21/05/2025
Ref: 250506 Report

MITCH AYRES SURVEYING

Eastside Roseville Action Group Inc
C/- Natasha Sherwood

Re: Bancroft Avenue, Lord Street, Roseville Avenue & Oliver Road, Roseville

Dear Natasha,

As per your instructions our company has surveyed levels at the frontages to properties on Bancroft Avenue, Lord Street, Roseville Avenue & Oliver Road, Roseville. This report should be read in conjunction with the provided level survey "Plan showing street levels over Bancroft Av, Lord St, Roseville Av & Oliver Rd, Roseville" Ref: 250506 Issue: 2.

Survey Methodology

Levels have been obtained using CORS NRTK GNSS methods. These levels have an accuracy range of ± 0.05m.

The boundaries shown on the plan have been compiled from DP1046731, DP1046734, DP1046912 and DP1046914 and are indicative only. No Boundary survey has been undertaken. The stratum limits of Sydney Metro Stratum lots are:

Lot and DP	Upper Limit	Lower Limit
Lot 1 DP1046731	RL 85.0 (AHD)	Unlimited in depth
Lot 1 DP1046734	RL 85.0 (AHD)	Unlimited in depth
Lot 1 DP1046912	RL 88.0 (AHD)	Unlimited in depth
Lot 1 DP1046914	RL 89.0 (AHD)	Unlimited in depth

Depth from Ground Level to the Upper Limit of the Sydney Metro Stratum Lots

Levels have been interpolated to the centre of the frontages of the properties listed in the table below. These interpolated levels have been derived from the CORS GNSS Observations (which are the levels plotted on the accompanying plan).

Mitch Ayres Surveying Pty Ltd
ABN 21 642 295 494
PO BOX 4226
Lugarno NSW 2210
T 0447 073 893
E adam@mitchayressurveying.com.au
Registered Surveyor SU009288
Adam Kesby B. Eng (Surveying)(Hons) UNSW

21/05/2025
Ref: 250506 Report

MITCH AYRES SURVEYING

Property Address	Lot and Deposited Plan	Interpolated Level at Centre of Street Frontage (AHD)	Upper Limit of Sydney Metro Stratum Lot Below (AHD)	Depth to Sydney Metro Stratum Lot (m) (Rounded to 0.1m)
21 Oliver Road, Roseville	Lot 4 DP1046731	93.78	85	8.8
23 Oliver Road, Roseville	Lot 5 DP1046731	93.24	85	8.2
25 Oliver Road, Roseville	Lot 6 DP1046731	92.61	85	7.6
16 Roseville Avenue, Roseville	Lot 2 DP1046734	93.15	85	8.2
18 Roseville Avenue, Roseville	Lot 3 DP1046734	92.18	85	7.2
20 Roseville Avenue, Roseville	Lot 4 DP1046734	91.28	85	6.3
11 Roseville Avenue, Roseville	Lot 5 DP1046734	94.01	85	9.0
15 Roseville Avenue, Roseville	Lot 6 DP1046734	92.86	85	7.9
17 Roseville Avenue, Roseville	Lot 7 DP1046734	92.01	85	7.0
19 Roseville Avenue, Roseville	Lot 8 DP1046734	91.09	85	6.1
21 Roseville Avenue, Roseville	Lot 9 DP1046734	90.07	85	5.1
8 Lord Street, Roseville	Lot 2 DP1046912	96.6	88	8.6
10 Lord Street, Roseville	Lot 3 DP1046912	95.04	88	7.0
12 Lord Street, Roseville	Lot 4 DP1046912	93.57	88	5.6
14 Lord Street, Roseville	Lot 5 DP1046912	92.31	88	4.3
7A Lord Street, Roseville	Lot 6 DP1046912	98.2	88	10.2
9 Lord Street, Roseville	Lot 7 DP1046912	95.99	88	8.0
11 Lord Street, Roseville	Lot 8 DP1046912	94.01	88	6.0
15 Lord Street, Roseville	Lot 9 DP1046912	92.38	88	4.4
2 Bancroft Avenue, Roseville	Lot 3 DP1046914	95.94	89	6.9
4 Bancroft Avenue, Roseville	Lot 4 DP1046914	95.5	89	6.5
6 Bancroft Avenue, Roseville	Lot 10 DP1046912	95.14	88	7.1

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MITCH AYRES SURVEYING

Protection Reserves

The protection of Sydney Metro infrastructure is outlined in section 4 of the “Sydney Metro Underground Corridor Protection Technical Guidelines’. This document can be found here:

https://www.sydneymetro.info/sites/default/files/2021-09/SM-Underground-Corridor-Protection-Technical-Guidelines.pdf

This document in full has also been attached to the end of this report.

Kind regards,

Adam Kesby
Registered Surveyor
ID SU009288

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Sydney Metro Underground Corridor Protection Technical Guidelines

Contents

Author:	Jiping Pan – Technical Executive, WSP; Antoni Kuras – Regional Executive, Geotechnics and Tunnels WSP; Denise Thornton – Corridor Protection Analyst, Sydney Metro
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Division:	Operations, Customer & Place Making
Reviewer:	Geoff Bateman – Technical Advisor, Sydney Metro
Review date:	As required

1 Introduction

The structural stability and operation of existing Sydney Metro underground infrastructure needs to be protected, including running tunnels, station caverns and shafts. Any new development near existing Sydney Metro underground infrastructure has the potential to impact on the structural stability and operations of this infrastructure. Similarly, developments proposed near planned metro underground infrastructure have the potential to impact on the feasibility of future metro construction.

