for the proposed modification. Representative viewpoints are shown in Figure 14-2.

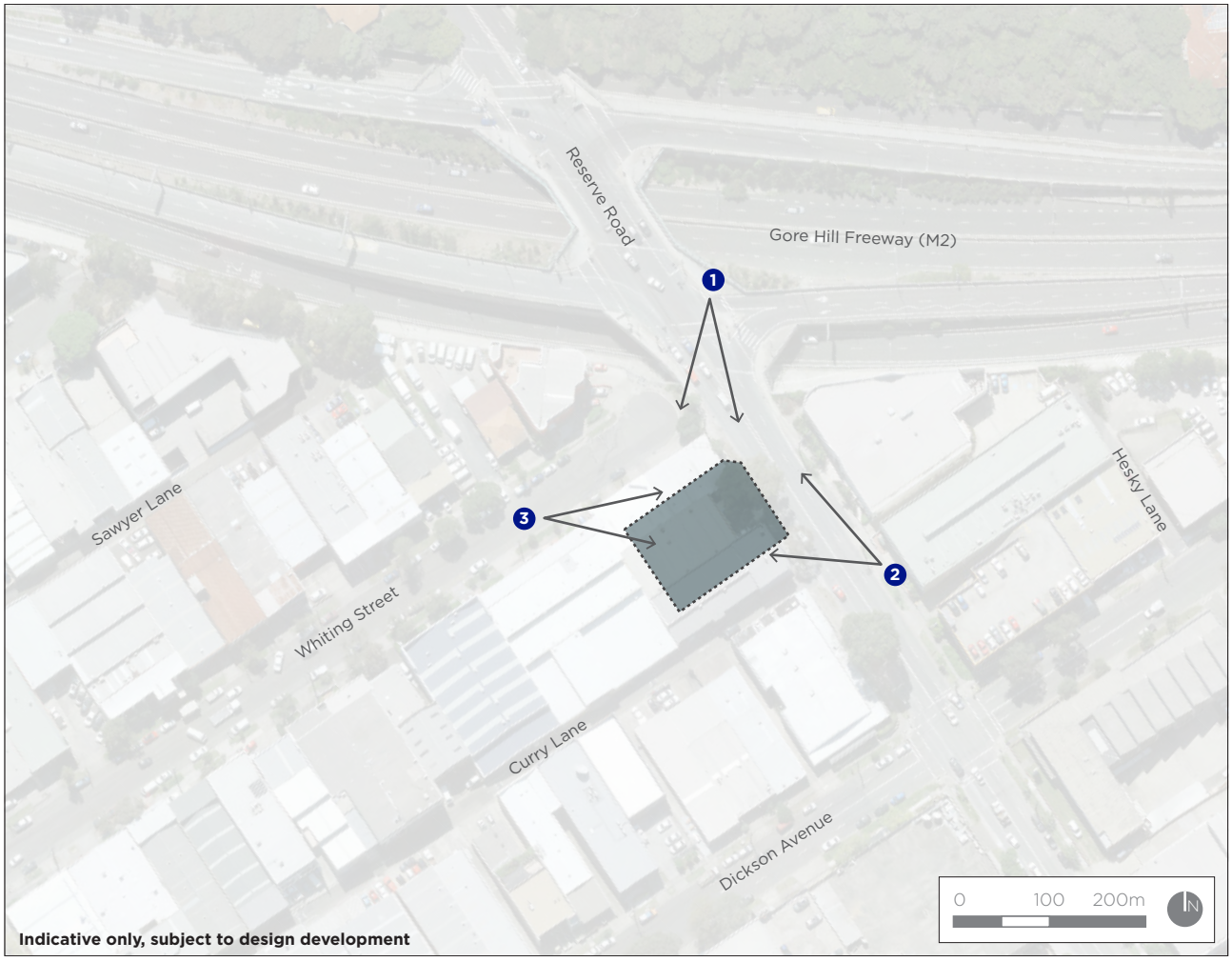

Figure 14-2 Artarmon substation representative viewpoints

Landscape character impacts

This assessment for the approved project identified potential impacts to one landscape character area, Butchers Lane and Barton Road. The approved project was identified as having negligible impact on this area during construction and operation. There would be no potential impact to this landscape character area as a result of the proposed modification.

The proposed modification has been assessed as having potential impact on one landscape character area, Reserve Road and Whiting Street, during construction and operation of the proposed modification as summarised in Table 14-11.

During construction, there would be a negligible impact on the landscape quality of Reserve Road and Whiting Street landscape character area. This is due to the containment of works within the project site and retention of the existing street tree on Whiting Street.

There would also be a negligible landscape impact during operation as the proposed substation building would have a consistent built form scale and character to the surrounding light industrial built form, and the Whiting Street streetscape would be reinforced with a landscape buffer.

Table 14-11 Artarmon substation landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Change rating	Impact rating	Change rating	Impact rating
Reserve Road and Whiting Street	Neighbourhood	No perceived change	Negligible	No perceived change	Negligible

Visual impacts

Daytime visual impacts

The assessment for the approved project identified negligible visual impacts during construction and operation, based on four representative viewpoints. None of these viewpoints would be impacted by the proposed modification.

The proposed modification would result in new daytime visual impacts during construction and operation as summarised in Table 14-12, based on the five representative viewpoints as outlined above.

During construction, there would be negligible to minor adverse visual impacts on these views due to the demolition of two existing buildings and the establishment of a worksite, which would be visible along Reserve Road and Whiting Street. Construction vehicles would be seen travelling along these streets to access the site. However, these elements would be visually absorbed into the character of the surrounding industrial landscape.

During operation, there would be a negligible visual impact due to the compatibility of the proposed substation building with the existing industrial landscape setting, and the proposed landscape buffer on Whiting Street which would filter views to the proposed buildings.

Table 14-12 Artarmon substation daytime visual impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Change rating	Impact rating	Change rating	Impact rating
Viewpoint 1: View southeast from Reserve Road bridge	Local	Noticeable reduction	Minor adverse	No perceived change	Negligible
Viewpoint 2: View northwest from Reserve Road	Local	Noticeable reduction	Minor adverse	No perceived change	Negligible
Viewpoint 3: View northeast along Whiting Street	Neighbourhood	Noticeable reduction	Negligible	No perceived change	Negligible

Night-time visual impacts

The assessment for the approved project identified negligible night-time visual impacts during construction and operation. Due to the changed location of the proposed modification, these impacts would no longer apply in relation to the proposed modification.

As indicated in Table 14-14, there would be new potential night-time visual impacts associated with construction and operation of the proposed modification, which have been identified as negligible. The lighting associated with the substation at this location would generally be in character with the existing lighting levels of the area (assessed as being 'E4: High district brightness').

Table 14-13 Artarmon substation night-time visual impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Proposed modification site	E4: High district brightness	No perceived change	Negligible	No perceived change	Negligible

14.3.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The proposed modification would be subject to relevant conditions of approval including the following which address urban design and visual amenity:

- Condition E99 – Visual amenity
- Condition E100 to E102 – Design Review Panel
- Condition E104 to E105 – Lighting and security.

It is also noted that Sydney Metro has developed design guidelines to guide the design development process and establish the aesthetic standards for the project. The Chatswood to Sydenham design guidelines were provided as part of the approved project.

GROUNDWATER AND GEOLOGY

CHAPTER FIFTEEN

15 Groundwater and geology

This chapter provides an assessment of the potential changes to impacts on groundwater and geology, as a result of the proposed modifications, and identifies any changes to mitigation measures to address these impacts.

15.1 Assessment methodology

The methodology for the assessment of groundwater and geology impacts was the same as was used for the assessment for the approved project and involved:

- A review of previous reports, publicly available data and web-based information searches, including:
  - *Sydney 1:100,000 Geological Series Sheet 9130* (NSW Department of Mineral Resources, 1983)
  - Office of Water Groundwater Database (NSW Department of Primary Industries, 2015)
  - Geological long section for the project alignment (Appendix F of the Environmental Impact Statement)
- Identification of potential changes to impacts of the proposed modifications on groundwater and geology
- Identification of any changes to mitigation measures to address potential groundwater and geology impacts.

An assessment of the existing environment, potential impacts and mitigation measures for each of the proposed modification sites is outlined below.

15.2 Victoria Cross Station

15.2.1 Existing environment

The existing groundwater and geology environment around Victoria Cross Station was described in the assessment for the approved project. This section provides further details relevant to the proposed modification.

Geology

A description of the geological formations underlying the proposed modification was determined from the geological long section, which was included in Appendix F of the Environmental Impact Statement. Hawkesbury Sandstone underlies the general Victoria Cross Station area, including the proposed modification site, and is characterised by medium to coarse-grained quartz sandstone.

Hydrogeology

The direction of groundwater flow could not be definitively determined based on current information, although the surrounding topography of the area and location of water bodies suggests that groundwater would flow in a generally south to south-easterly direction towards Sydney Harbour from the proposed modification site.

Based on geotechnical investigations carried out in and around Victoria Cross Station, the groundwater system is expected to consist of:

- A localised surface groundwater aquifer (where groundwater flows through overlying residual soils, fill and fractured shale layer). This aquifer is likely to be recharged by rainfall as well as incidental runoff from impervious surfaces such as platforms, platform canopies, roads and footpaths
- A deep groundwater aquifer (where groundwater flows through the underlying sandstone rock layers). Recharge of this aquifer is expected to be via downward percolation through the residual soil or fill.

A search of the NSW Office of Water PINNEENA database did not identify any registered groundwater users within one kilometre of the proposed modification site.

A search of the Bureau of Meteorology – Atlas of Groundwater Dependant Ecosystems indicated there were no groundwater dependant ecosystems located within one kilometre of the proposed modification.

15.2.2 Potential impacts

The assessment for the approved project identified that the excavation at the northern station services shaft would be a drained structure and would have an ongoing inflow of groundwater. Any underground tunnels at Victoria Cross Station would have segmental lining to prevent any interaction between surface water and groundwater. The excavation was identified as being likely to intercept the deeper groundwater aquifer. The assessment of the approved project also provided target changes to groundwater levels at surrounding land uses. The potential impacts of the proposed modification would generally be consistent with the approved project as outlined above.

As the nearest existing groundwater user is located greater than one kilometre from the proposed modification, no additional impacts are anticipated to any nearby groundwater user. The approved target changes to groundwater levels at surrounding land uses as identified for the approved project would also apply to the proposed modification.

The proposed modification, like the approved project, would result in the need to capture, treat and discharge water. As identified for the approved project, a water treatment plant would be located within the northern construction site. This treatment plant would be used to treat all intercepted groundwater for the approved project in relation to works in and around Victoria Cross Station, including the proposed modification. The groundwater would be treated to meet the requirements of the environment protection licence for the project, which are anticipated to be:

- pH – 6.5 to 8.5
- Total suspended solids – less than 50 milligrams per litre
- Oil and grease – non visible.

15.2.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

These measures would adequately manage the potential groundwater impacts of the proposed modification. No additional mitigation measures are considered necessary.

15.3 Artarmon substation

15.3.1 Existing environment

The existing groundwater and geology environment around the approved Artarmon substation site on Butchers Lane was described in the assessment of the approved project. This section provides further details relevant to the proposed modification.

Geology

A description of the geological formations underlying the proposed modification was determined from the geological long section, which was included in Appendix F of the Environmental Impact Statement. Mittagong formation (characterised by Interbedded shale, laminite and medium-grained quartz sandstone) and Hawkesbury Sandstone (characterised by medium to coarse-grained quartz sandstone) underlies the general site of the proposed Artarmon substation modification site.

Hydrogeology

The direction of groundwater flow could not be definitively determined based on current information, although the surrounding topography of the area and location of water bodies suggests that groundwater would flow in a generally northerly direction towards Flat Rock Creek from the proposed modification site.

A search of the NSW Office of Water PINNEENA database identified registered groundwater user within one kilometre of the proposed modification site (GW072478 – domestic water supply well about 600 metres to the south).

A search of the Bureau of Meteorology – Atlas of Groundwater Dependant Ecosystems indicated there were no groundwater dependant ecosystems located within one kilometre of the proposed modification.

15.3.2 Potential impacts

The assessment of the approved project identified that the Artarmon substation shaft would be a drained structure and would have an ongoing inflow of groundwater. This would also be the case for the proposed modification. Any underground tunnels would have segmental lining to prevent any interaction between surface water and groundwater.

As the nearest existing groundwater user is located about 600 metres from the proposed modification site, no additional impacts are anticipated to any nearby groundwater user. The approved target changes to groundwater levels at surrounding land uses as identified for the approved project would also apply to the proposed modification.

15.3.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

These measures would adequately manage the potential groundwater impacts of the proposed modification. No additional mitigation measures are considered necessary.

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CONTAMINATION

CHAPTER SIXTEEN

16 Contamination

This chapter provides an assessment of the potential changes to contamination impacts as a result of the proposed modifications, and identifies any changes to mitigation measures to address these impacts.

16.1 Assessment methodology

The assessment methodology applied for contamination was the same as that applied to the assessment of the approved project and involved:

- A review of contamination assessments previously carried out near the proposed sites, where available
- A review of publicly available data and web-based information searches, including the Contaminated Sites Register and Record of Notices (NSW Environment Protection Authority, 2015)
- A review of historical aerial photography to identify potential contamination sources located near the proposed sites based on previous land use
- Site inspections to determine potential contamination sources and verify those potential areas of environmental concern identified in the review
- Recommendations for additional investigations and / or management of potentially contaminated sites which may be encountered during construction
- Development of mitigation measures to address potential contamination impacts.

The following guidelines were considered (where relevant):

- *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998)
- *Guidelines for Consultants Reporting on Contaminated Sites* (Office of Environment and Heritage, 2000).

16.2 Victoria Cross Station

16.2.1 Existing environment

Known contaminated sites and potentially contaminated sites within and around Victoria Cross Station are identified in the assessment for the approved project. This section provides further details relevant to the proposed modification.

There is potential for contamination issues to be present within the site due to past demolition and excavation activities likely associated with former on-site buildings, including the more recent demolition of the former Georgian House aged care facility within the eastern portion of the site.

A search of the NSW EPA Contaminated Sites Register and Record of Notices (under Section 58 of the *Contaminated Land Management Act 1997*) indicated that there were no regulated or notified sites registered with the NSW EPA within 500 metres of the site.

Based on information from the Department of Primary Industries, Office of Water – Continuous water monitoring network website, no registered groundwater bores were located within one kilometre of the site.

A site inspection carried out in and around the site identified potential sources of contamination in areas of unsealed surfaces across the site which appeared to be covered by small quantities of demolition wastes (concrete, tiles etc.). Additionally the southern portion of an existing soil batter on the site appeared to be covered by fill material containing demolition wastes.

16.2.2 Potential impacts

Potentially contaminated sites

The assessment for the approved project identified a potential site of contamination interest within the footprint of the approved Victoria Cross Station site, associated with demolition of existing buildings. The likely risk of this site was identified as moderate (possible contamination / major demolition activities proposed). Any risks associated with the northern services building within this footprint would be removed by the proposed modification, however potential risks associated with construction of Victoria Cross Station would remain.

New areas of potential contamination interest in the vicinity of the proposed modification, and their associated risks are outlined in Table 16-1.

Table 16-1 Victoria Cross Station – potential areas of contamination interest

Potential area of interest	Location	Potential contaminant of concern	Potential contamination distribution	Likely risk
Demolition waste (No. 52 McLaren Street)	Across site surfaces and in stockpiled fill material within the eastern portion of the site	Heavy metals, hydrocarbons, pesticides, asbestos	Surface, shallow soils, stockpiled materials	**Moderate** The Georgian House was constructed between 1955 and 1965 (based on the aerial photograph review). It is possible that hazardous building materials (i.e. asbestos and lead) were used in its construction. Heavy metals, hydrocarbons and pesticides could also have been used to protect wooden structures within the building from termites. Considering that the wastes observed at the site are likely to be associated with the demolition of the Georgian House, it is possible that the fill material containing demolition wastes and demolition wastes observed across site surfaces could be contaminated.
Demolition waste (No. 50 McLaren Street)	Potentially across site surfaces of the western portion of the site	Heavy metals, hydrocarbons, pesticides, asbestos	Surface, shallow soils	**Low to Moderate** A building was demolished within this portion of the site between 1955 and 1965. The building demolished was constructed prior to 1930. It is possible that hazardous building materials (ie asbestos and lead) were used in its construction. Heavy metals, hydrocarbons and pesticides could also have been used to protect wooden structures within the building from termites. Although no demolition wastes were observed within this portion of the site, it is possible that some residual wastes could exist associated with past demolition works including those which have occurred under the development consent for an aged care facility at the site.

Based on Table 16-1, the proposed modification would introduce a potential interface with new areas of contamination interest. In particular, contaminated fill material containing demolition waste which would disturbed during construction.

Excavation of demolition wastes on the site potentially containing hazardous building materials and other contaminants would increase the potential exposure to construction workers and users of adjoining properties. This is particularly the case if asbestos is present within the demolition wastes unless appropriately managed. If contamination is present within demolition wastes, contaminants could migrate from the site and impact upon environmental receivers if not appropriately managed during construction. Mitigation measures and the conditions of approval would adequately address this risk (refer to section 16.2.3).

The potential impacts are unlikely to pose a risk to groundwater beneath the site because:

- The wastes materials are likely to be only associated with surface and shallow soils. The wastes are unlikely to be in direct contact with groundwater
- The potential contamination within the demolition waste is likely to be bound within the matrix of the waste materials and would not be readily leachable. Other potential contaminants (ie pesticides) are not readily soluble in water
- The geology underlying the site is likely to comprise massive sandstone. Groundwater movement through the sandstone is likely to be within secondary structures with minimal groundwater flow. The marine origin of the sandstone is likely to render the groundwater unsuitable as a potable water source. No registered groundwater bores were present within one kilometre of the site.

The potential impact associated with exposure or disturbance of contaminants during construction of the proposed modification would be consistent with the risks identified for the approved project. These are:

- Mobilisation of surface and subsurface contaminants (impacting groundwater, surface water and soils)
- Migration of potential contaminants into surrounding areas (impacting groundwater, surface water and soils) via leaching, overland flow and / or subsurface flow (water and / or vapour)
- Mobilising potential groundwater and / or surface water contaminants
- Exposure to site workers, site users and site visitors
- Exposure to surrounding environmental receivers (such as flora, fauna and surrounding ecosystems).