Sydney Metro under delegation from Transport for NSW (TfNSW) has an obligation to review the development applications of proposed developments near to Sydney Metro underground infrastructure, both planned and existing, to ensure impacts are appropriately assessed and managed. This guideline document has been developed to provide the requirements and technical guidance to assist developers with their assessment of development induced effects and the associated risks.

New civil infrastructure developments by NSW Government will be subject to an interface agreement and are not subject to the requirements of this guideline document.

2 Purpose of this document

This guideline document provides the technical requirements to assess and manage the risks associated with proposed developments near existing and future Metro underground infrastructure. This document is based and builds on the ASA Standard T HR CI 12051 ST Developments Near Rail Tunnels.

The purpose of this guideline document is to assist external developers in the planning, design, construction (including associated temporary works) and operation of proposed development near underground metro rail infrastructure. This guideline supports the requirements of the rail authority under relevant planning instruments including the *State Environmental Planning Policy (Infrastructure) 2007* (Infrastructure SEPP), *State Environmental Planning Policy (Major Infrastructure Corridors) 2020* and *State Environmental Planning Policy (Western Sydney Aerotropolis) 2020* to protect the safety, structural integrity and the safe and effective operation of existing or proposed rail infrastructure facilities from adjacent developments.

2.1 Scope

This guideline document covers proposed developments near the following existing, under construction and future metro lines:

- Metro North West Line including Sydney Metro converted Epping to Chatswood Rail Line (ECRL)
- Sydney Metro - City & Southwest
- Sydney Metro - West
- Sydney Metro - Western Sydney Airport and
- Other future Sydney Metro corridors.

It generally applies to proposed developments near Sydney Metro running tunnels and other underground infrastructure such as: cross passages between running tunnels; station caverns and adits; crossover caverns; station boxes and shafts; nozzle enlargements; services facility shafts; spur tunnel junctions; and dive/portal structures. Information regarding existing and planned new metro infrastructure can be sourced from Sydney Metro (refer to Section 11 for contact details).

There are different rail authorities for different rail corridors. If the proposed development requires referral or concurrence from other transport cluster agencies (TfNSW or Sydney Trains) separate documentation related to their rail infrastructure must be provided and will generally be dealt with separately.

3 Reference documents

The following documents have been referenced to prepare this document:

3.1 Transport for NSW standards

- T HR CI 12051 ST Developments Near Rail Tunnels.
- TS 20001 System Safety for New or Altered Assets
- T HR CI 12070 ST Miscellaneous Structures
- T HR CI 12075 ST Airspace Developments
- T HR CI 12080 ST External Developments
- T HR EL 12002 GU Electrolysis from Stray DC Current

3.2 Legislation and guidelines

- the Environmental Planning and Assessment Act 1979
- the Heritage Act 1977
- State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP)
- State Environmental Planning Policy (Sydney Region Growth Centres) 2006
- State Environmental Planning Policy (Major Infrastructure Corridors) 2020 (MIC SEPP)
- State Environmental Planning Policy (Western Sydney Aerotropolis) 2020 (WSA SEPP)
- Development Near Rail Corridors and Busy Roads 2008 – Interim Guidelines – Department of Planning, NSW Government
- Interim Construction Noise Guidelines (NSW EPA, 2009)
- Noise Policy for Industry (2017)

3.3 Other reference documents

- CIRIA C760, Guidance on Embedded Retaining Wall Design, 2017
- AS 2187: Part 2-2006 ‘Explosives – Storage and Use – Part 2: Use of Explosives’
- BS 7385 Part 2-1993 ‘Evaluation and measurement for vibration in buildings Part 2'
- Australian and International Standards referenced in any of the Transport for NSW standards and legislation and guidelines listed above

A Glossary of terminology and definitions used within this document is provided in Appendix C.

4 Protection reserves

Reference should be made to applicable legislation for a legal definition of rail corridor and rail infrastructure facilities. The definition of rail infrastructure facilities can be found in the Infrastructure SEPP.

Protection reserves define the extent of zones that have been established to protect existing metro infrastructure and protect the feasibility of planned metro infrastructure from adjacent proposed development.

For the purpose of assessing the effects of adjacent proposed developments, underground metro infrastructure includes, but is not limited to, the following:

- running tunnels and interconnecting cross passages
- station caverns and adits
- crossover caverns
- station boxes and shafts
- nozzle enlargements
- spur tunnel junctions
- services facility shafts and
- dive and portal structures.

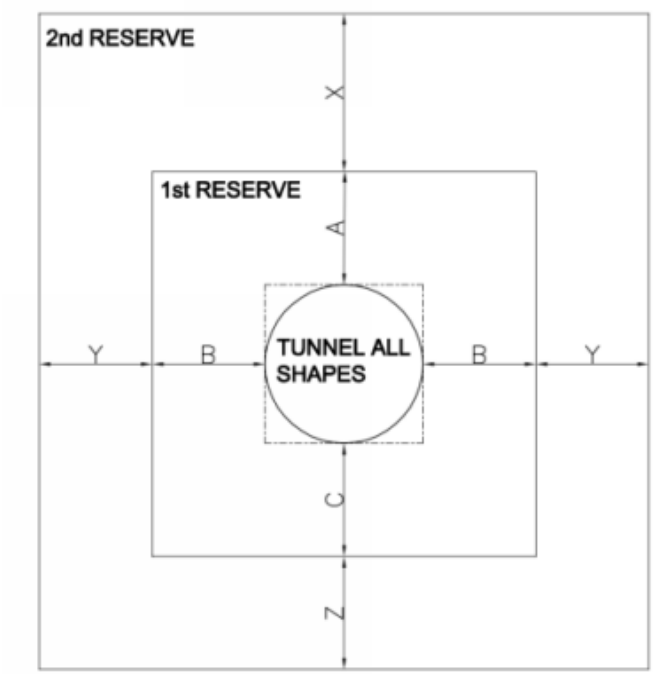
Appendix A includes descriptions of Sydney Metro infrastructure for each of the existing and future metro lines. These descriptions provide an overview of the metro alignments and general location of the underground elements for each section.

Protection reserves are defined in this document. Developers must establish the reserve zones based on the requirements provided within this document and ensure that the design and construction meet the stated requirements.

4.1 Protection reserves

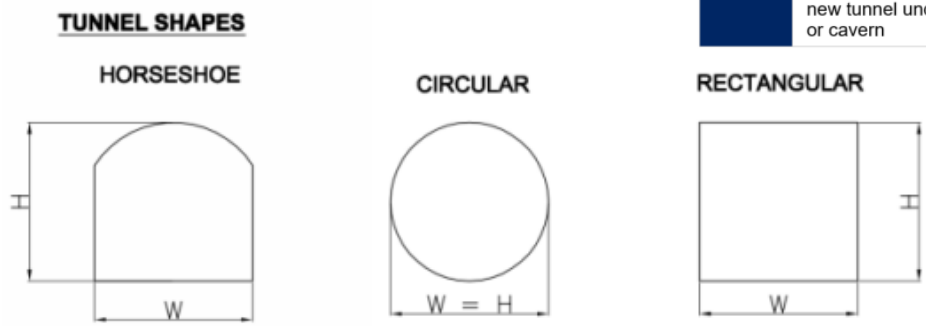
Protection reserves are categorised as either the 'first reserve' or 'second reserve'. Figure 4.1 and Figure 4.2 represent the zones that form the first reserve and the second reserve around metro underground infrastructure. Section 4.2 outlines the formula for calculating the first reserve. Section 4.3 outlines the formula for calculating the second reserve.

The location of the substratum and Sydney Metro infrastructure is required to calculate the first and second reserves (refer to Section 6.1 on how to obtain this information).



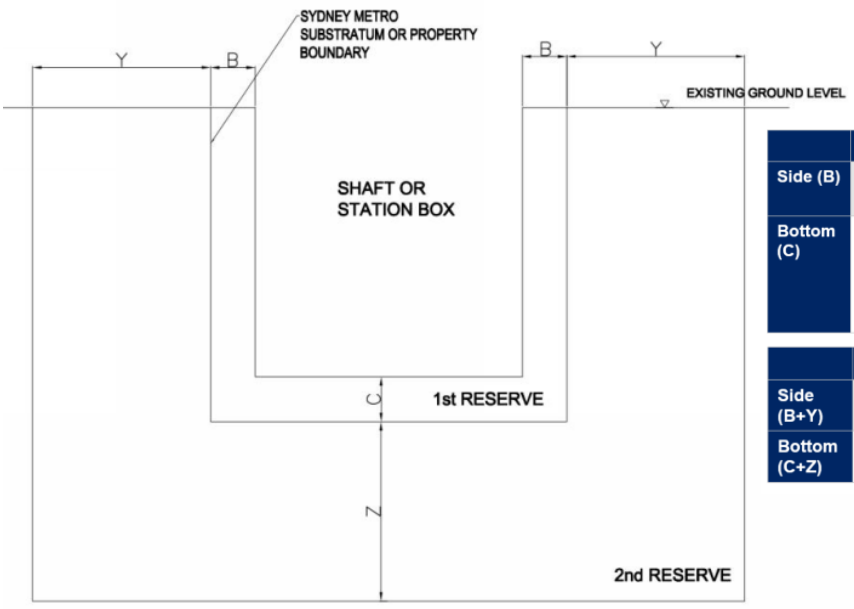
	First reserve dimensions (m)
Top (A)	The greater of the following: • 5 m from the crown of tunnel or cavern or • Support zone based on 1/3* tunnel width plus 1 metre (1/3*W+1) or • Extent of Sydney Metro substratum above crown
Side (B)	The greater of the following: • 5 m from side wall of tunnel or cavern or • Lateral extent of Sydney Metro substratum
Bottom (C)	The greater of the following: • 5 m below the invert of the tunnel or cavern or • Extent of Sydney Metro substratum below invert

	Second reserve dimensions (m)
Top (A+X)	The greater of the following: • 1.5 x (W+H) or • A + 25 or • Where 'W' and 'H' are width and height of the existing rail tunnel
Side (B+Y)	The greater of the following: • W or • B + 25
Bottom (C+Z)	C + 1.5 x (W_n + H_n) Where 'W_n' and 'H_n' are width and height of new tunnel under the existing metro tunnel or cavern



Note: all dimensions are taken from the excavated profile of tunnels and caverns

Figure 4.1 Protection reserves for metro tunnels and caverns



	First reserve dimensions (m)
Side (B)	• Lateral extent of Sydney Metro substratum or property boundary
Bottom (C)	The greater of the following: • 5 m below the invert of the shafts or boxes or • Extent of Sydney Metro substratum below invert

	Second reserve dimensions (m)
Side (B+Y)	• B + 25
Bottom (C+Z)	• C + 25

Figure 4.2 Protection reserves for shafts and station boxes

4.2 First reserve

The first reserve encompasses the ground that immediately surrounds the underground metro infrastructure. This zone represents the area that must not be encroached upon by any proposed development and its construction.

The limits of this zone are indicated in Figure 4.1 and Figure 4.2. These limits are determined based on an appreciation of general ground support principles and the substratum acquired for the Sydney Metro.