Potentially contaminating construction activities

Construction activities have the potential to result in contamination of soils and / or groundwater due to spills and leaks of fuel, oils and other hazardous materials. These potential impacts were also identified for the approved project and would be readily manageable by implementing standard construction environment mitigation measures identified for the approved project.

Mishandling of hazardous material waste has the potential to contaminate soils and to create health risks to construction workers and the community. These potential impacts were also identified for the approved project and would be managed in accordance with the mitigation measures identified for the approved project and relevant conditions of approval.

Operation

There would be no operational impacts in relation to contamination associated with the proposed modification site.

16.2.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

Additionally, the amendments to the mitigation measure outlined in Table 16-2 would apply to the proposed modification. The proposed mitigation measures, as amended, would be adequate to manage the potential impacts associated with the proposed modification.

Table 16-2 Mitigation measures – contamination

Reference	Mitigation measure	Applicable location
SCW1	Updated desktop contamination assessments would be carried out for Chatswood dive site, ***Artarmon Substation***, ***Victoria Cross Station***, Blues Point temporary site, Barangaroo Station, Central Station and Waterloo Station. If sufficient information is not available to determine the remediation requirements and the impact on potential receivers, then detailed contamination assessments, including collection and analysis of soil and groundwater samples would be carried out. Detailed contamination assessment would also be carried out for the Barangaroo power supply route within Hickson Road and the Marrickville power supply route adjacent to Sydney Park and Camdenville Oval. In the event a Remediation Action Plan is required, these would be developed in accordance with *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998) and a site auditor would be engaged.	CDS, AS, VC, BP, BN, CS, WS, PSR

The proposed modification would also be subject to relevant conditions of approval including the following which address contamination:

- Conditions E66 and E67 – Site Contamination Report
- Condition E68 – Site Audit Statement and Site Audit Report
- Conditions E69 and E70 – Unexpected Contaminated Land and Asbestos Finds Procedure.

16.3 Artarmon substation

16.3.1 Existing environment

Known contaminated sites and potentially contaminated sites within and around the Artarmon substation site are identified in the assessment for the approved project. This section provides further details relevant to the proposed modification.

There is potential for contamination issues to be present within the site due to past demolition of former on-site residential buildings, as well past and current commercial / industrial land use of site and surrounding area. The current use of the site and adjoining areas for auto mechanical repair purposes represents a potential contamination source associated with the use of chemicals, oils, fuels and solvents associated with these operations.

A search of the NSW EPA Contaminated Sites Register and Record of Notices (under Section 58 of the *Contaminated Land Management Act 1997*) indicated that there were no regulated or notified sites registered with the NSW EPA within 500 metres of the site.

Based on information from the Department of Primary Industries, Office of Water – Continuous water monitoring network website, two registered groundwater wells (GW103591 and GW103841) are located within 500 metres of the site (24 Herbert Street, Artarmon). Both groundwater wells were registered as monitoring bores. Contamination (if present) from the site is unlikely to impact users of groundwater as no beneficial users (eg potable, irrigation) of the groundwater resource are known to be present in areas in the near vicinity of the site.

A site inspection carried out in and around the site, from publically accessible areas only, which did not identify any immediate potential sources of contamination within the site, however warning stickers were observed on the eaves of the building at 104 Reserve Road which could indicate the presence of actual/possible asbestos containing materials within the structure of the building.

16.3.2 Potential impacts

Potentially contaminated sites

There were no potential sites of contamination interest identified for the approved project in relation to the approved Artarmon substation site.

The proposed modification would introduce new areas of potential contamination interest in the vicinity of the proposed modification, as outlined in Table 16-3 including their likely risk.

Table 16-3 Artarmon substation potential areas of contamination interest

Potential area of interest	Location	Potential contaminant of concern	Potential contamination distribution	Likely risk
Commercial / industrial use of site and surrounding area.	Potentially beneath the site.	Heavy metals, hydrocarbons, solvents	Soils (shallow and deep), groundwater, vapour	**Moderate** Commercial / industrial operations have been undertaken at the site and within adjoining buildings prior to 1965 up until present day. These operations could have used or are currently using chemicals which could have contaminated subsurface media associated with inappropriate storage, leaks and spills. These chemicals (especially if in liquid form) can migrate into and contaminate subsurface media.
Demolition of residential dwellings	Potentially across site surfaces of the site (buried beneath current on-site structures)	Heavy metals, hydrocarbons, pesticides, asbestos	Surface, shallow soils	**Low to Moderate** Residential dwellings were demolished across the site between 1955 and 1976. The dwellings demolished were constructed prior to 1943. It is possible that hazardous building materials (ie asbestos and lead) were used in their construction. Heavy metals, hydrocarbons and pesticides could also have been used to protect wooden structures within the buildings from termites. Although no demolition wastes were observed (site fully occupied by commercial buildings), it is possible that some residual wastes could exist beneath current on-site structures associated with past demolition works.

Potential area of interest	Location	Potential contaminant of concern	Potential contamination distribution	Likely risk
Waste materials from nearby brick kilns used as fill on-site	Potentially across site surfaces of the site (buried beneath current on-site structures)	Heavy metals, hydrocarbons, asbestos	Surface, shallow soils	**Low** Operation of the brick kilns likely to have occurred prior to the full development of the site. Potential for kiln wastes (coke and ash) to have been used as fill in areas surrounding the site. Considering the topography of the site (ie did not appear to be significantly raised in comparison to immediately adjoining premises) it is unlikely that significant fill has been used to facilitate construction of the site in the past.

Current (auto mechanical) and historical commercial land usage on and in areas adjoining the site could pose a contamination risk associated with inappropriate storage, leaks and spills of liquid chemicals (namely fuels, oils and solvents). The release of these chemicals could contaminate soils, groundwater and vapour beneath and down gradient of the site. If contaminated, the site may require remediation to remove and/or reduce contaminants to levels permissible for the proposed use of the site and that do not pose a risk to environmental receptors.

It is possible, although not observed during the site inspection, that demolition wastes could be present across the site associated with the demolition of residential dwellings present on site in the past. Excavation of demolition wastes containing hazardous building materials and other contaminants would increase the potential exposure to construction workers and users of adjoining properties, especially if asbestos is present within the demolition wastes and not adequately managed. If contamination is present within demolition wastes, contaminants could migrate from the site and impact upon environmental receivers if not appropriately managed during construction.

The potential impact associated with exposure or disturbance of contaminants during construction of the proposed modification would be consistent with the risks identified for the approved project. These are:

- Mobilisation of surface and subsurface contaminants (impacting groundwater, surface water and soils)
- Migration of potential contaminants into surrounding areas (impacting groundwater, surface water and soils) via leaching, overland flow and / or subsurface flow (water and / or vapour)
- Mobilising potential groundwater and / or surface water contaminants
- Exposure to site workers, site users and site visitors
- Exposure to surrounding environmental receivers (such as flora, fauna and surrounding ecosystems).

Potentially contaminating construction activities

Construction activities have the potential to result in contamination of soils and / or groundwater due to spills and leaks of fuel, oils and other hazardous materials. These potential impacts were also identified for the approved project and would be readily manageable by implementing standard construction environment mitigation measures identified for the approved project.

Mishandling of hazardous material waste has the potential to contaminate soils and to create health risks to construction workers and the community. These potential impacts were also identified for the approved project and would be managed in accordance with the mitigation measures identified for the approved project and relevant conditions of approval.

Operation

There would be no operational impacts in relation to contamination associated with the proposed modification site.

16.3.3 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

Additionally, the amendments to the mitigation measure outlined in Table 16-4 would apply to the proposed modification. The proposed mitigation measures, as amended, would be adequate to manage the potential impacts associated with the proposed modification.

Table 16-4 Mitigation measures – contamination

Reference	Mitigation measure	Applicable location
SCW1	Updated desktop contamination assessments would be carried out for Chatswood dive site, ***Artarmon Substation***, ***Victoria Cross Station***, Blues Point temporary site, Barangaroo Station, Central Station and Waterloo Station. If sufficient information is not available to determine the remediation requirements and the impact on potential receivers, then detailed contamination assessments, including collection and analysis of soil and groundwater samples would be carried out. Detailed contamination assessment would also be carried out for the Barangaroo power supply route within Hickson Road and the Marrickville power supply route adjacent to Sydney Park and Camdenville Oval. In the event a Remediation Action Plan is required, these would be developed in accordance with *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998) and a site auditor would be engaged.	CDS, AS, VC, BP, BN, CS, WS, PSR

The proposed modification would also be subject to relevant conditions of approval including the following which address contamination:

- Conditions E66 and E67 – Site Contamination Report
- Condition E68 – Site Audit Statement and Site Audit Report
- Conditions E69 and E70 – Unexpected Contaminated Land and Asbestos Finds Procedure.

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BIODIVERSITY

CHAPTER SEVENTEEN

17 Biodiversity

This chapter provides an assessment of the potential changes to contamination impacts as a result of the proposed modifications, and identifies any changes to mitigation measures to address these impacts.

17.1 Assessment methodology

The assessment methodlogy applied to the assessment of biodiversity in relation to the proposed modification is the same as the assessment methodology used for the approved project. In accordance with the approved project, the proposed modifications have been assessed in relation to key biodiversity policy and legislation including:

- *NSW Biodiversity Offsets Policy for Major Projects – Framework for Biodiversity Assessment 2014* (Office of Environment and Heritage, 2014b)
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Threatened Species Conservation Act 1995* (TSC Act)
- *Noxious Weeds Act 1993* (NW Act)
- *Environmental Planning and Assessment Act 1979* (EP&A Act)
- *Fisheries Management Act 1994* (FM Act).

17.1.1 Desktop assessment

Database searches

Two databases were searched in April 2017 to identify threatened entities listed under the TSC Act and EPBC Act (Commonwealth Matters of National Environmental Significance) known or likely to occur within ten kilometres of the proposed modification. These databases are:

- The NSW Bionet Wildlife Atlas – this is managed by the NSW Office of Environment and Heritage (OEH). A coordinate search was carried out to determine threatened species records listed under the TSC Act to within ten kilometres of the proposed modification. The search areas overlapped considerably and as such, search results were combined
- The Protected Matters Search Tool – this is managed by the Australian Government Department of the Environment and Energy (Department of the Environment and Energy). A coordinated search was carried out to determine threatened species, threatened ecological communities and migratory species listed under the EPBC Act known or likely to occur to within ten kilometres of the proposed modification.

Literature review

Reports, vegetation maps, topographic maps, aerial photography and literature were reviewed to provide an understanding of ecological values occurring or potentially occurring in the proposed modification areas and wider region. This material included:

- *Soil Landscapes of the Sydney 1:100 000 Sheet* (Chapman and Murphy 1989)
- *The Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area* (Department of Environment Climate Change and Water, 2009).

17.1.2 Field Survey

The proposed modification areas were inspected for terrestrial flora and fauna in May 2017. Site inspections were conducted at ground level from the site boundary and involved:

- Detection and identification of plant and animal species
- Detection and identification of environmental weeds and noxious weeds declared under the *Noxious Weeds Act 1993* for the North Sydney local government areas (LGA)
- Assessment of fauna habitat values
- Assessment of potential habitat for threatened flora and fauna species previously recorded within the localities.

17.1.3 Likelihood of occurrence

The database searches identified threatened flora and fauna species that have been recorded or that are likely to occur within ten kilometres of the study areas. The probability that each threatened species occurs within the study areas was determined as being either low, moderate, high or known.

17.1.4 Framework for Biodiversity Assessment

The impacts of the proposed modifications were considered with reference to the Framework for Biodiversity Assessment (FBA) (Office of Environment and Heritage, 2014b).

Given that no Plant Community Types listed in the NSW Vegetation Information System Database are located within the study sites, it was not possible to carry out an assessment using the FBA credit calculator.

17.2 Victoria Cross Station

17.2.1 Biodiversity study area

The study area for this assessment included all areas where biodiversity values would be potentially affected by the proposed modification. This encompassed the area within the site as well as areas immediately adjacent to the site including the road reserve along Miller Street to the west and McLaren Street to the south of the site.

The study area for the biodiversity assessment of the approved project did not include the Victoria Cross Station or the original services building location as it was identified these sites did not have any native biodiversity values that could be subject to impacts, due to the lack of any vegetated areas or other native habitat features.

17.2.2 Existing environment

The proposed modification site is cleared and vacant and northeast of the intersection of McLaren Street and Miller Street. The area is bounded by Miller Street to the west, McLaren Street to the south and existing buildings to the north and east of the site.

The vegetation of the site comprised hardstand areas with some grassland lined by trees and shrubs along the boundary of the site, including street trees along McLaren Street and Miller Street. This vegetation is characterised by planted native vegetation mixed with invasive exotic species. The site would provide some foraging and nesting habitat for common urban fauna. It otherwise has limited habitat value for fauna due to the disturbed nature of the site and adjoining areas including urban development and roads.

Flora

Trees species along the boundary of the site (or immediately adjacent on neigbouring property) include Bangalay (*Eucalyptus botryoides*), Spotted Gum (*Corymbia maculata*), Tallowwood (*Eucalyptus microcorys*), London Plane Tree (*Platanus x hispanica*), Moreton Bay Fig (*Ficus macrophylla*) and Camphor Laurel (*Cinnamomum camphora*).

The understorey of the study area largely consisted of hardstand and fully cleared areas, with the exception of some planted shrubs in garden beds adjoining McLaren Street, and a small grassed area in the western section of the study area adjoining Miller Street. Shrubs included common planted exotic species such as Murraya (*Murraya paniculata*), Oleander (*Nerium oleander*), Monstera (*Monstera deliciosa*), and Agapanthus (*Agapanthus praecox*). The grassed area in the west was dominated by exotic grass species, mainly Panic Veldtgrass (Ehrharta erecta).

All vegetation identified within the study area is mapped as Urban – Exotic / Native in *Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area* (Department of Environment, Climate Change and Water, 2009a) and field assessment has confirmed that all vegetation is planted or exotic regrowth. None of the vegetation identified in the study area falls within the description for any Plant Community Types listed in the NSW Vegetation Information System database.

No native vegetation communities were observed during site inspections, and none of the vegetation in the study area meets the criteria for any threatened ecological community listed under the EPBC Act or the TSC Act.

No threatened flora species were recorded. Given the low native flora habitat values of the study area, there is a low likelihood of any occurring, with the exception of planted non-local native specimens.

Two declared noxious weed species for the North Sydney Council control area were recorded in the study area: the creepers Madeira Vine (*Anredera cordifolia*) and Cat's Claw Creeper (*Dolichandra unguis-cati*). These were recorded growing on the fenceline adjoining the corner of Miller Street and Maclaren Street. Both species are in control class 4, with the following prescribed control requirement: 'the growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread'.

Fauna

The Protected Matters Search Tool identified 59 threatened fauna species and 78 migratory fauna species listed under the EPBC Act that are known or likely to occur within ten kilometres of the biodiversity study area. A search of the NSW Wildlife Atlas found records of 51 threatened fauna species that are known or likely to occur within ten kilometres of the biodiversity study area.

All species were assessed as having a low likelihood of occurrence at the site.

The site is located within a highly developed urban environment. Available habitats comprise adjacent built structures and scarce planted vegetation which would support low species diversity and very small numbers of vertebrate fauna adapted to urban environments. Planted vegetation along the boundary of the site, including planted vegetation located on Miller Street to the west of the site and McLaren Street to the south would provide limited shelter and foraging habitat for some fauna.

The adjacent buildings and structures provide some roosting habitat for birds.

Due to the urbanised noisy environment of the study area and lack of suitable habitat within adjacent buildings and infrastructure, there is a low likelihood that any microbats inhabit suitable roosting sites. Furthermore, there is a lack of available water and native vegetation in proximity to the site, reducing foraging opportunities for microbats.

Threatened bats including the TSC Act and Grey Headed Flying-fox may use the adjacent fig trees as foraging habitat.

Groundwater dependent ecosystems

A search of the National Atlas of Groundwater Dependent Ecosystems (BOM, 2017) did not identify any Groundwater Dependent Ecosystems within or adjacent to the study area.

17.2.3 Potential impacts

The following section outlines the potential impacts to biodiversity as a result of the proposed modification. As identified above, the approved project did not include any biodiversity values or associated impacts to be assessed in relation to Victoria Cross Station, including the previously proposed services building location. Therefore any impacts identified for the proposed modification would be additional to what was assessed in terms of biodiversity impacts for the approved project overall. Where relevant, impacts of the proposed modification have been compared against the overall biodiversity impacts of the approved project.

Construction

Key threatening processes

The proposed modification may result in the operation of key threatening processes or the exacerbation of a key threatening process currently in operation in the study area. Table 17-1 outlines the Key Threatening Processes which have been considered with regard to the proposed modification. These are consistent with the Key Threatening Processes identified for the approved project.

Table 17-1 Victoria Cross Station key threatening processes

Act	Key Threatening Process	Applicability to proposed modification
TSC Act	Loss of hollow-bearing trees.	No hollow-bearing trees would be removed for the Victoria Cross Station component of the proposed modification.
TSC Act	Invasion and establishment of exotic vines and scramblers	Exotic vines were recorded in the study area, mostly growing along the fenceline adjoining Miller Street. Species recorded within this area that are listed under the key threatening process include Madeira Vine (*Anredera cordifolia*), English Ivy (Hedera helix) and Cat's Claw Creeper (*Dolichandra unguis-cati*). There is a potential for disturbance during works to result in further spread of these species.

Flora impacts

Native vegetation is limited to planted trees and shrubs along the boundary of the site and occasional scattered regeneration of common native plant species within previously disturbed areas. There is however potential for earthworks and excavation to encroach the Tree Protection Zones (TPZ) and Structural Root Zones (SRZ) of the various trees along the boundary of the site. As required by condition of approval E6, all options to avoid tree removal would be considered during detailed construction planning.

Fauna impacts

Clearing of vegetation at the site during construction would be minimal. If required, clearing would result in the removal of some fauna habitat. Any impacts would be to a very small amount of vegetation and would therefore be minor and generally restricted to common fauna species that inhabit urban environments.

No buildings would be directly impacted by the works therefore the proposed modification is not likely to impact roosting and nesting fauna including microbat habitat. No microbats were observed within these sites during targeted surveys. As such, there is a low likelihood of microbats occurring at the site.

Fauna injury or death is most likely to occur during vegetation clearing (if required), but may also result from collisions with vehicles or construction plant, although this is highly unlikely in the highly urbanised environment of the project. The majority of fauna species recorded within the study area are highly mobile bird species. These species are likely to be able to move away from vegetation clearing activities quite readily. Any fauna inhabiting the hollows in hollow-bearing trees may be injured during tree-felling. This could potentially include hollow-dependent birds and mammals. Animals that are unable to disperse during active clearing – such as amphibians and reptiles – are also particularly susceptible to injury or death.

The proposed modification is unlikely to impact any threatened fauna species listed under the TSC Act or EPBC Act. As such, no threatened species are likely to be significantly impacted by the proposed modification.

Impacts to Groundwater Dependent Ecosystems

There would be no impact to Groundwater Dependent Ecosystems as a result of the proposed modification.

Operation

Fauna injury or death as a result of the approved project may result from collisions with trains, although this was identified as being unlikely due to the metro network operate within urban areas or underground, where it is unlikely many fauna species, including threatened species, would occur. To add to this, in the case of the proposed modification, this would consist of a stationary above ground services building and station entry, with a shaft and access to Victoria Cross Station underground. Therefore, there is unlikely to an impact to any fauna species, including threatened species, during operation of the proposed modification.

17.2.4 Assessment according to the Framework for Biodiversity Assessment

The NSW Biodiversity Offsets Policy for Major Projects, which clarifies, standardises and improves biodiversity offsetting for major project approvals, is underpinned by the Framework for Biodiversity Assessment (FBA). An assessment of the approved project under the FBA was carried out for the approved project to determine whether biodiversity offsets would be required. It was concluded that the impacts of the approved project on native vegetation would not require an offset, given that the approved project comprises planted or highly modified native vegetation. The proposed modification would not change this conclusion.

17.2.5 Mitigation measures

The Sydney Metro Construction Environmental Management Framework (provided as part of the Submissions and Preferred Infrastructure Report) sets out the environmental management approach and strategy for the project, and includes commitments regarding the development and implementation of a construction environmental management plan and associated sub-plans. The relevant project-specific mitigation measures identified for the approved project would also continue to apply to the project as proposed to be modified.

The proposed modification would be also subject to relevant conditions of approval including Condition E6 which requires preparation of comprehensive Tree Report by an independent, experienced and suitably qualified arborist prior to removing any tree.

CONSOLIDATED REVISED ENVIRONMENTAL MITIGATION MEASURES

CHAPTER EIGHTEEN

18 Consolidated revised environmental mitigation measures

This chapter provides a consolidated revised list of environmental mitigation measures applicable to construction and operation of the proposed modifications, including any new measures as identified in this modification report.

18.1 Approach to environmental mitigation and management

The project approach to environmental mitigation and management was described in the assessment of the approved project. The approach is illustrated by Figure 18-1 and includes:

- Project design – measures which are inherent in the design of the project to avoid and minimise impacts
- Mitigation measures – additional to the project design which are identified through the environment impact assessment in Chapters 8 to 26. These measures are consolidated in Table 18-1
- Construction environmental management framework – details the management processes and documentation for the project. Further details are provided in section 27.1.1 of the Environmental Impact Statement
- Construction noise and vibration strategy – identifies how Sydney Metro proposes to manage construction noise and vibration. Further details are provided in section 27.1.2 of the Environmental Impact Statement
- Design guidelines – provides an assurance of end-state design quality. Further details are provided in section 27.1.3 of the Environmental Impact Statement
- Environmental performance outcomes – which establish the intended outcomes which would be achieved by the project. The performance outcomes are identified in section 27.3 of the Environmental Impact Statement.

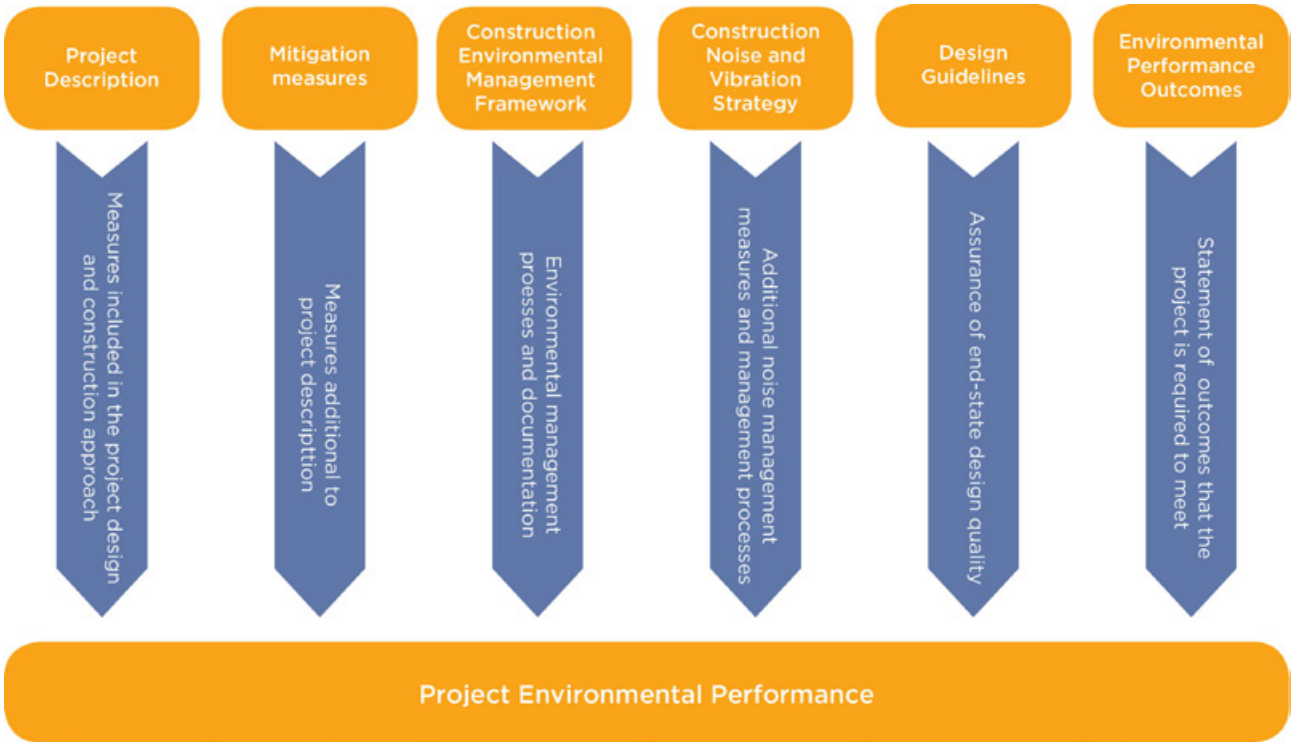

Figure 18-1 Project approach to environmental mitigation and management

This approach would also be applied to Victoria Cross Station and Artarmon substation components of the proposed modification.

18.2 Revised environmental mitigation measures

The list of mitigation measures presented in Chapter 11 of the Submissions and Preferred Infrastructure Report has been revised based on the assessment carried out for the proposed modification.

Table 18-1 provides the revised consolidated environmental mitigation measures. This table supersedes the mitigation measures presented in the Submissions and Preferred Infrastructure Report. New mitigation measures or additions to existing mitigation measures are shown in **bold** text, with deletions shown with a ~~strikethrough~~.

As per the approach for the approved project, the location(s) applicable to each mitigation measure are identified by using a unique identifier as follows:

- STW – Surface track works
- CDS – Chatswood dive site
- AS – Artarmon substation
- CN – Crows Nest Station
- VC – Victoria Cross Station
- BP – Blues Point temporary site
- GI – Ground improvement works
- BN – Barangaroo Station
- MP – Martin Place Station
- PS – Pitt Street Station
- CS – Central Station
- WS – Waterloo Station
- MDS – Marrickville dive site
- Metro rail tunnels – Metro rail tunnels not related to other sites (eg TBM works)
- PSR – Power supply routes.

Table 18-1 Revised consolidated environmental mitigation measures

ID	Mitigation measure	Applicable location(s)[1]
Construction traffic and transport		
T1	Ongoing consultation would be carried out with (as relevant to the location) the CBD Coordination Office, Roads and Maritime Services, Sydney Trains, NSW Trains, the Port Authority of NSW, Barangaroo Delivery Authority, local councils, emergency services and bus operators in order to minimise traffic and transport impacts during construction.	All except metro rail tunnels
T2	Road Safety Audits would be carried out at each construction site. Audits would address vehicular access and egress, and pedestrian, cyclist and public transport safety.	All except metro rail tunnels
T3	Directional signage and line marking would be used to direct and guide drivers and pedestrians past construction sites and on the surrounding network. This would be supplemented by Variable Message Signs to advise drivers of potential delays, traffic diversions, speed restrictions, or alternate routes.	All except metro rail tunnels
T4	In the event of a traffic related incident, co-ordination would be carried out with the CBD Coordination Office and / or the Transport Management Centre's Operations Manager.	All except metro rail tunnels
T5	The community would be notified in advance of proposed road and pedestrian network changes through media channels and other appropriate forms of community liaison.	All except metro rail tunnels
T6	Vehicle access to and from construction sites would be managed to ensure pedestrian, cyclist and motorist safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasions, police presence.	All except metro rail tunnels
T7	Additional enhancements for pedestrian, cyclist and motorist safety in the vicinity of the construction sites would be implemented during construction. This would include measures such as: • Use of speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers • Community educational events that allow pedestrians, cyclists or motorists to sit in trucks and understand the visibility restrictions of truck drivers, and for truck drivers to understand the visibility from a bicycle; and a campaign to engage with local schools to educate children about road safety and to encourage visual contact with drivers to ensure they are aware of the presence of children • Specific construction driver training to understand route constraints, expectations, safety issues, human error and its relationship with fitness for work and chain of responsibility duties, and to limit the use of compression braking • Use of In Vehicle Monitoring Systems (telematics) to monitor vehicle location and driver behavior • Safety devices on construction vehicles that warn drivers of the presence of a vulnerable road user located in the vehicles' blind spots and warn the vulnerable road user that a vehicle is about to turn.	All except metro rail tunnels
T8	Access to existing properties and buildings would be maintained in consultation with property owners.	All except metro rail tunnels
T9	All trucks would enter and exit construction sites in a forward gear, where feasible and reasonable.	All except metro rail tunnels

ID	Mitigation measure	Applicable location(s)[1]
T10	Any relocation of bus stops would be carried out by Transport for NSW in consultation with Roads and Maritime Services, the CBD Coordination Office (for relevant locations), the relevant local council and bus operators. Wayfinding and customer information would be provided to notify customers of relocated bus stops.	All except metro rail tunnels
T11	For special events that require specific traffic measures, those measures would be developed in consultation the CBD Coordination Office (for relevant locations), Roads and Maritime Services, Barangaroo Delivery Authority (for relevant locations) and the organisers of the event.	BN, MP, PS, CS
T12	Construction sites would be managed to minimise construction staff parking on surrounding streets. The following measures would be implemented: • Encouraging staff to use public or active transport • Encouraging ride sharing • Provision of alternative parking locations and shuttle bus transfers where feasible and reasonable. Transport for NSW would work with local councils to minimise adverse impacts of construction on parking and other kerbside use in local streets, such as loading zones, bus zones, taxi zones and coach zones.	All except metro rail tunnels
T13	Construction site traffic would be managed to minimise movements in the AM and PM peak periods.	All except metro rail tunnels
T14	Construction site traffic immediately around construction sites would be managed to minimise movements through school zones during pick up and drop off times.	All except metro rail tunnels
T15	Pedestrian and cyclist access would be maintained at Crows Nest during the temporary closure of Hume Street, and at Martin Place during the temporary partial closure of Martin Place. Wayfinding and customer information would be provided to guide pedestrians and cyclists to alternative routes.	CN, MP
T16	Timing for the temporary closure of the Devonshire Street tunnel would avoid periods of peak pedestrian demand. Wayfinding and customer information would be provided to guide pedestrians to alternative routes.	CS
T17	Consultation would occur with the Harbour Master, Roads and Maritime Services and Sydney Ferries' to ensure shipping channels are maintained during the Sydney Harbour ground improvement works.	GI
T18	During the closure of existing entrances to Martin Place Station, marshalls would be provided during the AM and PM peak periods to direct customers to available access and egress points.	MP
T19	Where existing parking is removed to facilitate construction activities, alternative parking facilities would be provided where feasible and reasonable.	All except metro rail tunnels
T20	Alternative pedestrian routes and property access would be provided where these are affected during the construction of the power supply routes.	PSR
T21	The potential combined impact of trucks from multiple construction sites would be further considered during the development of Construction Traffic Management Plans.	All except metro rail tunnels
T22	Where existing footpath routes used by pedestrians and / or cyclists are affected by construction, a condition survey would be carried out to confirm they are suitable for use (eg suitably paved and lit), with any necessary modifications to be carried out in consultation with the relevant local council.	All except metro rail tunnels

ID	Mitigation measure	Applicable location(s)[1]
Operational traffic and transport		
OpT1	Enhancement of pedestrian infrastructure in the vicinity of Victoria Cross and Martin Place stations would be investigated further in consultation with (as relevant to the location) the CBD Coordination Office, Roads and Maritime Services and the relevant local council.	VC, MP
OpT2	Access would be maintained to neighbouring properties.	All except metro rail tunnels
OpT3	The design of the interface between the Frank Channon Walk extension and the signalised intersection at Mowbray Road / Hampden Road (including any shared zone proposal) would be developed in consultation with Roads and Maritime Services and Willoughby Council.	CDS
OpT4	Transport for NSW would work with local councils to minimise adverse impacts of operation on parking and other kerbside use in local streets, such as loading zones, bus zones, taxi zones and coach zones.	All except metro rail tunnels
OpT5	During detailed design, Transport for NSW would consult with Inner West Council, Roads and Maritime Services and other stakeholder on strategies to reduce the number of staged pedestrian marked foot crossings at the Edinburgh Road / Edgeware Road intersection.	MDS
Construction noise and vibration		
NV1	The Construction Noise and Vibration Strategy would be implemented with the aim of achieving the noise management levels where feasible and reasonable. This would include the following example standard mitigation measures where feasible and reasonable: • Provision of noise barriers around each construction site • Provision of acoustic sheds at Chatswood dive site, Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street, Waterloo and Marrickville dive site • The coincidence of noisy plant working simultaneously close together would be avoided • Offset distances between noisy plant and sensitive receivers would be increased • Residential grade mufflers would be fitted to all mobile plant • Dampened rock hammers would be used • Non-tonal reversing alarms would be fitted to all permanent mobile plant • High noise generating activities would be scheduled for less sensitive period considering the nearby receivers • The layout of construction sites would consider opportunities to shield receivers from noise. This would also include carrying out the requirements in relation to construction noise and vibration monitoring.	All
NV2	Unless compliance with the relevant traffic noise criteria can be achieved, night time heavy vehicle movements at the Chatswood dive site, Crows Nest Station, Victoria Cross Station and Waterloo Station sites would be restricted to: • The Pacific Highway and Mowbray Road at the Chatswood dive site • The Pacific Highway, Hume Street and Oxley Street at the Crows Nest Station construction site • McLaren Street, Miller Street and Berry Street at the Victoria Cross Station construction site • Battery Road and Raglan Street at the Waterloo Station construction site.	CDS, CN, VC, WS

ID	Mitigation measure	Applicable location(s)[1]
NV3	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	All except metro rail tunnels
NV4	Feasible and reasonable measures would be implemented to minimise ground borne noise where exceedances are predicted.	All
NV5	Feasible and reasonable mitigation measures would be implemented where power supply works would result in elevated noise levels at receivers. This would include: • Carrying out works during the daytime period when in the vicinity of residential receivers • Where out of hours works are required, scheduling the noisiest activities to occur in the evening period (up to 10 pm) • Use of portable noise barriers around particularly noisy equipment such as concrete saws.	PSR
NV6	Transport for NSW would engage an Independent Acoustic Advisor to act independently of the design and construction teams and provide oversight of construction methods, construction noise and vibration planning, management and mitigation, and construction noise and vibration monitoring and reporting. The key responsibilities of the Independent Acoustic Advisor would include : • Assurance of contractor noise and vibration planning, modelling, management and monitoring practices • Verification of compliance with relevant guidelines and approval requirements • Audit noise and vibration management practices.	All
NV7	Alternative demolition techniques that minimise noise and vibration levels would be investigated and implemented where feasible and reasonable. This would include consideration of: • The use of hydraulic concrete shears in lieu of hammers/rock breakers • Sequencing works to shield noise sensitive receivers by retaining building wall elements • Locating demolition load out areas away from the nearby noise sensitive receivers • Providing respite periods for noise intensive works • Methods to minimise structural-borne noise to adjacent buildings including separating the structural connection prior to demolition through saw-cutting and propping, using hand held splitters and pulverisers or hand demolition • Installing sound barrier screening to scaffolding facing noise sensitive neighbours • Modifying demolition works sequencing / hours to minimise impacts during peak pedestrian times and / or adjoining neighbour outdoor activity periods.	All except metro rail tunnels