Table 4.1 Definition of first reserve for tunnels and caverns

Boundary (Dimension Reference as shown in Figure 4.1)	Reserve dimensions (m)
Top (A)	The greater of the following: • 5 m from the crown of tunnel or cavern or • Support zone based on 1/3* tunnel width plus 1 metre (1/3*W+1) or • Extent of Sydney Metro substratum above crown
Side (B)	The greater of the following: • 5 m from side wall of tunnel or cavern or • Lateral extent of Sydney Metro substratum
Bottom (C)	The greater of the following: • 5 m below the invert of the tunnel or cavern or • Extent of Sydney Metro substratum below invert

Note: References to the tunnel are to the outer edge of the tunnel lining. Refer to Appendix A on details of tunnel diameter.

Table 4.2 Definition of first reserve for shafts and station boxes

Boundary (Dimension Reference as shown in Figure 4.2)	Reserve dimensions (m)
Side (B)	• Lateral extent of Sydney Metro substratum or property boundary
Bottom (C)	The greater of the following: • 5 m below the invert of the shafts or boxes or • Extent of Sydney Metro substratum below invert

4.3 Second reserve

The second reserve zone surrounds the first reserve and covers the areas where proposed developments have the potential to adversely impact on the performance of the support elements of underground infrastructure, metro operations or the feasibility of planned metro infrastructure.

Any proposed developments that take place within the second reserve require an engineering assessment of the works to demonstrate that induced effects on the underground rail infrastructure are acceptable to Sydney Metro, in accordance with the performance requirements outlined in Section 9 of this document.

The limits that apply to the second reserve are summarised in Table 4.3 and Table 4.4 below.

Table 4.3 Definition of second reserve for tunnels and caverns

Boundary (Dimension Reference as shown in Figure 4.1)	Reserve dimensions (m)
Top (A+X)	The greater of the following: • 1.5 x (W+H) or • A + 25 or • Where 'W' and 'H' are width and height of the existing rail tunnel
Side (B+Y)	The greater of the following: • W or • B + 25
Bottom (C+Z)	C + 1.5 x (W_n + H_n) Where 'W_n' and 'H_n' are width and height of new tunnel under the existing metro tunnel or cavern

Note: References to the tunnel are to the outer edge of the tunnel lining. Refer to Appendix A on details of tunnel diameter.

Table 4.4 Definition of second reserve for shafts and boxes

Boundary (Dimension Reference as shown in Figure 4.2)	Reserve dimensions (m)
Side (B+Y)	• B + 25
Bottom (C+Z)	• C + 25

The following factors have been considered to establish the extent of the second reserve:

- potential stress and displacement influence zones associated with external developments that consider the expected zone of negligible ground stress changes due to construction
- extent of shear displacement of horizontal rock defect or bedding and joints during construction
- potential groundwater drawdown influence zone and
- vibration influence zone.

4.4 Construction restrictions placed on protection reserves

Table 4.5 provides the construction restrictions that are applied to each reserve zone as shown in Figure 4.1 and Figure 4.2.

Table 4.5 Construction restrictions

Types of construction	First reserve	Second reserve
Excavation for basements, footings	Not allowed	• Excavations less than 2.0 m depth from surface level, assessment not required. • Excavation greater than 2.0 m depth, assessment required.
Shallow footings or pile foundations	Not allowed	Allowed, subject to load restrictions. Assessment required.
Tunnels and underground excavations	Not allowed	Allowed, subject to assessment.
Ground anchors	Not allowed	Allowed, subject to assessment.
Demolition of existing subsurface structures	Not allowed	Allowed, subject to assessment.
Penetrative subsurface investigations e.g. boreholes, instrumentation	Allowed away from support zone. Assessment required.	Allowed, subject to assessment (refer to Section 7.1 for requirements)

5 Potential impacts from developments

5.1 General

The scope of this guideline includes proposed construction above, below or alongside the existing or future metro infrastructure, that is located within the protection reserves and construction that is located outside these protection reserves, but still has the potential to cause construction-induced groundwater drawdown and vibration that may affect underground metro infrastructure.

Proposed developments near metro infrastructure must be planned, designed, constructed and maintained to ensure the protection of existing and future metro infrastructure including effects on:

- the safety and structural integrity of the tunnels and associated infrastructure by development related loads, induced ground displacement or structural lining movement and
- the safe and effective operation of the network including the operational capacity, maintenance and the efficiency of the network during any stage of the proposed development.

Development related loads and ground displacements could have the potential to cause deformation of existing tunnels and other associated structures and, in extreme situations, could cause structural failure and collapse. The tunnel and cavern support elements and the surrounding ground need to be protected to avoid movement of structural lining which could cause structural instability, groundwater ingress and encroachment of support into rail functional areas, such as rolling stock kinematic envelopes.

The following sections discuss those aspects of developments where construction restrictions are placed within the second reserve and includes safety and environmental considerations.

5.2 Construction restrictions

The following key construction activities are permitted within the second reserve, but have the potential to affect metro infrastructure, as such restrictions may apply to construction activity within the second reserve:

- excavation for basements and shafts – above / beside or below
- shallow footing or pile foundation – above / beside or below
- tunnels and underground excavations – above / beside or below
- ground anchors – above / beside or below
- demolitions of existing structure – above or beside
- geotechnical investigations / instrumentation – above / beside or below.

Whilst these restrictions focus mainly on impacts to existing underground infrastructure, in many cases they may be equally applicable to future metro infrastructure. The intent of construction restrictions for future metro infrastructure is to ensure that the feasibility of future metro construction and operations is not adversely affected by new developments and their construction.

The construction of new developments must take into account:

- the construction constraints, particularly live road and rail operating conditions

- noise and vibration restrictions and track possession constraints that are inherent to working near to an operating rail environment and
- access requirements that may be necessary for inspection and maintenance purposes.