ID	Mitigation measure	Applicable location(s)[1]
Operational noise and vibration		
OpNV1	The height and extent of noise barriers adjacent to the northern surface track works would be confirmed during detailed design with the aim of not exceeding trigger levels from the *Rail Infrastructure Noise Guidelines* (Environment Protection Authority, 2013). At property treatments would be offered where there are residual exceedances of the trigger levels.	STW
OpNV2	Track form would be confirmed during the detailed design process in order to meet the relevant ground-borne noise and vibration criteria from the *Rail Infrastructure Noise Guidelines* (EPA, 2013) and the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (DECC, 2007a).	Metro rail tunnels
OpNV3	Stations and ancillary facilities including train breakout noise from draught relief shafts would be designed to meet the applicable noise criteria derived from the *Industrial Noise Policy* (EPA, 2000).	All except metro rail tunnels
Business impacts		
BI1	Specific consultation would be carried out with businesses potentially impacted during construction. Consultation would aim to identify and develop measures to manage the specific construction impacts for individual businesses.	All
BI2	A business impact risk register would be developed to identify, rate and manage the specific construction impacts for individual businesses.	All
BI3	Appropriate signage would be provided around construction sites to provide visibility to retained businesses.	All except metro rail tunnels
Non-Aboriginal heritage		
NAH1	Archival recording and reporting of the following heritage items would be carried out in accordance with the NSW Heritage Office's *How to Prepare Archival Records of Heritage Items* (1998a), and *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006): • The internal heritage fabric and any non-original elements removed from within the curtilage of Mowbray House, Chatswood • The interior, exterior and setting of the shop at 187 Miller Street, North Sydney • The fabric and setting of the North Sydney bus shelters requiring removal and temporary relocation at Victoria Cross Station and Blues Point temporary site • Any component of the Blues Point Waterfront Group and the McMahons Point South heritage conservation area to be directly affected or altered, including vegetation and significant landscape features • Hickson Road wall in the vicinity of proposed ventilation risers and skylights for Barangaroo Station • The interior, exterior and setting of the 'Flat Building' at 7 Elizabeth Street, Sydney • Martin Place, between Elizabeth and Castlereagh streets, Sydney • The heritage fabric of areas of the existing Martin Place Station affected by the project • The Rolling Stock Officers Garden, Rolling Stock Officers Building and Cleaners Amenities Building in Sydney Yard and any other component of the Sydney Terminal and Central Railway Stations group to be removed or altered • Directly impacted parts of the Congregational Church at Waterloo.	CDS, VC, BP, MP, CS, WS

ID	Mitigation measure	Applicable location(s)[1]
NAH2	The archaeological research design would be implemented. Significant archaeological findings would be considered for inclusion in heritage interpretation (as per NAH8) for the project and be developed in consultation with the relevant local council.	CDS, CN, VC, BP, BN, MP, PS, CS, WS, PSR
NAH3	An Exhumation Policy and Guideline would be prepared and implemented. It would be developed in accordance with the *Guidelines for Management of Human Skeletal Remains* (NSW Heritage Office, 1998b) and NSW Health Policy Directive – Exhumation of human remains (December, 2013). It would be prepared in consultation with NSW Heritage Office and NSW Health.	All except metro rail tunnels
NAH4	The method for the demolition of existing buildings and / or structures at Chatswood dive site, Victoria Cross Station, Martin Place Station, Pitt Street Station, Central Station and Waterloo Station would be developed to minimise direct and indirect impacts to adjacent and / or adjoining heritage items.	CDS, VC, MP, PS, CS, WS
NAH5	Prior to total or partial demolition of heritage items at Victoria Cross and Martin Place stations, heritage fabric for salvage would be identified and reuse opportunities for salvaged fabric considered. This would include salvage and reuse of heritage tiles to be impacted at Martin Place Station.	VC, MP
NAH6	An appropriately qualified and experienced heritage architect would form part of the Sydney Metro Design Review Panel and would provide independent review periodically throughout detailed design.	All
NAH7	The project design would be sympathetic to heritage items and, where reasonable and feasible, minimise impacts to the setting of heritage items. The detailed design for Martin Place Station and Central Station would be developed with input from a heritage architect.	STW, CDS, CN, VC, BN, MP, PS, CS, WS, MDS
NAH8	Appropriate heritage interpretation would be incorporated into the design for the project in accordance with the NSW Heritage Manual, the NSW Heritage Office's *Interpreting Heritage Places and Items: Guidelines* (August 2005), and the NSW Heritage Council's *Heritage Interpretation Policy*.	CDS, CN, VC, BP, BN, MP, PS, WS
NAH9	A Central Station heritage interpretation plan would be developed and implemented. It would be consistent with the *Central Station Conservation Management Plan* (Rappoport and Government Architects Office, 2013) and in accordance with the guidelines identified in NAH8.	CS
NAH10	The detailed design of the Sydney Yard Access Bridge would be carried out in accordance with the relevant specific element principles in the Design Guidelines.	CS
NAH11	Except for heritage significant elements affected by the project, direct impact on other heritage significant elements forming part of the following items would be avoided: • The Blues Point Waterfront Group (including the former tram turning circle, stone retaining wall, bollards and steps) • The Millers Point and Dawes Point Village Precinct • The existing Martin Place Station • Sydney Terminal and Central Railway Stations group • Sydney Yard (including the Shunters Hut and Prince Alfred Sewer).	BP, BN, MP, CS
NAH12	Power supply works would be designed and constructed to avoid impacts to the Tank Stream and Bennelong Stormwater Channel.	PSR

ID	Mitigation measure	Applicable location(s)[1]
NAH13	The design and detailed construction planning of work at Central Station would consider the requirements of the *Central Station Conservation Management Plan* (Rappoport and Government Architects Office, 2013) and include consideration of opportunities for the retention, conservation and / or reuse of original and significant heritage fabric and movable heritage items. Consultation would be carried out with Sydney Trains and the Heritage Council of NSW during design development.	CS
NAH14	The final design and location of the new connection and opening at Martin Place Railway Station would minimise removal of the significant red ceramic tiling where feasible and reasonable.	MP
NAH15	Opportunities for the reuse of any tiles at Martin Place Railway Station that are removed would be investigated.	MP
NAH16	Opportunities for the reuse of the circular seating within Martin Place Station would be investigated.	MP
NAH17	Opportunities for the salvage and reuse of the bus shelters temporarily removed at Victoria Cross and Blues Point would be investigated in consultation with North Sydney Council.	VC, BP
NAH18	Works at Central Station would be carried out with the oversight of heritage specialists.	CS
NAH19	Subject to outcomes of consultation with the church, temporary and permanent works at the Congregational Church would: • Minimise impacts to heritage fabric • Be sympathetic to the heritage values and architectural form of the building.	WS
Aboriginal heritage		
AH1	Aboriginal stakeholder consultation would be carried out in accordance with the NSW Office of Environment and Heritage's Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010.	All
AH2	The cultural heritage assessment report would be implemented.	All
AH3	Archaeological test excavation (and salvage when required) would be carried out where intact natural soil profiles with the potential to contain significant archaeological deposits are encountered at the Blues Point temporary site, Barangaroo Station, Martin Place Station, Pitt Street Station, Central Station, Waterloo Station and Marrickville dive site. Excavations would be conducted in accordance with the methodology outlined in the Aboriginal cultural heritage assessment report	BP, BN, MP, PS, CS, WS, MDS
AH4	Appropriate Aboriginal heritage interpretation would be incorporated into the design for the project in consultation with Aboriginal stakeholders.	All
AH5	Feasible and reasonable mitigation at the ground improvement locations would be identified in consultation with the Office of Environment and Heritage.	GI
AH6	The Aboriginal cultural heritage assessment report would address areas of archaeological potential associated with the power supply routes.	PSR

ID	Mitigation measure	Applicable location(s)[1]
Landscape character and visual amenity		
Construction		
LV1	Where feasible and reasonable, the elements within construction sites would be located to minimise visual impacts, for example materials and machinery would be stored behind fencing.	All except metro rail tunnels
LV2	Existing trees to be retained would be protected prior to the commencement of construction in accordance with *Australian Standard AS4970 the Australian Standard for Protection of Trees on Development Sites and Adjoining Properties*.	All except metro rail tunnels
LV3	Lighting of construction sites would be oriented to minimise glare and light spill impact on adjacent receivers.	All except metro rail tunnels
LV4	Visual mitigation would be implemented as soon as feasible and reasonable after the commencement of construction, and remain for the duration of the construction period.	All except metro rail tunnels
LV5	Opportunities for the retention and protection of existing trees would be identified during detailed construction planning.	All except metro rail tunnels
LV6	The design and maintenance of construction site hoardings would aim to minimise visual amenity and landscape character impacts, including the prompt removal of graffiti. Public art opportunities would be considered.	All except metro rail tunnels
LV7	The selection of materials and colours for acoustic sheds would aim to minimise their visual prominence.	CDS, CN, VC, BN, MP, PS, WS, MDS
LV8	Tunnel boring machine retrieval works at the Blues Point temporary site would be timed to avoid key harbour viewing events.	BP
LV9	Benching would be used where feasible and reasonable at Blues Point temporary site to minimise visual amenity impacts.	BP
LV10	Temporary impacts to public open space would be rehabilitated in consultation with the relevant local council and / or landowner.	All except metro rail tunnels
Operation		
LV11	Cut off and direct light fittings (or similar technologies) would be used to minimise glare and light spill onto private property.	CDS, AS, MDS
LV12	Where feasible and reasonable, vegetation would be provided to screen and visually integrate sites with the surrounding area.	STW, CDS, AS, MDS
LV13	Identify and implement appropriate landscape treatments for Frank Channon Walk.	STW, CDS
LV14	The architectural treatment of Artarmon substation would minimise visual amenity and landscape character impacts.	AS
LV15	The Harbour cycles sculpture at North Sydney would be reinstated at a location determined in consultation with North Sydney Council.	VC
LV16	The P&O Fountain, the mid-20th century bas relief sculpture and the Douglas Annand glass screen at 55 Hunter Street would be reinstated at a location determined in consultation with City of Sydney Council.	MP

ID	Mitigation measure	Applicable location(s)[1]
LV17	Opportunities would be investigated to provide a permanent wall for street art at Marrickville dive site in consultation with Marrickville Council.	MDS
LV18	Noise barriers would be transparent where they are augmenting existing transparent noise barriers.	STW
LV19	Notification processes in relation to moral rights for public art and architecture under *Commonwealth Copyright Act 1968* would be carried out.	All except metro rail tunnels
Groundwater and geology		
GWG1	A detailed geotechnical model for the project would be developed and progressively updated during design and construction. The detailed geotechnical model would include: • Assessment of the potential for damage to structures, services, basements and other sub-surface elements through settlement or strain • Predicted changes to groundwater levels, including at nearby water supply works. Where building damage risk is rated as moderate or higher (as per the CIRIA 1996 risk-based criteria), a structural assessment of the affected buildings / structures would be carried out and specific measures implemented to address the risk of damage. With each progressive update of the geotechnical model the potential for exceedance of the following target changes to groundwater levels would be reviewed: • Less than 2.0 metres – general target • Less than 4.0 metres – where deep building foundations present • Less than 1.0 metre – residual soils • Less than 0.5 metre – residual soils (Blues Point) (fill / Aeolian sand). Where a significant exceedance of target changes to groundwater levels are predicted at surrounding land uses and nearby water supply works, an appropriate groundwater monitoring program would be developed and implemented. The program would aim to confirm no adverse impacts on groundwater levels or to appropriately manage any impacts. Monitoring at any specific location would be subject to the status of the water supply work and agreement with the landowner. The geotechnical model and groundwater monitoring program would be developed in consultation with the Department of Primary Industries (water).	All
GWG2	Condition surveys of buildings and structures in the vicinity of the tunnel and excavations would be carried out prior to the commencement of excavation at each site.	All
Soils, contamination and water quality		
Construction		
SCW1	Updated desktop contamination assessments would be carried out for Chatswood dive site, **Victoria Cross Station**, **Artarmon substation**, Blues Point temporary site, Barangaroo Station, Central Station and Waterloo Station. If sufficient information is not available to determine the remediation requirements and the impact on potential receivers, then detailed contamination assessments, including collection and analysis of soil and groundwater samples would be carried out. Detailed contamination assessment would also be carried out for the Barangaroo power supply route within Hickson Road and the Marrickville power supply route adjacent to Sydney Park and Camdenville Oval. In the event a Remediation Action Plan is required, these would be developed in accordance with *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998) and a site auditor would be engaged.	CDS, **AS**, **VC**, BP, BN, CS, WS, PSR

ID	Mitigation measure	Applicable location(s)[1]
SCW2	Prior to ground disturbance in high probability acid sulfate areas at Barangaroo Station, Waterloo Station and Marrickville dive site, testing would be carried out to determine the presence of acid sulfate soils. If acid sulfate soils are encountered, they would be managed in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee, 1998).	BN, WS, MDS
SCW3	Erosion and sediment control measures would be implemented in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction Volume 2* (Department of Environment and Climate Change, 2008a). Measures would be designed as a minimum for the 80th percentile; 5-day rainfall event.	All except metro rail tunnels
SCW4	Discharges from the construction water treatment plants would be monitored to ensure compliance with the discharge criteria in an environment protection licence issued to the project.	All except metro rail tunnels
SCW5	A silt curtain would be used around the Sydney Harbour ground improvement work barges.	GI
SCW6	A water quality monitoring program would be implemented to monitor water quality within Sydney Harbour during ground improvement work. The water quality monitoring program would be carried out to detect any potential impacts on the water quality of Sydney Harbour from the ground improvement work and inform management responses in the event any impacts are identified. Specific monitoring locations and frequencies would be determined during the development of the program in consultation with the Environment Protection Authority.	GI
Operation		
SCW7	Discharges from the tunnel water treatment plant would be monitored to ensure compliance with the discharge criteria determined in consultation with the NSW Environment Protection Authority.	MDS
Social impacts and community infrastructure		
SO1	Direct impacts to public open space at the Blues Point temporary site would be minimised.	BP
SO2	Specific consultation would be carried out with sensitive community facilities (including aged care, child care centres, educational institutions and places of worship) potentially impacted during construction. Consultation would aim to identify and develop measures to manage the specific construction impacts for individual sensitive community facilities.	All except metro rail tunnels
Biodiversity		
B1	An ecologist would be present during the removal of any hollow-bearing trees.	CDS
B2	Potential bat roosting locations at Central Station, Waterloo Station and Marrickville dive sites would be checked by a qualified ecologist or wildlife handler prior to demolition. Any bats found would be relocated, unless in torpor, in which case the relocation would be delayed until the end of the torpor period.	CS, WS, MDS
B3	The local WIRES group and / or veterinarian would be contacted if any fauna are injured on site or require capture and / or relocation.	All except metro rail tunnels
B4	Procedures would be developed and implemented, in accordance with the National System for the Prevention and Management of Marine Pest Incursions, during Sydney Harbour ground improvement works to avoid transportation of marine pests from other locations, particularly the marine alga Caulerpa taxifoli.	GI

ID	Mitigation measure	Applicable location(s)[1]
Flooding and hydrology		
Construction		
FH1	Detailed construction planning would consider flood risk at Barangaroo Station, Martin Place Station and the Waterloo Station construction sites. This would include identification of measures to, where feasible and reasonable, not worsen existing flooding characteristics up to and including the 100 year annual recurrence interval event in the vicinity of the project. Not worsen is defined as: • A maximum increase flood levels of 50mm in a 100 year Average Recurrence Interval flood event • A maximum increase in time of inundation of one hour in a 100 year Average Recurrence Interval flood event • No increase in the potential for soil erosion and scouring from any increase in flow velocity in a 100 year Average Recurrence Interval flood event..	BN, MP, WS
FH2	The site layout and staging of construction activities at Marrickville dive site would avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required.	MDS
FH3	Overland flow diversions during construction at the Marrickville dive site would meet the following criteria, where feasible and reasonable: • Not worsen existing flooding characteristics up to and including the 100 year annual recurrence interval event in the vicinity of the project • Dedicated evacuation routes would not be adversely impacted in flood events up to and including the probable maximum flood. This may include the requirement for changes to existing arrangements for flood warning systems and signage. Construction planning for the Marrickville dive site would be carried out in consultation with the State Emergency Services and Inner West Council. Not worsen is defined as: • A maximum increase flood levels of 50mm in a 100 year Average Recurrence Interval flood event • A maximum increase in time of inundation of one hour in a 100 year Average Recurrence Interval flood event • No increase in the potential for soil erosion and scouring from any increase in flow velocity in a 100 year Average Recurrence Interval flood event.	MDS
Operation		
FH4	Where feasible and reasonable, detailed design would result in no net increase in stormwater runoff rates in all storm events unless it can be demonstrated that increased runoff rates as a result of the project would not increase downstream flood risk.	STW, AS, MDS
FH5	Where space permits, on-site detention of stormwater would be introduced where stormwater runoff rates are increased. Where there is insufficient space for the provision of on-site detention, the upgrade of downstream infrastructure would be implemented where feasible and reasonable.	STW, AS, MDS
FH6	Detailed design would occur in consultation with Inner West Council to ensure future drainage improvement works around the Marrickville dive site would not be precluded.	MDS
FH7	Consultation would be carried out with Inner West Council to ensure flood-related outcomes of the project are consistent with any future floodplain risk management study and / or plan developed for the Marrickville Valley Catchment.	MDS

ID	Mitigation measure	Applicable location(s)[1]
FH8	The frequency of Sydney Trains rail service disruptions due to flooding would not be increased in the vicinity of the Marrickville dive structure.	MDS
FH9	Design of the project would be reviewed to, where feasible and reasonable, not worsen existing flooding characteristics up to and including the 100 year annual recurrence interval event in the vicinity of the project. Detailed flood modelling would consider: • Potential changes to flood prone land and flood levels • Potential changes to overland flow paths • Redistribution of surface runoff as a result of project infrastructure • Behaviour of existing stormwater runoff • Potential changes required to flood evacuation routes, flood warning systems and signage. Flood modelling to support detailed design would be carried out in accordance with the following guidelines: • *Floodplain Development Manual* (NSW Government, 2005b) • *Floodplain Risk Management Guideline: Practical Consideration of Climate Change* (DECC, 2007b) • *Floodplain Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW, 2010c) • *New guideline and changes to section 117 direction and EP&A Regulation on flood prone land, Planning Circular PS 07-003* (NSW Department of Planning, 2007). Flood modelling and consideration of mitigation measures would be carried out in consultation with the relevant local councils, the Office of Environment and Heritage and the State Emergency Services. Not worsen is defined as: • A maximum increase flood levels of 50mm in a 100 year Average Recurrence Interval flood event • A maximum increase in time of inundation of one hour in a 100 year Average Recurrence Interval flood event • No increase in the potential for soil erosion and scouring from any increase in flow velocity in a 100 year Average Recurrence Interval flood event.	All except metro rail tunnels
FH10	During detailed design, project infrastructure would be designed to meet the following criteria, where feasible and reasonable: • Locate station and service entrances to underground stations above the greater of the 100 year annual recurrence interval flood level plus 500mm or the probable maximum flood level • Provide site surface grading and drainage collection systems at the Chatswood and Marrickville dive structures to manage the risk of local catchment and overland flooding for events up to and including the probable maximum flood event • Locate aboveground rail system facilities (such as traction power supply sub stations) at least above the 100 year annual recurrence interval flood level plus 500mm • Protect facilities that are identified as being critical to emergency response operations from the probable maximum flood level.	All except metro rail tunnels

ID	Mitigation measure	Applicable location(s)[1]
Air quality		
AQ1	The engines of all on-site vehicles and plant would be switched off when not in use for an extended period.	All
AQ2	Plant would be well maintained and serviced to minimise emissions. Emissions from plant would be considered as part of pre-acceptance checks.	All
AQ3	Construction site layout and placement of plant would consider air quality impacts to nearby receivers.	All except metro rail tunnels
AQ4	Hard surfaces would be installed on long term haul routes and regularly cleaned.	All except metro rail tunnels
AQ5	Unsurfaced haul routes and work area would be regularly damped down in dry and windy conditions.	All except metro rail tunnels
AQ6	All vehicles carrying loose or potentially dusty material to or from the site would be fully covered.	All except metro rail tunnels
AQ7	Stockpiles would be managed to minimise dust generation.	All except metro rail tunnels
AQ8	Demolition would be managed to minimise dust generation.	All except metro rail tunnels
AQ9	Ventilation from acoustic sheds would be filtered.	CDS, CN, VC, BN, MP, PS, WS, MDS
Hazard and risk		
Construction		
HR1	All hazardous substances that may be required for construction would be stored and managed in accordance with the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005) and *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011).	All
HR2	Dial before you dig searches and non-destructive digging would be carried out to identify the presence of underground utilities.	All
HR3	A hazardous material survey would be completed for those buildings and structures suspected of containing hazardous materials (particularly asbestos) prior to their demolition. If asbestos is encountered, it would be handled and managed in accordance with relevant legislation, codes of practice and Australian standards.	CDS, CN, VC, MP, PS, CS, WS, MDS
HR4	The method for delivery of explosives would developed prior to the commencement of blasting in consultation with the Department of Planning and Environment and be timed to avoid the need for on-site storage.	CN, VC, BN, MP, PS, WS
Operation		
HR5	All hazardous substances that may be required for operation would be stored and managed in accordance with the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005) and *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011).	All

ID	Mitigation measure	Applicable location(s)[1]
Waste management		
Construction		
WM1	All waste would be assessed, classified, managed and disposed of in accordance with the *NSW Waste Classification Guidelines*.	All
WM2	100 per cent of spoil that can be reused would be beneficially reused in accordance with the project spoil reuse hierarchy.	All
WM3	A recycling target of at least 90 per cent would be adopted for the project.	All
WM4	Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	All
Operation		
WM5	Generation of operation phase waste would be minimised.	All
Sustainability		
Construction		
SUS1	Sustainability initiatives would be incorporated into the detailed design and construction of the project to support the achievement of the project sustainability objectives.	All
SUS2	A best practice level of performance would be achieved using market leading sustainability rating tools during design and construction.	All
SUS3	A workforce development and industry participation strategy would be developed and implemented during construction.	All
SUS4	Climate change risk treatments would be incorporated into the detailed design of the project including: • Ensuring that adequate flood modelling is carried out and integrated with design • Testing the sensitivity of air-conditioning systems to increased temperatures, and identify potential additional capacity of air-conditioning systems that may be required within the life of the project, with a view to safeguarding space if required • Testing the sensitivity of ventilation systems to increased temperatures and provide adequate capacity.	All
SUS5	An iterative process of greenhouse gas assessments and design refinements would be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance would be measured in terms of a percentage reduction in greenhouse gas emissions from a defined reference footprint.	All
SUS6	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	All
Operation		
SUS7	Sustainability initiatives would be incorporated into the operation of the project to support the achievement of the project sustainability objectives.	All
SUS8	Periodic review of climate change risks would be carried out to ensure ongoing resilience to the impacts of climate change.	All
SUS9	A workforce development and industry participation strategy would be developed and implemented during operation.	All
SUS10	100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation would be offset.	All

ID	Mitigation measure	Applicable location(s)[1]
Cumulative impacts		

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

1 *STW: Surface track works; CDS: Chatswood dive site; AS: Artarmon substation; CN: Crows Nest Station; VC: Victoria Cross Station; BP: Blues Point temporary site; GI: Ground improvement works; BN: Barangaroo Station; MP: Martin Place Station; PS: Pitt Street Station; CS: Central Station; WS: Waterloo Station; MDS: Marrickville dive site; Metro rail tunnels: Metro rail tunnels not related to other sites (eg TBM works); PSR: Power supply routes.*

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JUSTIFICATION AND CONCLUSION

CHAPTER NINETEEN

19 Justification and conclusion

The proposed modifications would involve changes to the approved project at Victoria Cross Station and at Artarmon substation site. The justification and outcomes for these proposed changes are outlined below.

19.1.1 Victoria Cross Station modification

The proposed modification at Victoria Cross Station was identified in response to Condition A21 of the planning approval, which required further detailed analysis of alternative locations for the northern services building in order to improve environmental outcomes. It also responds to opportunities to provide a northern station entrance to serve as a key enabler to improve access in the northern part of the North Sydney CBD and support opportunities for future growth.

The form of the northern station services building would be generally consistent with the approved project, with the addition of a lift-only station entry and plaza at this location.

The proposed modification would generally result in improved environmental outcomes as it would:

- Extend the reach of the station catchment to include additional destinations such as the Mater Hospital, the North Sydney Oval, North Sydney Boys High School, the residential and mixed use area to Falcon Street, and Neutral Bay via the footbridge over the Warringah Freeway
- Benefit customers who are expected to board or alight bus services on Miller Street at Victoria Cross Station by providing a northern entry that would improve transfer opportunities. In particular, this would benefit mobility impaired customers by reducing the distance between stops and enabling transfer to the station before reaching the busy North Sydney CBD
- Reduce the impact of the approved project on public transport services, as the bus stop at 194 Miller Street would no longer need to be temporarily located during construction. This would also reduce heritage impacts as these bus shelters are heritage listed
- Result in generally lower level exceedances of airborne noise management levels and the avoidance of ground borne noise management level exceedances on the highly noise sensitive receiver being the recording studio and theatre on the Monte Sant' Angelo Mercy College site
- Have some minor beneficial impacts as a result of the new visually open and transparent station entry and plaza at this location which is currently a vacant lot.

Some additional minor environmental impacts would also occur as a result of the proposed modification as follows:

- Although the proposed modification would remove construction traffic associated with the approved northern station services building on Miller Street between Berry and McLaren streets, there would be some additional impacts on Walker Street for southbound traffic and additional construction traffic from the northern construction site associated with the more equal distribution of spoil removal between the southern and northern construction sites
- There would be some minor to negligible impacts to local heritage items and impact on potential archaeological resources as a result of the proposed modification; however the magnitude of these impacts would be similar to those assessed for the approved project, with the elimination of impacts to the heritage listed Sydney bus shelters on Miller Street as identified above
- There would be some minor adverse landscape character and visual impacts as a result of the proposed modification; however these would be similar to impacts identified for the approved project
- The proposed modification would introduce a potential interface with new areas of low to moderate potential for contamination. In particular, contaminated fill material containing demolition waste which would disturbed during construction
- There would be some additional biodiversity impacts as a result of the proposed modification; however these would be limited to minor impacts as a result of some potential clearing of planted trees and some minor potential indirect impacts to adjacent habitat.

The proposed modification would be constructed in accordance with the Sydney Metro Construction Environmental Management Framework provided as part of the Submissions and Preferred Infrastructure Report for the approved project. While the project-specific mitigation measures identified for the approved project are generally sufficient to address the potential impacts of the proposed modification, some additional measures or changes to measures have been identified to manage specific potential impacts of the proposed modification. The relevant conditions of approval for the approved project would also apply.

Overall, the Victoria Cross Station component of the proposed modification is considered to be justified and would represent an overall beneficial outcome for the approved project; with the addition of a new northern station entry for Victoria Cross Station.

19.1.2 Artarmon substation modification

The proposed Artarmon substation component of the modification responds to Willoughby City Council and community feedback received during the exhibition of the Environmental Impact Statement and is consistent with the commitment given in the Submissions and Preferred Infrastructure Report to investigate alternative sites for the Artarmon substation.

The form of the substation in the new location at 98-104 Reserve Road would be generally consistent with the approved project, and would include an aboveground building with an associated shaft to reticulate cables to the tunnels below.

The proposed modification would result in improved environmental outcomes as it would result in lower level exceedances of airborne and ground-borne noise management levels at residential receivers due to increased distance of construction works from these receivers.

Some additional minor environmental impacts would also occur as a result of the proposed modification as follows:

- Increased level exceedances of airborne and ground-borne noise management levels at commercial receivers immediately adjacent to the proposed modification site
- Some minor adverse visual impacts during construction of the proposed modification due to the demolition of two existing buildings and the establishment of a worksite, which would be visible along Reserve Road and Whiting Street. However, it is expected that these elements would be visually absorbed into the character of the surrounding industrial landscape
- Introduce a potential interface with new areas of potential for contamination associated with current and past land uses (moderate risk), previous demolition of residential dwellings at the site (low to moderate risk) and potential waste materials from nearby brick kilns used as fill on-site (low risk).

The proposed modification would be constructed in accordance with the Sydney Metro Construction Environmental Management Framework provided as part of the Submissions and Preferred Infrastructure Report for the approved project. While the project-specific mitigation measures identified for the approved project are generally sufficient to address the potential impacts of the proposed modification, some additional measures or changes to measures have been identified to manage specific potential impacts of the proposed modification. The relevant conditions of approval for the approved project would also apply.

Overall, the Artarmon substation component of the proposed modification is considered to be justified and would represent an overall beneficial outcome for the approved project with reduced noise and amenity impacts and improved land use compatibility.

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GLOSSARY

Glossary

Term	Definition
AHIMS	Aboriginal Heritage Information Management System
BOM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
dB	Decibels
dBA	A-weighted decibels
DCP	Development Control Plan
DoS	Degree of saturation
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ETCM	Enhanced Train Crowding Model
FBA	Framework for Biodiversity Assessment
FM Act	*Fisheries Management Act 1994*
GML	Godden Mackay Logan
HCA	Heritage Conservation Area
Hz	Hertz
ICNG	Interim Construction Noise Guideline
ICOMOS	International Council on Monuments and Sites
INP	Industrial Noise Policy
LEP	Local Environmental Plan
LGA	Local Government Area
LoS	Level of service
NCAs	Noise catchment areas
NMLs	Noise management levels
NW Act	*Noxious Weeds Act 1993*
OEH	Office of Environment and Heritage
pH	Potential of hydrogen
PPV	Peak Particle Velocity
PTPM	Public Transport Project Model
RBL	Rating background level
RNP	Road Noise Policy
Roads and Maritime	Roads and Maritime Services
SRZ	Structural Root Zone
SWL	Sound power level
TPZ	Tree Protection Zone
TSC Act	*Threatened Species Conservation Act 1995*
v/c	Ratio between traffic volumes and capacity
VDV	Vibration Dose Value

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SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

APPENDIX A

Secretary's environmental assessment requirements

Desired Performance Outcome	Requirement	Where addressed
1. **Environmental Impact Assessment Process** **The process for assessment of the proposal is transparent, balanced, well focussed and legal.**	**1.** The Environmental Impact Statement must be prepared in accordance with Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (the Regulation).	Not applicable
	2. It is the Proponent's responsibility to determine whether the project needs to be referred to the Commonwealth Department of the Environment for an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Proponent must contact the Commonwealth Department of the Environment immediately if it is determined that an approval is required under the EPBC Act, as supplementary environmental assessment requirements may need to be issued to ensure a streamlined assessment under the Bilateral agreement can be achieved. **3.** Where the project requires approval under the EPBC Act and is being assessed under the Bilateral Agreement the EIS should address: **a.** Consideration of any Protected Matters that may be impacted by the development where the Commonwealth Minister has determined that the proposal is a Controlled Action. **b.** Identification and assessment of those Protected Matters that are likely to be significantly impacted. **c.** Details of how significant impacts to Protected Matters have been avoided, mitigated and, if necessary, offset. **d.** Consideration of, and reference to, any relevant conservation advices, recovery plans and threat abatement plans. **4.** The onus is on the Proponent to ensure legislative requirements relevant to the project are met.	Chapter 4

Desired Performance Outcome	Requirement	Where addressed
2. Environmental Impact Statement **The project is described in sufficient detail to enable clear understanding that the project has been developed through an iterative process of impact identification and assessment and project refinement to avoid, minimise or offset impacts so that the project, on balance, has the least adverse environmental, social and economic impact, including its cumulative impacts.**	**1.** The EIS must include, but not necessarily be limited to, the following: **a.** executive summary; **b.** a description of the project, including all components and activities (including ancillary components and activities) required to construct and operate it; **c.** a statement of the objective(s) of the project; **d.** a summary of the strategic need for the project with regard to its critical State significance and relevant State Government policy; **e.** an analysis of any feasible alternatives to the project; **f.** a description of feasible options within the project; **g.** a description of how alternatives to and options within the project were analysed to inform the selection of the preferred alternative / option. The description must contain sufficient detail to enable an understanding of why the preferred alternative to and options(s) within the project were selected; **h.** potential opportunities for further network expansion and consideration of relationship to other Government public transport initiatives; a concise description of the general biophysical and socioeconomic environment that is likely to be impacted by the project (including offsite impacts). Elements of the environment that are not likely to be affected by the project do not need to be described; **i.** a demonstration of how the project design has been developed to avoid or minimise likely adverse impacts; **j.** the identification and assessment of key issues as provided in the 'Assessment of Key Issues' performance outcome; **k.** a statement of the outcome(s) the proponent will achieve for each key issue; **l.** measures to avoid, minimise or offset impacts must be linked to the impact(s) they treat, so it is clear which measures will be applied to each impact; **m.** an assessment of the cumulative impacts of the project taking into account other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed (for example WestConnex, Barangaroo, any approved construction in the relevant precincts);	Not applicable, however the following is noted: - Description of the modification is provided in Chapters 6 and 7 - Need and justification for the modification is provided in Chapter 2 - Options analysis for the elements of the modification is provided in Chapter 3

Desired Performance Outcome	Requirement	Where addressed
	n. statutory context of the project as a whole, including: – how the project meets the provisions of the EP&A Act and EP&A Regulation; – a list of any approvals that must be obtained under any other Act or law before the project may lawfully be carried out; **o.** a chapter that synthesises the environmental impact assessment and provides: – a succinct but full description of the project for which approval is sought; – a description of any uncertainties that still exist around design, construction methodologies and/or operational methodologies and how these will be resolved in the next stages of the project; – a compilation of the impacts of the project that have not been avoided; – a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or offset these impacts; – a compilation of the outcome(s) the proponent will achieve; and – the reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts. **p.** relevant project plans, drawings, diagrams in an electronic format that enables integration with mapping and other technical software. **2.** The EIS must only include data and analysis that is reasonably needed to make a decision on the proposal. Relevant information must be succinctly summarised in the EIS and included in full in appendices. Irrelevant, conflicting or duplicated information must be avoided.	