5.2.1 Open excavations

Open excavations can be above and/or to the side of underground metro infrastructure and could potentially:

- alter the in-situ stress regime in the ground that directly affects support elements of underground infrastructure and other sensitive infrastructure and
- reduce the structural support provided by the surrounding rock where the rockmass provides active support.

Temporary and permanent anchors can be used to support open excavations, underground excavations and provide uplift resistance for construction cranes and basements. High stress concentrations around ground anchors can affect the surrounding ground locally and potentially impact on the stability of the rockmass and existing underground structures.

A range of excavation methods are available to excavate ground for new developments. Activities such as rock breaking, pile driving and rock drilling/cutting works have the potential to impose temporary loads and excessive noise and vibration on metro infrastructure. Vibration can dislodge rock wedges on existing metro tunnels and caverns, as well as impose additional non-uniform load patterns on the support of metro tunnels and caverns.

Ground improvement works such as grouting and ground freezing can affect existing metro tunnel and cavern structures. Grouting can block water drainage paths and impose excessive hydrostatic loads on tunnel and cavern support. Specialised techniques such as ground freezing can cause volume increase that can impose loads on nearby tunnel and cavern support.

In addition, excavation activities will induce ground borne vibration with the potential to affect metro infrastructure.

5.2.2 Foundations

Additional pressures from shallow spread footings and piled foundations designed to support proposed developments could potentially increase the stresses in the permanent concrete structural linings of metro tunnels and caverns and the surrounding rockmass. The effects of the foundation loads must be considered, including opportunities to redistribute bearing pressures away from the protection reserves to minimise the impacts.

Of interest are the changes in stress distribution from foundations within the ground above or surrounding existing (or future metro) underground infrastructure, as a consequence of development construction. Issues of potential concern relate to increase in vertical or horizontal pressures beneath foundation elements, increases in shear stress along known existing bedding planes in the rockmass and uplift pressures below the invert of metro underground infrastructure.

Ground borne vibration from activities such as pile driving or bored piles installation and sheet pile installation must be considered.

5.2.3 Underground excavation

Underground excavations include the construction of adjacent rail and road tunnels (above, to the side and below), utility tunnels, cable conduits, drainage pipes, and pedestrian walkways and underpasses. Such underground excavations could potentially significantly alter the in-situ stress field in the surrounding ground resulting in stress concentrations, stress relief and displacements. These changes can significantly affect the existing metro tunnel and cavern support elements.

In cases where underground excavations are designed to be drained structures (that is, the structural lining and ground support of tunnel and caverns are built to support the ground but permit groundwater to flow into the excavation) consideration must be given to the groundwater drawdown that this will cause and the impacts that this will have on nearby metro infrastructure.

Ground borne vibration caused by tunnelling must also be considered.

5.2.4 Demolition

The demolition of any existing buildings or basements may affect existing metro underground infrastructure and cause disruption to metro operations. Where necessary, measures may be needed to protect metro assets during demolition works of existing buildings and structures.

5.2.5 Geotechnical investigations

Development activity requires geotechnical and subsurface investigations that can include drill holes, geophysical exploration, in-situ tests and permeability tests. During construction, instrumentation holes such as inclinometers, piezometers and extensometers can be drilled to measure the ground reaction and the impacts.

Importantly, the drilling of boreholes and installation of instrumentation must be planned to avoid existing metro infrastructure and avoid disruption to metro operations.

5.3 Safety

Developments near underground metro infrastructure must address the following aspects of safety in respect of the metro and its operation at any stage of the life cycle of that development:

- structural safety
- operational safety
- fire safety
- inspection and maintenance and
- floor protection.

Consideration must be given to maintenance and to future users of the development. Importantly, new development must not obstruct emergency access to metro infrastructure and any maintenance access requirements.

Approvals from Sydney Metro are required to enter into the metro assets for dilapidation survey, installation of instruments, monitoring and visual inspections. Persons carrying out these activities must be accompanied by safety personnel from Sydney Metro or from Sydney Metro approved organisations when entering metro tunnels.

5.4 Protection of environment

The developer must take into account the environmental impacts that can affect the metro with a view to minimising any effects during the whole life cycle of development. Typical considerations for developments in the urban environment are as follows:

- stormwater management
- noise and vibration
- air quality, particularly dust
- traffic impacts
- visual impact and amenity
- ability and ease to maintain and 'retro-fit' improvements over time
- disposal and re-use at life cycle end
- ecological impact due to draw-down
- groundwater contamination and
- construction materials to be as low toxicity as possible.

5.5 Transport planning, place making and precinct activation

Sydney Metro is committed to ensuring that its rail corridors and infrastructure provide opportunities for development, place making and integration with the local precincts.

Sydney Metro manages metro operations to deliver integrated, reliable, customer-focused and efficient services, for the current and future metro network, precincts and corridors. It is focussed on developing an integrated metro network with connected and thriving precincts, achieving urban amenity, commercial viability and supporting corridor growth.

Better Placed [1]and Movement and Place [2]are the leading state government design policies for design and place principles for consideration.

[1] https://www.governmentarchitect.nsw.gov.au/policies/better-placed

[2] https://www.governmentarchitect.nsw.gov.au/guidance/movement-and-place

6 Development applications and construction

Proposed development may trigger the requirement for referral for comment or concurrence from Sydney Metro. An urban planner will be able to advise when legislation is triggered to require comments or concurrence. TfNSW has delegated its rail authority functions in relation to the Sydney Metro corridors to Sydney Metro. Different documentation is required at different stages to enable Sydney Metro to confirm the potential impact on Sydney Metro corridors.