Desired Performance Outcome	Requirement	Where addressed
3. Assessment of Key Issues* **Key issue impacts are assessed objectively and thoroughly to provide confidence that the project will be constructed and operated within acceptable levels of impact.** * Key issues are nominated by the Proponent in the CSSI project application and by the Department in the SEARs. Key issues need to be reviewed throughout the preparation of the EIS to ensure any new key issues that emerge are captured. The key issues identified in this document are not exhaustive but are key issues common to most CSSI projects.	**1.** The level of assessment of likely impacts must be proportionate to the significance of, or degree of impact on, the issue, within the context of the proposal location and the surrounding environment. The level of assessment must be commensurate to the degree of impact and sufficient to ensure that the Department and other government agencies are able to understand and assess impacts.	Chapters 9 to 17
	2. For each key issue the Proponent must: **a.** describe the biophysical and socio-economic environment, as far as it is relevant to that issue; **b.** describe the legislative and policy context, as far as it is relevant to the issue; **c.** identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts; **d.** demonstrate how potential impacts have been avoided (through design, or construction or operation methodologies); **e.** detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant).	Chapters 9 to 17
	3. Where multiple reasonable and feasible options to avoid or minimise impacts are available, they must be identified and considered and the proposed measure justified taking into account the public interest.	Chapter 3
4. Consultation **The project is developed with meaningful and effective engagement during project design and delivery.**	**1.** The project must be informed by consultation, including with relevant government agencies, infrastructure and service providers, special interest groups, affected landowners, businesses and the community. The consultation process must be undertaken in accordance with the current guidelines. **2.** The Proponent must document the consultation process, and demonstrate how the project has responded to the inputs received. **3.** The Proponent must describe the timing and type of community consultation proposed during the design and delivery of the project, the mechanisms for community feedback, the mechanisms for keeping the community informed, and procedures for complaints handling and resolution.	Chapter 5

Desired Performance Outcome	Requirement	Where addressed
5. Biodiversity **The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity.** **Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.**	**1.** The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA). **2.** The Proponent must assess any impacts on biodiversity values not covered by the FBA as specified in s2.3. **3.** The Proponent must assess impacts on the following [EECs, threatened species and/or populations] and provide the information specified in s9.2 of the FBA. **4.** The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the *Threatened Species Conservation Act 1997* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environmental Protection and Biodiversity Conservation Act 2000* (EPBC Act).	Not applicable
6. Flooding **The project minimises adverse impacts on existing flooding characteristics.** **Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure.**	**1.** The Proponent must assess and model (where required), taking into account any relevant Council-adopted flood model or latest flood data available from Councils, the impacts on flood behaviour during construction and operation for a full range of flood events up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including: **a.** any detrimental increases in the potential flood affectation of other properties, assets and infrastructure; **b.** consistency (or inconsistency) with applicable Council floodplain risk management plans; **c.** compatibility with the flood hazard of the land; **d.** compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land; **e.** downstream velocity and scour potential; **f.** impacts the development may have upon existing community emergency management arrangements for flooding. These matters must be discussed with the State Emergency Services and Council; and **g.** any impacts the development may have on the social and economic costs to the community as consequence of flooding.	Not applicable

Desired Performance Outcome	Requirement	Where addressed
7. Heritage **The design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places.** **The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.**	**1.** The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of:	Chapter 12 Chapter 13 Chapter 17
	a. Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines;	Chapter 13
	b. Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan;	Chapter 13
	c. environmental heritage, as defined under the *Heritage Act 1977*; and **d.** items listed on the National and World Heritage lists. **2.** Where impacts to State or locally significant heritage items are identified, the assessment must: **a.** include a statement of heritage impact for all heritage items (including significance assessment); **b.** consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant);	Chapter 12
	c. outline measures to avoid and minimise those impacts in accordance with the current guidelines; and	Chapter 12 Chapter 13
	d. be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria).	Chapter 12 Chapter 13
	3. Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the Code of Practice for *Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010).	Not applicable
	4. Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines.	Not applicable

Desired Performance Outcome	Requirement	Where addressed
8. Noise and Vibration – Amenity Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community.	**1.** The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers including commercial premises, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	Chapter 10
	2. If blasting is required, the relevant requirements of *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (ANZEC 1990) are to be assessed.	Chapter 10
9. Noise and Vibration – Structural Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage. Increases in noise emissions and vibration affecting environmental heritage as defined in the *Heritage Act 1977* during operation of the project are effectively managed.	**1.** The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Chapter 10 Chapter 12
	2. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Chapter 10

Desired Performance Outcome	Requirement	Where addressed
10. Socio-economic, Land Use and Property The project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities. The project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure.	**1.** The Proponent must assess social and economic impacts in accordance with the current guidelines.	Not applicable
	2. The Proponent must assess impacts from construction and operation on potentially affected properties, approved development applications, businesses, public open space, recreational users and land and water users (for example, recreational and commercial fishers, oyster farmers), including property acquisitions/adjustments, access, amenity and relevant statutory rights.	Chapter 8 Chapter 9 Chapter 11 Chapter 14
	3. Assess the likely risks of the project to public safety, paying particular attention to subsidence risks, bushfire risks and the handling and use of dangerous goods.	Not applicable
11. Soils The environmental values of land, including soils, subsoils and landforms, are protected. Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination.	**1.** The Proponent must verify the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) within, and in the area likely to be impacted by, the project.	Not applicable
	2. The Proponent must assess the impact of the project on acid sulfate soils (including impacts of acidic runoff offsite) in accordance with the current guidelines.	Not applicable
	3. The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Chapter 16
	4. The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the project area.	Not applicable
	5. The Proponent must assess the impacts of the project on soil salinity and how it may affect groundwater resources and hydrology.	Not applicable
	6. The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Not applicable

Desired Performance Outcome	Requirement	Where addressed
12. Sustainability The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources. Conservation of natural resources is maximised.	**1.** The Proponent must assess the project against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	Not applicable
13. Transport and Traffic Network connectivity, safety and efficiency of the transport system in the vicinity of the project are managed to minimise impacts. The safety of transport system customers is maintained. Impacts on network capacity and the level of service are effectively managed. Works are compatible with existing infrastructure and future transport corridors.	**1.** The Proponent must assess construction transport and traffic (vehicle, pedestrian and cyclists) impacts, including, but not necessarily limited to:	Chapter 9
	a. a considered approach to route identification and scheduling of transport movements;	Chapter 9
	b. the number, frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements);	Chapter 9
	c. the capacity of or need to upgrade roads proposed as construction vehicle routes including Bedwin Road;	Chapter 9
	d. changes to existing local and regional road networks including access to and around the proposed Chatswood tunnelling site;	Chapter 9
	e. construction worker parking;	Chapter 9
	f. the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times and sensitive road users and parking arrangements), including access to the Overseas Passenger Terminal for deliveries and passenger coaches;	Chapter 9
	g. details of how construction and scheduling of works are to be coordinated in regard to public events; cumulative traffic impacts resulting from concurrent work on Westconnex, Barangaroo, Sydney Light Rail and other key construction projects in the Sydney CBD;	Not applicable
	h. alternatives to road transport of construction spoil;	Chapter 9
	i. access constraints and impacts on public transport, pedestrian access and cyclists;	Chapter 9
	j. the need to close, divert or otherwise reconfigure elements of the road and cycle network associated with construction of the project;	Chapter 9
	k. assess the likely risks of the project to public safety, paying particular attention to pedestrian safety and users of Sydney Harbour; and	Chapter 9

Desired Performance Outcome	Requirement	Where addressed
	l. impacts to water based traffic and shipping channels on users of Sydney Harbour with particular reference to the channel between Blues Point and Millers Point for passage to and from White Bay, Glebe Island and Gore Cove.	Not applicable
	2. The Proponent must assess the operational transport impacts of the project, including: **a.** forecast travel demand and traffic volumes for the project and the surrounding road, cycle and public transport network; **b.** travel time analysis; **c.** performance of interchanges and intersections by undertaking a coordinated level of service analysis at locations affected by stations; **d.** wider transport interactions (local and regional roads, permanent loss of parking, the need for kiss and ride facilities, cycling, public and freight transport); **e.** induced traffic and operational implications for public transport (particularly with respect to strategic bus corridors and bus routes) and consideration of opportunities to improve public transport; **f.** impacts to pedestrian access in and around stations and connecting streets, capacity of streets at peak pedestrian times, including phasing of traffic lights, intersection crossing times and connectivity between stations **g.** assess the benefits to each station and the general vicinity of walking and cycling catchments and the provision of infrastructure to support sustainable transport options. **h.** impacts on cyclists and pedestrian access and safety; and **i.** opportunities to integrate cycling and pedestrian elements with surrounding networks and in the project.	Chapter 9

Desired Performance Outcome	Requirement	Where addressed
14 Urban design **The project design complements the visual amenity, character and quality of the surrounding environment.** **The project contributes to the accessibility and connectivity of communities.**	**1.** The Proponent must: **a.** identify the urban design and landscaping aspects of the project and its components; **b.** include consideration of urban design principles adopted by each council or within each station precinct; **c.** assess the impact of the project on the urban, rural and natural fabric; **d.** explore the use of Crime Prevention Through Environmental Design (CPTED) principles during the design development process, including natural surveillance, lighting, walkways, signage and landscape; and **e.** identify urban design strategies and opportunities to enhance healthy, cohesive and inclusive communities.	Chapter 6 Chapter 14
15. Visual Amenity **The project minimises adverse impacts on the visual amenity of the built and natural environment (including public open space) and capitalises on opportunities to improve visual amenity.**	**1.** The Proponent must assess the visual impact of the project and any ancillary infrastructure on: **a.** views and vistas; **b.** streetscapes, key sites and buildings; **c.** the local community. **2.** The Proponent must provide artist impressions and perspective drawings of the project to illustrate how the project has responded to the visual impact through urban design and landscaping.	Chapter 14
16. Waste **All wastes generated during the construction and operation of the project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects environmental values.**	**1.** The Proponent must assess predicted waste generated from the project during construction and operation, including: **a.** a) classification of the waste in accordance with the current guidelines; **b.** b) estimates / details of the quantity of bulk earthworks and spoil balance to be generated during construction of the project; **c.** c) handling of waste including measures to facilitate segregation and prevent cross contamination; **d.** d) management of waste including indicative location and volume of stockpiles; **e.** e) waste minimisation and reuse; **f.** f) lawful disposal or recycling locations for each type of waste using a hierarchy which prioritises higher value end use; and **g.** g) contingencies for the above, including managing unexpected waste volumes. **2.** The Proponent must assess potential environmental impacts from the excavation, handling, storage on site and transport of the waste particularly with relation to sediment/leachate control, noise and dust.	Not applicable

Desired Performance Outcome	Requirement	Where addressed
17. Water – Hydrology Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised. The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved). Sustainable use of water resources.	**1.** The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the FBA.	Chapter 15 Chapter 17
	2. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	Chapter 15 Chapter 17
	a. natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	Not applicable
	b. impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement;	Chapter 15
	c. changes to environmental water availability and flows, both regulated/licensed and unregulated/ rules-based sources;	Not applicable
	d. direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses;	Not applicable
	e. minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the conveyance capacity of existing stormwater systems where discharges are proposed through such systems; and	Chapter 15
	f. water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Chapter 15
	3. The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	Not applicable

Desired Performance Outcome	Requirement	Where addressed
18. Water – Quality The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable).	**1.** The Proponent must: **a.** state the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values; **b.** identify all pollutants that may be introduced into the water cycle and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment; **c.** identify the rainfall event that the water quality protection measures will be designed to cope with; **d.** assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes; **e.** demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: – where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and – where the NSW WQOs are not currently being met, activities will work toward their achievement over time; **f.** justify, if required, why the WQOs cannot be maintained or achieved over time; **g.** demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented; **h.** identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; and **i.** identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Not applicable
19. Utilities The project is designed, construction and operated to minimise impacts to utilities and provision of such to the public.	**1.** The Proponent must consider: **a.** the impact of the project on the integrity of trunk assets and the need to augment or relocate; **b.** opportunities to support initiatives adopted by Councils and utilities providers; and **c.** how access to assets will be maintained during construction.	Not applicable

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NOISE AND VIBRATION TECHNICAL INFORMATION

APPENDIX B

Victoria Cross

Construction Airborne Noise Assessment Results

Table 1 NML Exceedances - Enabling Works - Worst-Case Impacts

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver LAeq(15minute) (dBA)				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			Worst-case[1]	Typical Range				0 dB	1-10dB	11-20dB	>20dB	
		Day		Lower[3]	To	Upper[2]						
Establishment of site compounds												
A	RES	75	75	58	To	67	1	1	-	-	-	0
B	COM	70	76	62	To	71	1	-	1	-	-	0
C	RES	75	69	57	To	66	11	11	-	-	-	0
D	RES	75	75	59	To	71	3	3	-	-	-	0
E	OED	55	73	57	To	69	1	-	-	1	-	0
E	OCC	50	68	49	To	64	1	-	-	1	-	0
E	OTH	50	55	44	To	54	1	-	1	-	-	0
E	RES	75	71	52	To	65	3	3	-	-	-	0
F	OED	55	66	49	To	61	2	1	1	-	-	0
G	OCB	60	65	49	To	60	1	1	-	-	-	0
G	RES	75	59	47	To	56	9	9	-	-	-	0
G	OTH	50	51	38	To	49	1	1	-	-	-	0
G	OED	55	50	33	To	47	4	4	-	-	-	0
G	OPW	55	48	36	To	45	1	1	-	-	-	0
H	COM	70	64	45	To	57	9	9	-	-	-	0
H	OOP	60	51	36	To	45	1	1	-	-	-	0
H	RES	75	51	43	To	47	23	23	-	-	-	0
Clearance and diversion of services												
A	RES	75	74	57	To	66	1	1	-	-	-	0
B	COM	70	75	61	To	70	1	1	-	-	-	0
C	RES	75	68	56	To	65	11	11	-	-	-	0
D	RES	75	74	58	To	70	3	3	-	-	-	0
E	OED	55	72	56	To	68	1	-	-	1	-	0
E	OCC	50	67	48	To	63	1	-	-	1	-	0
E	OTH	50	54	43	To	53	1	-	1	-	-	0
E	RES	75	70	51	To	64	3	3	-	-	-	0
F	OED	55	65	48	To	60	2	1	1	-	-	0
G	OCB	60	64	48	To	59	1	1	-	-	-	0
G	RES	75	58	46	To	55	9	9	-	-	-	0
G	OTH	50	50	37	To	48	1	1	-	-	-	0
G	OED	55	49	32	To	46	4	4	-	-	-	0
G	OPW	55	47	35	To	44	1	1	-	-	-	0
H	COM	70	63	44	To	56	9	9	-	-	-	0
H	OOP	60	50	35	To	44	1	1	-	-	-	0
H	RES	75	50	42	To	46	23	23	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 2 NML Exceedances - Enabling Works - Supporting Works Only

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			LAeq(15minute) (dBA)									
			Worst-case[1]	Typical Range								
		Day		Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Establishment of site compounds												
A	RES	75	72	55	To	64	1	1	-	-	-	0
B	COM	70	73	59	To	68	1	1	-	-	-	0
C	RES	75	66	54	To	63	11	11	-	-	-	0
D	RES	75	72	56	To	68	3	3	-	-	-	0
E	OED	55	70	54	To	66	1	-	-	1	-	0
E	OCC	50	65	46	To	61	1	-	-	1	-	0
E	OTH	50	52	41	To	51	1	-	1	-	-	0
E	RES	75	68	49	To	62	3	3	-	-	-	0
F	OED	55	63	46	To	58	2	1	1	-	-	0
G	OCB	60	62	46	To	57	1	1	-	-	-	0
G	RES	75	56	44	To	53	9	9	-	-	-	0
G	OTH	50	48	35	To	46	1	1	-	-	-	0
G	OED	55	47	30	To	44	4	4	-	-	-	0
G	OPW	55	45	33	To	42	1	1	-	-	-	0
H	COM	70	61	42	To	54	9	9	-	-	-	0
H	OOP	60	48	33	To	42	1	1	-	-	-	0
H	RES	75	48	40	To	44	23	23	-	-	-	0
Clearance and diversion of services												
A	RES	75	73	56	To	65	1	1	-	-	-	0
B	COM	70	74	60	To	69	1	1	-	-	-	0
C	RES	75	67	55	To	64	11	11	-	-	-	0
D	RES	75	73	57	To	69	3	3	-	-	-	0
E	OED	55	71	55	To	67	1	-	-	1	-	0
E	OCC	50	66	47	To	62	1	-	-	1	-	0
E	OTH	50	53	42	To	52	1	-	1	-	-	0
E	RES	75	69	50	To	63	3	3	-	-	-	0
F	OED	55	64	47	To	59	2	1	1	-	-	0
G	OCB	60	63	47	To	58	1	1	-	-	-	0
G	RES	75	57	45	To	54	9	9	-	-	-	0
G	OTH	50	49	36	To	47	1	1	-	-	-	0
G	OED	55	48	31	To	45	4	4	-	-	-	0
G	OPW	55	46	34	To	43	1	1	-	-	-	0
H	COM	70	62	43	To	55	9	9	-	-	-	0
H	OOP	60	49	34	To	43	1	1	-	-	-	0
H	RES	75	49	41	To	45	23	23	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 3 NML Exceedances - Earthworks - Worst-Case Impacts

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			LAeq(15minute) (dBA)									
			Worst-case[1]	Typical Range								
		Day		Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Piling works												
A	RES	75	80	64	To	69	1	1	-	-	-	0
B	COM	70	81	72	To	76	1	-	1	-	-	0
C	RES	75	74	70	To	71	11	11	-	-	-	0
D	RES	75	67	64	To	65	3	3	-	-	-	0
E	OED	55	66	62	To	63	1	-	1	-	-	0
E	OCC	50	56	54	To	54	1	-	1	-	-	0
E	OTH	50	53	49	To	51	1	-	1	-	-	0
E	RES	75	61	57	To	59	3	3	-	-	-	0
F	OED	55	57	54	To	55	2	2	-	-	-	0
G	OCB	60	70	64	To	65	1	-	1	-	-	0
G	RES	75	64	60	To	61	9	9	-	-	-	0
G	OTH	50	56	48	To	54	1	-	1	-	-	0
G	OED	55	55	47	To	52	4	4	-	-	-	0
G	OPW	55	53	49	To	50	1	1	-	-	-	0
H	COM	70	69	59	To	62	9	9	-	-	-	0
H	OOP	60	56	45	To	50	1	1	-	-	-	0
H	RES	75	56	52	To	52	23	23	-	-	-	0
Construction of working platform												
A	RES	75	80	64	To	69	1	1	-	-	-	0
B	COM	70	81	72	To	76	1	-	1	-	-	0
C	RES	75	74	70	To	71	11	11	-	-	-	0
D	RES	75	67	64	To	65	3	3	-	-	-	0
E	OED	55	66	62	To	63	1	-	1	-	-	0
E	OCC	50	56	54	To	54	1	-	1	-	-	0
E	OTH	50	53	49	To	51	1	-	1	-	-	0
E	RES	75	61	57	To	59	3	3	-	-	-	0
F	OED	55	57	54	To	55	2	2	-	-	-	0
G	OCB	60	70	64	To	65	1	-	1	-	-	0
G	RES	75	64	60	To	61	9	9	-	-	-	0
G	OTH	50	56	48	To	54	1	-	1	-	-	0
G	OED	55	55	47	To	52	4	4	-	-	-	0
G	OPW	55	53	49	To	50	1	1	-	-	-	0
H	COM	70	69	59	To	62	9	9	-	-	-	0
H	OOP	60	56	45	To	50	1	1	-	-	-	0
H	RES	75	56	52	To	52	23	23	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 4 NML Exceedances - Earthworks - Supporting Works Only