Documentation must be provided as part of the development application package lodged with the consent authority to demonstrate that induced effects will be acceptable to Sydney Metro infrastructure. Sydney Metro may also request documentation and supporting information at the design, construction and operation stages of the proposed development.

Staged developments must include appropriate levels of technical and design requirements to be lodged with the initial development application, along with documentation that defines how the phased construction period will be managed, including a design change process for concurrence of potential future design changes.

6.1 Pre-development application

This guideline document provides information on what needs to be considered for proposed developments in the vicinity of the Sydney Metro rail corridor and ideally should be distributed to the development team. Appendix B provides a check list of the documents required to be included in the lodgement package. The latest version of this guideline document can be downloaded from Sydney Metro's website[3].

The following can be carried out or made reference to in order to determine corridor protection zones and the location of the Sydney Metro infrastructure and substratum (if relevant):

- Request the location of the Sydney Metro infrastructure for the proposed development site (refer to Section 11 for Sydney Metro contact details).
- Stratum information (where available) can be obtained through:
    - The owners who were notified of the location of the stratum as part of the acquisition process and
    - The survey plans of acquisition registered with Land Registry Services, NSW (a registered surveyor should be able to assist with this) and
    - Dial Before You Dig Service

It is recommended that experienced and qualified specialists be engaged early as part of your development team.

The information provided in this guideline should enable developers to lodge the required documentation with their development application without the need for a meeting with Sydney Metro. However, it is understood that in some situations where the development is located directly over Sydney Metro infrastructure that developers may want to have a meeting to discuss their preliminary design. In this situation a request should be sent to Sydney Metro for a meeting (refer to Section 11 for Sydney

[3] www.sydneymetro.info

Metro contact details). Sydney Metro may recover costs associated with meeting with the developer.

The following documents should be provided prior to the meeting for comment and discussion during the meeting:

- location of site layout
- existing easements/stratum on land and for the metro underground infrastructure
- architectural layout showing the general arrangement of the development
- plans and drawings of existing metro infrastructure obtained from Sydney Metro that show protection reserve boundaries based on this guideline document
- section view and plan view of the proposed development (including the reduced level of basements) and protection reserves and
- site investigation plans (if they involve drilling within the protection reserves).

6.2 Development application lodgement

Where legislation requires referral or concurrence in relation to Sydney Metro rail corridors for proposed developments the developer must submit the following documents as part of their development application package:

- a detailed survey plan prepared by a NSW registered surveyor, which accurately defines the boundaries between the development, the rail corridor (including first and second reserve), rail infrastructure and any Sydney Metro easements (including right of ways) or stratums, covenants and caveats.
- cross section drawings showing the rail corridor (including first and second reserve), and proposed basement and/or foundation excavation. All measurements contained within the cross-section drawings must be verified by a registered surveyor.
- geotechnical investigation report with details in accordance with Section 7.1 of this guideline document
- impact assessment report with details in accordance with Section 7.2 of this guideline document
- risk assessment report in accordance with Section 7.3 of this guideline document
- instrumentation and monitoring plan with details in accordance with Section 10 of this guideline document and
- noise, vibration and electrolysis studies and control measures if available, in accordance with Section 7 of this guideline document, otherwise this will be required prior to construction certificate.

6.2.1 Concept development application lodgement

Concept development applications set out concept proposals for the development of a site, and for which detailed proposals for the site or for separate parts of the site are to be the subject of a subsequent development application or applications. Sydney Metro will consider the likely impact of the concept proposals (and any first stage of development included in the application).

Where legislation requires referral or concurrence in relation to Sydney Metro rail corridors for proposed developments the developer must lodge the following documents as part of their concept development application package:

- geotechnical desktop study and concept foundation design that meet the standards and requirements of Sydney Metro
- a detailed survey plan prepared by a NSW registered surveyor, which accurately defines the boundaries between the development, the rail corridor (including first and second reserve), rail infrastructure and any Sydney Metro easements (including right of ways) or stratums, covenants and caveats and
- cross-section drawings showing the rail corridor (including first and second reserve), proposed basements, locations of lifts and recommended type of foundation adjacent to the rail corridor; all measurements contained within the cross section drawings must be verified by a registered surveyor.

Subsequent detailed development applications will need to be consistent with this guideline document and will be reviewed by Sydney Metro when they are referred to Sydney Metro.

6.3 Post development application approval

Based on the information provided to support the development application Sydney Metro may require the developer to provide the following information and documentation at the following stages of project development as conditions of consent.

6.3.1 Prior to construction

The following documents may need to be submitted prior to construction commencement:

- detailed ground and vibration monitoring plan including trigger levels, action plans and remedial measures, details of the instrumentation and baseline monitoring readings (refer to Section 10)
- construction schedule, construction management plan including sequence plan identifying impacts
- construction layout of equipment relative to metro infrastructure
- final detailed Safe Work Method Statements (refer to Section 8)
- temporary safety plans and measures
- temporary works plan, temporary access, vehicle, plant and equipment such as cranes (including mobile cranes) and stockpiling
- noise, vibration and electrolysis studies and control measures
- a rail related risk assessment and management plan
- list of machinery to be used during excavation/construction
- groundwater control plans, environmental aspects including contamination
- design loadings and certified drawings for construction related works that affect metro infrastructure
- agreed interface activities plan with Sydney Metro and
- condition and dilapidation survey reports of all metro infrastructure affected by the development (refer to Section 8.2).

6.3.2 During construction

The following documentation may need to be submitted to Sydney Metro at agreed intervals by the developer, during the development construction phase:

- monitoring report at agreed intervals, which includes monitoring results and assessment by the geotechnical or structural consultant
- notification of work progress at agreed intervals, which is applicable during excavations, foundations and support installations, superstructure construction up to the ground level
- interim dilapidation survey reports as appropriate
- any changes to the design and construction methods for approval by Sydney Metro and
- rock face mapping, inspection and assessment reports.

6.3.3 After construction completion and prior to issue of occupation certificate

Sydney Metro may request the following documentation from the developer, after completion of the construction:

- one set of as-built structural and foundation plans signed by a qualified person
- one set of as-built drawings for ground anchors and other support details near the affected metro infrastructure
- monitoring summary report
- copy of the geotechnical mapping report carried out during excavation works
- dilapidation survey report conducted after construction completion (refer to Section 8.2)
- structural safety report
- operational safety report and
- current mitigation verification report, including maintenance base line measurements referenced to measured locations (refer to Section 9.4).

7 Engineering investigations and assessments

The developer must prepare the following documentation in support of their development application during the course of the development process:

- geotechnical investigation report
- engineering impact assessment report
- risk assessment report
- dilapidation survey report
- drainage report
- noise and vibration report
- electrolysis report and
- a summary report that presents the main conclusion and results from the above reports.

This section of this guideline document provides an explanation of the information that needs to be included in these reports to enable Sydney Metro to ascertain the relative impact of the development on existing and future Sydney Metro underground infrastructure. In terms of the engineering investigations and assessments undertaken for future metro infrastructure, the intent of these is to ensure the feasibility of future metro construction is not adversely affected by new developments and their construction.

The main aim of these assessments and investigations is to demonstrate that there will be no adverse effects arising from the proposed development within the defined protection reserves. The acceptability of the effects predicted (as determined through investigation and assessment) must be viewed against the performance requirements described in Section 9 of this guideline document, as well as compliance with relevant standards and codes.

The secondary aim is to provide confidence that any proposed development is ‘fit for purpose’. This is to ensure that the development owner and tenants do not have unrealistic expectations in regards to the impacts of noise and vibration that they may be exposed to as a result of Sydney Metro operations and maintenance.

The developer should approach Sydney Metro for information that defines the extent of existing and future metro infrastructure in order to undertake these investigations and assessments.

7.1 Geotechnical investigation

The developer must carry out detailed geotechnical investigations of the soil or rock strata above, alongside and below existing and future Sydney Metro underground infrastructure, as appropriate, to establish the existing ground conditions within the area affected by the proposed development. Geotechnical investigations must be undertaken by suitably qualified and experienced consultant. The results of the investigation must be presented in a geotechnical investigation report.

The intent of these geotechnical investigations must be as follows:

- Provide information that enables a geological model to be developed. Based on this model, sections must be prepared that illustrate the ground conditions in and around the interface of the proposed development with the Sydney Metro underground infrastructure of concern.

- Establish any likely in-situ stress conditions within the soils and underlying rockmass surrounding the interface.
- Describe any potential presence of critical geological features such as bedding planes, joints and dykes.
- Present an interpretation of relevant rock and soil properties based on the results and any in-situ and laboratory testing that has been undertaken. If no in-situ or laboratory testing has been carried out, industry established rock and soil properties can be adopted with supporting justification.
- Provide an interpretation of the existing groundwater regime within and surrounding the interface.
- Identify and describe the presence of any human-made features within the development site.

The scope of the geotechnical investigation undertaken to support the development application may comprise the following:

- drilled boreholes
- in-situ testing
- geological mapping and
- geophysical exploration.

Whilst the installation of instrumentation and the drilling of investigation boreholes is permissible within the first and second reserve of the rail corridor, they should be located and orientated to avoid the supporting systems of existing metro underground infrastructure. This will require a detailed study of existing arrangements to demonstrate that risk to the underground infrastructure is appropriately managed for acceptance by Sydney Metro prior to the drilling of boreholes.

If boreholes 2m or deeper are to be drilled within the first or second protection reserves Sydney Metro is to confirm no objection to boreholes prior to drilling. The following information is to be provided to Sydney Metro:

- Proposed borehole location plan and cross sections, verified by a registered surveyor, showing:
- the distances from the boreholes to the tunnel reserve boundaries (first and second reserves)
- the distances from the sub-stratum boundary and
- borehole details (e,g. diameter and depth).
- A copy of the Safe Work Method Statement for the proposed works including a requirement to notify Sydney Metro if the driller encounters any indications that Sydney Metro underground infrastructure may has been encountered (e.g. sudden increase or decrease in ground resistance to drilling, interception of voids, sudden loss of water within boreholes) then Sydney Metro is to be immediately contacted on one of the Sydney Metro project enquiry numbers:
- Sydney Metro – City & Southwest – 1800 171 386
- Metro North West Line – (02) 9854 4805
- Sydney Metro – West – 1800 612 173
- Sydney Metro – Western Sydney Airport – 1800 717 703.
- Any other requirements consistent with Section 7.1 of these guidelines.

Please allow two weeks for confirmation of no objection to boreholes from Sydney Metro. All boreholes must be carefully grouted to their full depth with a bentonite and cement grout mixture upon completion.

As a minimum the geotechnical investigation report will need to present the following information:

- borehole location plan, borehole logs, test results, geological mapping, photographic documentation and other relevant information
- description of the soil profile of the area
- critical geological features such as bedding planes, joints and dykes
- other relevant data from geotechnical investigation
- rock and soil properties, laboratory and in-situ test results
- existing in-situ stress states in soils and rocks
- groundwater levels
- detailed geotechnical model for the analysis including geotechnical design parameters
- comments on foundation design, methods of shoring and excavation and
- a copy of all plans, geotechnical data, operations and maintenance records with any qualifications and limitations provided by Sydney Metro to the developer.