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			LAeq(15minute) (dBA)									
			Worst-case[1]	Typical Range								
		Day		Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Piling works												
A	RES	75	78	62	To	67	1	1	-	-	-	0
B	COM	70	79	70	To	74	1	-	1	-	-	0
C	RES	75	72	68	To	69	11	11	-	-	-	0
D	RES	75	65	62	To	63	3	3	-	-	-	0
E	OED	55	64	60	To	61	1	-	1	-	-	0
E	OCC	50	54	52	To	52	1	-	1	-	-	0
E	OTH	50	51	47	To	49	1	1	-	-	-	0
E	RES	75	59	55	To	57	3	3	-	-	-	0
F	OED	55	55	52	To	53	2	2	-	-	-	0
G	OCB	60	68	62	To	63	1	-	1	-	-	0
G	RES	75	62	58	To	59	9	9	-	-	-	0
G	OTH	50	54	46	To	52	1	-	1	-	-	0
G	OED	55	53	45	To	50	4	4	-	-	-	0
G	OPW	55	51	47	To	48	1	1	-	-	-	0
H	COM	70	67	57	To	60	9	9	-	-	-	0
H	OOP	60	54	43	To	48	1	1	-	-	-	0
H	RES	75	54	50	To	50	23	23	-	-	-	0
Construction of working platform												
A	RES	75	75	59	To	64	1	1	-	-	-	0
B	COM	70	76	67	To	71	1	-	1	-	-	0
C	RES	75	69	65	To	66	11	11	-	-	-	0
D	RES	75	62	59	To	60	3	3	-	-	-	0
E	OED	55	61	57	To	58	1	-	1	-	-	0
E	OCC	50	51	49	To	49	1	1	-	-	-	0
E	OTH	50	48	44	To	46	1	1	-	-	-	0
E	RES	75	56	52	To	54	3	3	-	-	-	0
F	OED	55	52	49	To	50	2	2	-	-	-	0
G	OCB	60	65	59	To	60	1	1	-	-	-	0
G	RES	75	59	55	To	56	9	9	-	-	-	0
G	OTH	50	51	43	To	49	1	1	-	-	-	0
G	OED	55	50	42	To	47	4	4	-	-	-	0
G	OPW	55	48	44	To	45	1	1	-	-	-	0
H	COM	70	64	54	To	57	9	9	-	-	-	0
H	OOP	60	51	40	To	45	1	1	-	-	-	0
H	RES	75	51	47	To	47	23	23	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver
Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver
Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver
Note 4: Based on Typical Upper noise level
Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 5 NML Exceedances - Construction of Acoustic Shed - Worst-Case Impacts

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			LAeq(15minute) (dBA)									
			Worst-case[1]	Typical Range								
		Day		Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Construction of Acoustic Shed												
A	RES	75	76	63	To	63	1	1	-	-	-	1
B	COM	70	77	67	To	67	1	1	-	-	-	0
C	RES	75	71	66	To	66	11	11	-	-	-	0
D	RES	75	69	65	To	65	3	3	-	-	-	0
E	OED	55	70	63	To	63	1	-	1	-	-	0
E	OCC	50	60	54	To	54	1	-	1	-	-	0
E	OTH	50	55	51	To	51	1	-	1	-	-	0
E	RES	75	61	57	To	57	3	3	-	-	-	0
F	OED	55	58	55	To	55	2	2	-	-	-	0
G	OCB	60	64	60	To	60	1	1	-	-	-	0
G	RES	75	60	55	To	55	9	9	-	-	-	0
G	OTH	50	53	47	To	47	1	1	-	-	-	0
G	OED	55	50	42	To	42	4	4	-	-	-	0
G	OPW	55	50	43	To	43	1	1	-	-	-	0
H	COM	70	63	56	To	56	9	9	-	-	-	0
H	OOP	60	50	44	To	44	1	1	-	-	-	0
H	RES	75	52	48	To	48	23	23	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 6 NML Exceedances - Excavation - Worst-Case Impacts

Receiver Area	Type	NMLs					Noise Level at Worst Affected Receiver		NML Exceedance at Worst Affected Receiver[6]					Total Number of Receivers in Catchment	Number of 'Highly Noise Affected'[5]
							Worst-case[1]								
		Day	DOOH	EVE	Night	SD	$L_{Aeq(15m)}$	$L_{Aeq(1m)}$	Day	DOOH	EVE	Night	SD		
Excavation of rippable material															
A	RES	75	70	62	56	66	60	n/a	0	0	n/a	n/a	n/a	1	0
B	COM	70	70	n/a	n/a	n/a	58	n/a	0	0	n/a	n/a	n/a	1	0
C	RES	75	70	62	56	66	54	n/a	0	0	n/a	n/a	n/a	11	0
D	RES	75	70	62	56	66	51	n/a	0	0	n/a	n/a	n/a	3	0
E	OED	55	n/a	n/a	n/a	n/a	50	n/a	0	0	n/a	n/a	n/a	1	0
E	OCC	50	50	n/a	n/a	n/a	42	n/a	0	0	n/a	n/a	n/a	1	0
E	OTH	50	50	50	n/a	n/a	36	n/a	0	0	n/a	n/a	n/a	1	0
E	RES	75	70	62	56	66	44	n/a	0	0	n/a	n/a	n/a	3	0
F	OED	55	n/a	n/a	n/a	n/a	42	n/a	0	0	n/a	n/a	n/a	2	0
G	OCB	60	60	60	60	n/a	49	n/a	0	0	n/a	n/a	n/a	1	0
G	RES	75	70	62	56	66	44	n/a	0	0	n/a	n/a	n/a	9	0
G	OTH	50	50	50	n/a	n/a	37	n/a	0	0	n/a	n/a	n/a	1	0
G	OED	55	n/a	n/a	n/a	n/a	32	n/a	0	0	n/a	n/a	n/a	4	0
G	OPW	55	55	n/a	n/a	n/a	36	n/a	0	0	n/a	n/a	n/a	1	0
H	COM	70	70	n/a	n/a	n/a	47	n/a	0	0	n/a	n/a	n/a	9	0
H	OOP	60	60	60	n/a	n/a	38	n/a	0	0	n/a	n/a	n/a	1	0
H	RES	75	70	62	56	66	38	n/a	0	0	n/a	n/a	n/a	23	0
Excavation using rockbreakers															
A	RES	75	70	62	56	66	68	n/a	0	0	n/a	n/a	n/a	1	0
B	COM	70	70	n/a	n/a	n/a	66	n/a	0	0	n/a	n/a	n/a	1	0
C	RES	75	70	62	56	66	62	n/a	0	0	n/a	n/a	n/a	11	0
D	RES	75	70	62	56	66	59	n/a	0	0	n/a	n/a	n/a	3	0
E	OED	55	n/a	n/a	n/a	n/a	58	n/a	3	0	n/a	n/a	n/a	1	0
E	OCC	50	50	n/a	n/a	n/a	50	n/a	0	0	n/a	n/a	n/a	1	0
E	OTH	50	50	50	n/a	n/a	44	n/a	0	0	n/a	n/a	n/a	1	0
E	RES	75	70	62	56	66	52	n/a	0	0	n/a	n/a	n/a	3	0
F	OED	55	n/a	n/a	n/a	n/a	50	n/a	0	0	n/a	n/a	n/a	2	0
G	OCB	60	60	60	60	n/a	57	n/a	0	0	n/a	n/a	n/a	1	0
G	RES	75	70	62	56	66	52	n/a	0	0	n/a	n/a	n/a	9	0
G	OTH	50	50	50	n/a	n/a	45	n/a	0	0	n/a	n/a	n/a	1	0
G	OED	55	n/a	n/a	n/a	n/a	40	n/a	0	0	n/a	n/a	n/a	4	0
G	OPW	55	55	n/a	n/a	n/a	44	n/a	0	0	n/a	n/a	n/a	1	0
H	COM	70	70	n/a	n/a	n/a	55	n/a	0	0	n/a	n/a	n/a	9	0
H	OOP	60	60	60	n/a	n/a	46	n/a	0	0	n/a	n/a	n/a	1	0
H	RES	75	70	62	56	66	46	n/a	0	0	n/a	n/a	n/a	23	0
Excavation using drill and blast															
A	RES	75	70	62	56	66	69	n/a	0	0	n/a	n/a	n/a	1	0
B	COM	70	70	n/a	n/a	n/a	67	n/a	0	0	n/a	n/a	n/a	1	0
C	RES	75	70	62	56	66	63	n/a	0	0	n/a	n/a	n/a	11	0
D	RES	75	70	62	56	66	60	n/a	0	0	n/a	n/a	n/a	3	0
E	OED	55	n/a	n/a	n/a	n/a	59	n/a	4	0	n/a	n/a	n/a	1	0
E	OCC	50	50	n/a	n/a	n/a	51	n/a	1	1	n/a	n/a	n/a	1	0
E	OTH	50	50	50	n/a	n/a	45	n/a	0	0	n/a	n/a	n/a	1	0
E	RES	75	70	62	56	66	53	n/a	0	0	n/a	n/a	n/a	3	0
F	OED	55	n/a	n/a	n/a	n/a	51	n/a	0	0	n/a	n/a	n/a	2	0
G	OCB	60	60	60	60	n/a	58	n/a	0	0	n/a	n/a	n/a	1	0
G	RES	75	70	62	56	66	53	n/a	0	0	n/a	n/a	n/a	9	0

Receiver Area	Type	NMLs					Noise Level at Worst Affected Receiver		NML Exceedance at Worst Affected Receiver[6]					Total Number of Receivers in Catchment	Number of 'Highly Noise Affected'[5]
							Worst-case[1]								
		Day	DOOH	EVE	Night	SD	$L_{Aeq(15m)}$	$L_{Aeq(1m)}$	Day	DOOH	EVE	Night	SD		
G	OTH	50	50	50	n/a	n/a	46	n/a	0	0	n/a	n/a	n/a	1	0
G	OED	55	n/a	n/a	n/a	n/a	41	n/a	0	0	n/a	n/a	n/a	4	0
G	OPW	55	55	n/a	n/a	n/a	45	n/a	0	0	n/a	n/a	n/a	1	0
H	COM	70	70	n/a	n/a	n/a	56	n/a	0	0	n/a	n/a	n/a	9	0
H	OOP	60	60	60	n/a	n/a	47	n/a	0	0	n/a	n/a	n/a	1	0
H	RES	75	70	62	56	66	47	n/a	0	0	n/a	n/a	n/a	23	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Note 6: Use of heavy plant precluded from evening and night-time periods

Table 7 NML Exceedances - Excavation Works - Supporting Works Only

Receiver Area	Type	NMLs					Noise Level at Worst Affected Receiver		NML Exceedance at Worst Affected Receiver					Total Number of Receivers in Catchment	Number of 'Highly Noise Affected'[5]
							Worst-case[1]								
		Day	DOOH	EVE	Night	SD	$L_{Aeq(15m)}$	$L_{Aeq(1m)}$	Day	DOOH	EVE	Night	SD		
Excavation of rippable material															
A	RES	75	70	62	56	66	54	54	0	0	0	0	0	1	0
B	COM	70	70	n/a	n/a	n/a	52	52	0	0	0	0	0	1	0
C	RES	75	70	62	56	66	48	48	0	0	0	0	0	11	0
D	RES	75	70	62	56	66	45	45	0	0	0	0	0	3	0
E	OED	55	n/a	n/a	n/a	n/a	44	44	0	0	0	0	0	1	0
E	OCC	50	50	n/a	n/a	n/a	36	36	0	0	0	0	0	1	0
E	OTH	50	50	50	n/a	n/a	30	30	0	0	0	0	0	1	0
E	RES	75	70	62	56	66	38	38	0	0	0	0	0	3	0
F	OED	55	n/a	n/a	n/a	n/a	36	36	0	0	0	0	0	2	0
G	OCB	60	60	60	60	n/a	43	43	0	0	0	0	0	1	0
G	RES	75	70	62	56	66	38	38	0	0	0	0	0	9	0
G	OTH	50	50	50	n/a	n/a	31	31	0	0	0	0	0	1	0
G	OED	55	n/a	n/a	n/a	n/a	26	26	0	0	0	0	0	4	0
G	OPW	55	55	n/a	n/a	n/a	30	30	0	0	0	0	0	1	0
H	COM	70	70	n/a	n/a	n/a	41	41	0	0	0	0	0	9	0
H	OOP	60	60	60	n/a	n/a	32	32	0	0	0	0	0	1	0
H	RES	75	70	62	56	66	32	32	0	0	0	0	0	23	0
Excavation using rockbreakers															
A	RES	75	70	62	56	66	55	55	0	0	0	0	0	1	0
B	COM	70	70	n/a	n/a	n/a	53	53	0	0	0	0	0	1	0
C	RES	75	70	62	56	66	49	49	0	0	0	0	0	11	0
D	RES	75	70	62	56	66	46	46	0	0	0	0	0	3	0
E	OED	55	n/a	n/a	n/a	n/a	45	45	0	0	0	0	0	1	0
E	OCC	50	50	n/a	n/a	n/a	37	37	0	0	0	0	0	1	0
E	OTH	50	50	50	n/a	n/a	31	31	0	0	0	0	0	1	0
E	RES	75	70	62	56	66	39	39	0	0	0	0	0	3	0
F	OED	55	n/a	n/a	n/a	n/a	37	37	0	0	0	0	0	2	0
G	OCB	60	60	60	60	n/a	44	44	0	0	0	0	0	1	0
G	RES	75	70	62	56	66	39	39	0	0	0	0	0	9	0
G	OTH	50	50	50	n/a	n/a	32	32	0	0	0	0	0	1	0
G	OED	55	n/a	n/a	n/a	n/a	27	27	0	0	0	0	0	4	0
G	OPW	55	55	n/a	n/a	n/a	31	31	0	0	0	0	0	1	0
H	COM	70	70	n/a	n/a	n/a	42	42	0	0	0	0	0	9	0
H	OOP	60	60	60	n/a	n/a	33	33	0	0	0	0	0	1	0
H	RES	75	70	62	56	66	33	33	0	0	0	0	0	23	0
Excavation using drill and blast															
A	RES	75	70	62	56	66	51	51	0	0	0	0	0	1	0
B	COM	70	70	n/a	n/a	n/a	49	49	0	0	0	0	0	1	0
C	RES	75	70	62	56	66	45	45	0	0	0	0	0	11	0
D	RES	75	70	62	56	66	42	42	0	0	0	0	0	3	0
E	OED	55	n/a	n/a	n/a	n/a	41	41	0	0	0	0	0	1	0
E	OCC	50	50	n/a	n/a	n/a	33	33	0	0	0	0	0	1	0
E	OTH	50	50	50	n/a	n/a	27	27	0	0	0	0	0	1	0
E	RES	75	70	62	56	66	35	35	0	0	0	0	0	3	0
F	OED	55	n/a	n/a	n/a	n/a	33	33	0	0	0	0	0	2	0
G	OCB	60	60	60	60	n/a	40	40	0	0	0	0	0	1	0
G	RES	75	70	62	56	66	35	35	0	0	0	0	0	9	0
G	OTH	50	50	50	n/a	n/a	28	28	0	0	0	0	0	1	0
G	OED	55	n/a	n/a	n/a	n/a	23	23	0	0	0	0	0	4	0

Receiver Area	Type	NMLs					Noise Level at Worst Affected Receiver		NML Exceedance at Worst Affected Receiver					Total Number of Receivers in Catchment	Number of 'Highly Noise Affected'[5]
							Worst-case[1]								
		Day	DOOH	EVE	Night	SD	$L_{Aeq(15m)}$	$L_{Aeq(1m)}$	Day	DOOH	EVE	Night	SD		
G	OPW	55	55	n/a	n/a	n/a	27	27	0	0	0	0	0	1	0
H	COM	70	70	n/a	n/a	n/a	38	38	0	0	0	0	0	9	0
H	OOP	60	60	60	n/a	n/a	29	29	0	0	0	0	0	1	0
H	RES	75	70	62	56	66	29	29	0	0	0	0	0	23	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 8 NML Exceedances - Station Services Building Construction - Worst-Case Impacts

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			LAeq(15minute) (dBA)									
			Worst-case[1]	Typical Range								
		Day		Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Construction of new buildings and fitout - Inside acoustic shed												
A	RES	75	62	62	To	62	1	1	-	-	-	0
B	COM	70	60	60	To	60	1	1	-	-	-	0
C	RES	75	56	56	To	56	11	11	-	-	-	0
D	RES	75	53	53	To	53	3	3	-	-	-	0
E	OED	55	52	52	To	52	1	1	-	-	-	0
E	OCC	50	44	44	To	44	1	1	-	-	-	0
E	OTH	50	38	38	To	38	1	1	-	-	-	0
E	RES	75	46	46	To	46	3	3	-	-	-	0
F	OED	55	44	44	To	44	2	2	-	-	-	0
G	OCB	60	51	51	To	51	1	1	-	-	-	0
G	RES	75	46	46	To	46	9	9	-	-	-	0
G	OTH	50	39	39	To	39	1	1	-	-	-	0
G	OED	55	34	34	To	34	4	4	-	-	-	0
G	OPW	55	38	38	To	38	1	1	-	-	-	0
H	COM	70	49	49	To	49	9	9	-	-	-	0
H	OOP	60	40	40	To	40	1	1	-	-	-	0
H	RES	75	40	40	To	40	23	23	-	-	-	0
Construction of new buildings and fitout - Without acoustic shed												
A	RES	75	84	73	To	73	1	1	-	-	-	0
B	COM	70	80	76	To	76	1	-	1	-	-	0
C	RES	75	78	75	To	75	11	11	-	-	-	1
D	RES	75	71	69	To	69	3	3	-	-	-	0
E	OED	55	70	67	To	67	1	-	-	1	-	0
E	OCC	50	60	58	To	58	1	-	1	-	-	0
E	OTH	50	57	55	To	55	1	-	1	-	-	0
E	RES	75	65	63	To	63	3	3	-	-	-	0
F	OED	55	61	59	To	59	2	-	2	-	-	0
G	OCB	60	70	68	To	68	1	-	1	-	-	0
G	RES	75	66	64	To	64	9	9	-	-	-	0
G	OTH	50	60	58	To	58	1	-	1	-	-	0
G	OED	55	56	51	To	51	4	4	-	-	-	0
G	OPW	55	57	54	To	54	1	1	-	-	-	0
H	COM	70	67	63	To	63	9	9	-	-	-	0
H	OOP	60	55	49	To	49	1	1	-	-	-	0
H	RES	75	57	56	To	56	23	23	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 9 NML Exceedances - Station Services Building Construction Works - Supporting Works Only

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			LAeq(15minute) (dBA)									
			Worst-case[1]	Typical Range								
		Day		Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Construction of new buildings and fitout - Inside acoustic shed												
A	COM	70	58	58	To	58	1	1	-	-	-	0
B	COM	70	56	56	To	56	1	1	-	-	-	0
C	RES	75	52	52	To	52	11	11	-	-	-	0
D	RES	75	49	49	To	49	3	3	-	-	-	0
E	OED	55	48	48	To	48	1	1	-	-	-	0
E	OCC	50	40	40	To	40	1	1	-	-	-	0
E	OTH	50	34	34	To	34	1	1	-	-	-	0
E	RES	75	42	42	To	42	3	3	-	-	-	0
F	OED	55	40	40	To	40	2	2	-	-	-	0
G	OCB	60	47	47	To	47	1	1	-	-	-	0
G	RES	75	42	42	To	42	9	9	-	-	-	0
G	OTH	50	35	35	To	35	1	1	-	-	-	0
G	OED	55	30	30	To	30	4	4	-	-	-	0
G	OPW	55	34	34	To	34	1	1	-	-	-	0
H	COM	70	45	45	To	45	9	9	-	-	-	0
H	OOP	60	36	36	To	36	1	1	-	-	-	0
H	RES	75	36	36	To	36	23	23	-	-	-	0
Construction of new buildings and fitout - Without acoustic shed												
A	RES	75	80	69	To	69	1	1	-	-	-	0
B	COM	70	76	72	To	72	1	-	1	-	-	0
C	RES	75	74	71	To	71	11	11	-	-	-	0
D	RES	75	67	65	To	65	3	3	-	-	-	0
E	OED	55	66	63	To	63	1	-	1	-	-	0
E	OCC	50	56	54	To	54	1	-	1	-	-	0
E	OTH	50	53	51	To	51	1	-	1	-	-	0
E	RES	75	61	59	To	59	3	3	-	-	-	0
F	OED	55	57	55	To	55	2	2	-	-	-	0
G	OCB	60	66	64	To	64	1	-	1	-	-	0
G	RES	75	62	60	To	60	9	9	-	-	-	0
G	OTH	50	56	54	To	54	1	-	1	-	-	0
G	OED	55	52	47	To	47	4	4	-	-	-	0
G	OPW	55	53	50	To	50	1	1	-	-	-	0
H	COM	70	63	59	To	59	9	9	-	-	-	0
H	OOP	60	51	45	To	45	1	1	-	-	-	0
H	RES	75	53	52	To	52	23	23	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Construction Ground-borne Noise and Vibration Assessment Results

Table 10 Ground-borne NML Exceedances - Earthworks - Worst-case Impacts

Receiver Area	Type	Shortest distance to vibration intensive works (m)	NML[1]	Ground-borne Noise	NML Exceedance
				LAeq(15minute) (dBA)	Piling (bored) works
			Day		Day
A	RES	5	45	37	0
B	COM	7	50	35	0
C	RES	20	45	25	0
E	EDU	35	45	19	0

Note 1: Internal NML

Table 11 Ground-borne NML Exceedances - Shaft Excavation - Worst-case Impacts

Receiver Area	Type	Shortest distance to vibration intensive works (m)	NML[1]				Ground-borne Noise		NML Exceedance							
							LAeq(15min) (dBA)		Day		DOOH		EVE		NIGHT	
			Day	DOOH	EVE	Night	Rock drilling with non-percussive rock drill	Excavation and trimming with rockbreaker	Rock drilling with non-percussive rock drill	Excavation and trimming with rockbreaker	Rock drilling with non-percussive rock drill	Excavation and trimming with rockbreaker	Rock drilling with non-percussive rock drill	Excavation and trimming with rockbreaker	Rock drilling with non-percussive rock drill	Excavation and trimming with rockbreaker
A	RES	5	45	45	40	35	37	75	0	30	0	30	0	n/a	2	n/a
B	COM	14	50	50	n/a	n/a	28	65	0	15	0	15	n/a	n/a	n/a	n/a
C	RES	20	45	45	40	35	25	60	0	15	0	15	0	n/a	0	n/a
E	EDU	35	45	n/a	n/a	n/a	19	50	0	5	n/a	n/a	n/a	n/a	n/a	n/a

Note 1: Internal NML

Artarmon

Construction Airborne Noise Assessment Results

Table 12 NML Exceedances - Enabling Works - Worst-Case Impacts

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			LAeq(15minute) (dBA)									
			Worst-case[1]	Typical Range								
		Day		Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Vegetation Clearing												
A	RES	59	66	66	To	66	2	-	2	-	-	0
B	RES	59	61	61	To	61	103	95	8	-	-	0
C	RES	59	68	68	To	68	156	142	14	-	-	0
C	OED	55	60	60	To	60	18	14	4	-	-	0
D	COM	70	86	86	To	86	279	268	8	3	-	0
D	OCC	50	59	59	To	59	2	1	1	-	-	0
D	IND	75	59	59	To	59	20	20	-	-	-	0
Demolition of acquisition buildings and other structures												
A	RES	59	66	66	To	66	2	-	2	-	-	0
B	RES	59	60	60	To	60	103	101	2	-	-	0
C	RES	59	67	67	To	67	156	138	18	-	-	0
C	OED	55	60	60	To	60	18	11	7	-	-	0
D	COM	70	93	93	To	93	279	264	10	3	2	0
D	OCC	50	58	58	To	58	2	1	1	-	-	0
D	IND	75	58	58	To	58	20	20	-	-	-	0
Clearance and diversion of services												
A	RES	59	50	50	To	50	2	2	-	-	-	0
B	RES	59	44	44	To	44	103	103	-	-	-	0
C	RES	59	51	51	To	51	156	156	-	-	-	0
C	OED	55	44	44	To	44	18	18	-	-	-	0
D	COM	70	77	77	To	77	279	277	2	-	-	0
D	OCC	50	42	42	To	42	2	2	-	-	-	0
D	IND	75	42	42	To	42	20	20	-	-	-	0
Establishment of site compounds												
A	RES	59	51	51	To	51	2	2	-	-	-	0
B	RES	59	45	45	To	45	103	103	-	-	-	0
C	RES	59	52	52	To	52	156	156	-	-	-	0
C	OED	55	45	45	To	45	18	18	-	-	-	0
D	COM	70	78	78	To	78	279	277	2	-	-	0
D	OCC	50	43	43	To	43	2	2	-	-	-	0
D	IND	75	43	43	To	43	20	20	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 13 NML Exceedances - Enabling Works - Supporting Works Only

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver LAeq(15minute) (dBA)				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
			Worst-case[1]	Typical Range								
		Day		Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Vegetation Clearing												
A	RES	59	56	56	To	56	2	2	-	-	-	0
B	RES	59	51	51	To	51	103	103	-	-	-	0
C	RES	59	58	58	To	58	156	156	-	-	-	0
C	OED	55	50	50	To	50	18	18	-	-	-	0
D	COM	70	76	76	To	76	279	276	3	-	-	0
D	OCC	50	49	49	To	49	2	2	-	-	-	0
D	IND	75	49	49	To	49	20	20	-	-	-	0
Demolition of acquisition buildings and other structures												
A	RES	59	49	49	To	49	2	2	-	-	-	0
B	RES	59	43	43	To	43	103	103	-	-	-	0
C	RES	59	50	50	To	50	156	156	-	-	-	0
C	OED	55	43	43	To	43	18	18	-	-	-	0
D	COM	70	76	76	To	76	279	277	2	-	-	0
D	OCC	50	41	41	To	41	2	2	-	-	-	0
D	IND	75	41	41	To	41	20	20	-	-	-	0
Clearance and diversion of services												
A	RES	59	49	49	To	49	2	2	-	-	-	0
B	RES	59	43	43	To	43	103	103	-	-	-	0
C	RES	59	50	50	To	50	156	156	-	-	-	0
C	OED	55	43	43	To	43	18	18	-	-	-	0
D	COM	70	76	76	To	76	279	277	2	-	-	0
D	OCC	50	41	41	To	41	2	2	-	-	-	0
D	IND	75	41	41	To	41	20	20	-	-	-	0
Establishment of site compounds												
A	RES	59	48	48	To	48	2	2	-	-	-	0
B	RES	59	42	42	To	42	103	103	-	-	-	0
C	RES	59	49	49	To	49	156	156	-	-	-	0
C	OED	55	42	42	To	42	18	18	-	-	-	0
D	COM	70	75	75	To	75	279	277	2	-	-	0
D	OCC	50	40	40	To	40	2	2	-	-	-	0
D	IND	75	40	40	To	40	20	20	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver

Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver

Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver

Note 4: Based on Typical Upper noise level

Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 14 NML Exceedances - Earthworks - Worst-Case Impacts

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver LAeq(15minute) (dBA)				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
		Day	Worst-case[1]	Typical Range Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Piling works												
A	RES	59	56	56	To	56	2	2	-	-	-	0
B	RES	59	50	50	To	50	103	103	-	-	-	0
C	RES	59	57	57	To	57	156	156	-	-	-	0
C	OED	55	50	50	To	50	18	18	-	-	-	0
D	COM	70	83	83	To	83	279	274	3	2	-	0
D	OCC	50	48	48	To	48	2	2	-	-	-	0
D	IND	75	48	48	To	48	20	20	-	-	-	0
Construction of working platform												
A	RES	59	56	56	To	56	2	2	-	-	-	0
B	RES	59	50	50	To	50	103	103	-	-	-	0
C	RES	59	57	57	To	57	156	156	-	-	-	0
C	OED	55	50	50	To	50	18	18	-	-	-	0
D	COM	70	83	83	To	83	279	274	3	2	-	0
D	OCC	50	48	48	To	48	2	2	-	-	-	0
D	IND	75	48	48	To	48	20	20	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver
Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver
Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver
Note 4: Based on Typical Upper noise level
Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 15 NML Exceedances - Earthworks - Supporting Works Only

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver LAeq(15minute) (dBA)				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
		Day	Worst-case[1]	Typical Range Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Piling works												
A	RES	59	54	54	To	54	2	2	-	-	-	0
B	RES	59	48	48	To	48	103	103	-	-	-	0
C	RES	59	55	55	To	55	156	156	-	-	-	0
C	OED	55	48	48	To	48	18	18	-	-	-	0
D	COM	70	81	81	To	81	279	274	3	2	-	0
D	OCC	50	46	46	To	46	2	2	-	-	-	0
D	IND	75	46	46	To	46	20	20	-	-	-	0
Construction of working platform												
A	RES	59	51	51	To	51	2	2	-	-	-	0
B	RES	59	45	45	To	45	103	103	-	-	-	0
C	RES	59	52	52	To	52	156	156	-	-	-	0
C	OED	55	45	45	To	45	18	18	-	-	-	0
D	COM	70	78	78	To	78	279	277	2	-	-	0
D	OCC	50	43	43	To	43	2	2	-	-	-	0
D	IND	75	43	43	To	43	20	20	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver
Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver
Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver
Note 4: Based on Typical Upper noise level
Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 16 NML Exceedances - Excavation - Worst-Case Impacts

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver LAeq(15minute) (dBA)				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
		Day	Worst-case[1]	Typical Range Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Excavation of rippable material												
A	RES	59	58	58	To	58	2	2	-	-	-	0
B	RES	59	52	52	To	52	103	103	-	-	-	0
C	RES	59	59	59	To	59	156	156	-	-	-	0
C	OED	55	52	52	To	52	18	18	-	-	-	0
D	COM	70	85	85	To	85	279	270	7	2	-	0
D	OCC	50	50	50	To	50	2	2	-	-	-	0
D	IND	75	50	50	To	50	20	20	-	-	-	0
Excavation using rockbreakers												
A	RES	59	66	66	To	66	2	-	2	-	-	0
B	RES	59	60	60	To	60	103	101	2	-	-	0
C	RES	59	67	67	To	67	156	138	18	-	-	0
C	OED	55	60	60	To	60	18	11	7	-	-	0
D	COM	70	93	93	To	93	279	264	10	3	2	0
D	OCC	50	58	58	To	58	2	1	1	-	-	0
D	IND	75	58	58	To	58	20	20	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver
Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver
Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver
Note 4: Based on Typical Upper noise level
Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG
Note 6: Use of heavy plant precluded from evening and night-time periods

Table 17 NML Exceedances - Excavation Works - Supporting Works Only

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver LAeq(15minute) (dBA)				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
		Day	Worst-case[1]	Typical Range Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Excavation of rippable material												
A	RES	59	52	52	To	52	2	2	-	-	-	0
B	RES	59	46	46	To	46	103	103	-	-	-	0
C	RES	59	53	53	To	53	156	156	-	-	-	0
C	OED	55	46	46	To	46	18	18	-	-	-	0
D	COM	70	79	79	To	79	279	276	3	-	-	0
D	OCC	50	44	44	To	44	2	2	-	-	-	0
D	IND	75	44	44	To	44	20	20	-	-	-	0
Excavation using rockbreakers												
A	RES	59	53	53	To	53	2	2	-	-	-	0
B	RES	59	47	47	To	47	103	103	-	-	-	0
C	RES	59	54	54	To	54	156	156	-	-	-	0
C	OED	55	47	47	To	47	18	18	-	-	-	0
D	COM	70	80	80	To	80	279	275	4	-	-	0
D	OCC	50	45	45	To	45	2	2	-	-	-	0
D	IND	75	45	45	To	45	20	20	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver
Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver
Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver
Note 4: Based on Typical Upper noise level
Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 18 NML Exceedances - Station Services Building Construction - Worst-Case Impacts

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver LAeq(15minute) (dBA)				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
		Day	Worst-case[1]	Typical Range Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Construction of new buildings and fitout												
A	RES	59	60	60	To	60	2	1	1	-	-	0
B	RES	59	54	54	To	54	103	103	-	-	-	0
C	RES	59	61	61	To	61	156	152	4	-	-	0
C	OED	55	54	54	To	54	18	18	-	-	-	0
D	COM	70	87	87	To	87	279	270	7	2	-	0
D	OCC	50	52	52	To	52	2	1	1	-	-	0
D	IND	75	52	52	To	52	20	20	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver
Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver
Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver
Note 4: Based on Typical Upper noise level
Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Table 19 NML Exceedances - Station Services Building Construction Works - Supporting Works Only

Receiver Area	Type	NML	Noise Level at Worst Affected Receiver LAeq(15minute) (dBA)				Total Number of Receivers in Catchment	Number of Receiver with NML Exceedances[4] of:				Number of 'Highly Noise Affected'[5]
		Day	Worst-case[1]	Typical Range Lower[3]	To	Upper[2]		0 dB	1-10dB	11-20dB	>20dB	
Construction of new buildings and fitout												
A	RES	59	56	56	To	56	2	2	-	-	-	0
B	RES	59	50	50	To	50	103	103	-	-	-	0
C	RES	59	57	57	To	57	156	156	-	-	-	0
C	OED	55	50	50	To	50	18	18	-	-	-	0
D	COM	70	83	83	To	83	279	274	3	2	-	0
D	OCC	50	48	48	To	48	2	2	-	-	-	0
D	IND	75	48	48	To	48	20	20	-	-	-	0

Note 1: Representative of the noise intensive equipment located at the **closest** construction boundary location to the receiver
Note 2: Representative of the noise intensive equipment located within the **near** area of the construction footprint to the receiver
Note 3: Representative of the noise intensive equipment located within the **far** area of the construction footprint to the receiver
Note 4: Based on Typical Upper noise level
Note 5: 'Highly noise affected' residential receivers LAeq(15minute) >75 dBA as described in the ICNG

Construction Ground-borne Noise and Vibration Assessment Results

Table 20 Ground-borne NML Exceedances - Demolition of Structures - Worst-case Impacts

Receiver Area	Type	NML[1]	NML Exceedance[2,3]	
			EIS	Relocated Site
		Day	Day	Day
A	RES	45	(0)	(0)
B	RES	45	(1)	(0)
C	RES	45	(0)	(0)
C	OED	35	(0)	(0)
D	COM	50	(0)	3
D	OCC	40	(0)	(0)
D	IND	50	(0)	(0)

Legend

Category 0	Category 1	Category 2	Category 3
NML Compliance	NML exceedance of less than 10 dB	NML exceedance of between 10 dB and 20 dB	NML exceedance of more than 20 dB

Note 1: Nominated internal NML

Note 2: Representative of the worst-case noise intensive equipment noise level for works located at the closest construction boundary location to the receiver

Note 3: Results not presented in the EIS are denoted in parentheses and represent assumed noise level exceedance categories based on the assumptions presented in the EIS.

Table 21 Ground-borne NML Exceedances - Earthworks - Worst-case Impacts

Receiver Area	Type	NML[1]	NML Exceedance[2,3]	
			EIS	Relocated Site
		Day	Day	Day
A	RES	45	(0)	0
B	RES	45	(0)	0
C	RES	45	(0)	0
C	OED	35	(0)	0
D	COM	50	(0)	1
D	OCC	40	(0)	0
D	IND	50	(0)	0

Legend

Category 0	Category 1	Category 2	Category 3
NML Compliance	NML exceedance of less than 10 dB	NML exceedance of between 10 dB and 20 dB	NML exceedance of more than 20 dB

Note 1: Internal NML

Note 2: Representative of the worst-case noise intensive equipment noise level for works located at the closest construction boundary location to the receiver

Note 3: Results not presented in the EIS are denoted in parentheses and represent assumed noise level exceedance categories based on the assumptions presented in the EIS.

Table 22 Ground-borne NML Exceedances - Shaft Excavation - Worst-case Impacts

Receiver Area	Type	NML[1]	NML Exceedance[2,3]	
			EIS	Relocated Site
		Day	Day	Day
A	RES	45	(0)	(0)
B	RES	45	(1)	(0)
C	RES	45	(0)	(0)
C	OED	35	(0)	(0)
D	COM	50	(0)	3
D	OCC	40	(0)	(0)
D	IND	50	(0)	(0)

Legend

Category 0	Category 1	Category 2	Category 3
NML Compliance	NML exceedance of less than 10 dB	NML exceedance of between 10 dB and 20 dB	NML exceedance of more than 20 dB

Note 1: Internal NML

Note 2: Representative of the worst-case noise intensive equipment noise level for works located at the closest construction boundary location to the receiver

Note 3: Results not presented in the EIS are denoted in parentheses and represent assumed noise level exceedance categories based on the assumptions presented in the EIS.

CHATSWOOD TO SYDENHAM

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