7.2 Engineering impact assessment

The developer must carry out an engineering analysis and impact assessment to demonstrate that the effects of the proposed development on tunnels and underground facilities will not cause unacceptable adverse impacts on future or existing Sydney Metro infrastructure. The engineering assessment must be carried out by Competent Persons with appropriate qualifications and experience in tunnel design and analysis. In some cases, Sydney Metro may request the developer to arrange independent verification of the engineering analysis and impact assessment based on the project complexity and the potential effects on metro infrastructure.

The results of the analysis and assessment must be presented in an engineering report. The engineering assessment report must be prepared and endorsed by a Competent Person and submitted to Sydney Metro.

The engineering analysis and impact assessment must take into account any other adjacent development activities planned for the future or that are taking place at the time of analysis. This information can be obtained from Sydney Metro.

Depending on the complexity of the development, a two-dimensional or three-dimensional numerical modelling (finite element [FE] or finite difference [FD]) may be required to demonstrate that induced effects on the rail infrastructure will be acceptable to Sydney Metro through predicting the effects on the underground construction at different stages of construction and the eventual or current operation of the metro. The modelling must also consider the effects of associated temporary works, such as construction loading (e.g. demolition, tower cranes and material stockpiling).

If undertaken, numerical modelling must fulfil the following requirements:

- be based on a realistic geological model derived from the subsurface information gathered through the geotechnical investigation and

- must incorporate critical geological features that may be present, such as bedding planes, weak layers, joints and other discontinuities.

If necessary, the results from this numerical modelling may need to be validated during construction by comparison with the results from the field monitoring of installed instrumentation.

As a minimum the impact assessment report must include the following:

- Details of the scope of the development.
- Verified survey plans by a NSW registered surveyor that show the location of the proposed development in relation to the metro easements, protection reserves and the planned or existing metro alignment including track centre lines and details of the underground structures.
- The metro underground infrastructure must be shown in plan and various sections with the inclusion of the protection reserves as defined in this guideline document to clearly illustrate the comparative position of the development in relation to the existing or planned metro infrastructure. They must also extend to the expected physical zone of influence, which is the extent to which the development is expected to affect the surrounding ground.
- Detailed drawings depicting structural layout, foundation layout, foundation loads, drainage plans, temporary works such as dewatering, shoring and anchoring and permanent works of the proposed development.
- Structural drawings that show the designs for shoring, as recommended by the geotechnical consultant engaged by the developer.
- Predicted displacements of existing or planned metro underground infrastructure (if constructed prior to the proposed development) due to proposed development at various stages, namely pre-construction (including demolition), excavation, development construction and post-construction.
- Predicted displacements, stresses and structural actions as imposed on the structural support of metro infrastructure structure at various stages of construction, namely pre-construction (including demolition), excavation, development construction and post-construction. In most cases this support will be in the form of watertight structural concrete linings.
- Structural assessments of these predicted effects on existing and planned metro infrastructure (if constructed prior to the proposed development). This must include as appropriate the structural integrity of underground support (such as structural linings), track beds, existing drainage structures, waterproofing measures and structural clearances.
- Appropriate sensitivity analysis to ensure that the predictions are not adversely affected by reasonable variations in input parameters and different conditions that can occur during all stages of development construction.
- Assessment of the effects of construction techniques and methodology on the underground metro infrastructure.
- Provide discussion on any design assumptions, qualifications or limitations that have been applied. This discussion must indicate how these have been considered as part of the sensitivity analysis and then integrated as identified risks as part of the risk assessment (as discussed below).
- Recommendations regarding any planned preventive or remedial action that may be required to limit development induced impacts on metro infrastructure.
- Noise and vibration assessment report (refer Section 8.6).

- Stray currents report, including a risk assessment (refer to Section 9.4).
- Certification that the proposed development will not induce unacceptable adverse effects on metro infrastructure.

7.3 Risk assessment

Developers have a legal duty to eliminate risks to ensure safe rail operations so far as is reasonably practicable (SFAIRP). As such developers must identify all reasonably foreseeable safety risks and hazards to the metro or its operations and eliminate these risks where reasonably practicable and where it does not minimise each risk SFAIRP.

The identified risks and their SFAIRP demonstration must be documented in a manner that can be provided as assurance evidence to Sydney Metro. TS 20001 System Safety for New or Altered Assets describes the assurance for changes impacting rail or transport assets. Reference should also be made to T HR CI 12075 ST when preparing the risk assessment.

A rail related risk assessment report must be prepared and submitted for consideration and approval by Sydney Metro in accordance with the safety management system for Sydney Metro and address/include the following:

- safety in design that covers and the whole of asset life cycle, including all stages of construction
- identify all hazards and risks to the development and metro facilities including metro support elements and other infrastructure
- present the risk identification process that has been adopted which considers the entire asset life cycle of the metro infrastructure
- apply and present a risk ranking in accordance with the Sydney Metro safety management system
- confirm that all risks can and will be managed so far as is reasonably practicable (SFAIRP) and
- present the controls that are needed to manage risks from the proposed development to metro infrastructure; these may include early warning criteria for monitoring. The risk of the proposal to Sydney Metro infrastructure will be reflected in the amount of public liability insurance required as a condition of consent.

7.4 Dilapidation survey

As part of an engineering assessment, dilapidation surveys of existing metro infrastructure may be requested by Sydney Metro to be submitted as part of the development application prior to the issue of a construction certificate. If required by Sydney Metro, the developer must arrange, with Sydney Metro, for a dilapidation survey to be undertaken of metro infrastructure in proximity to the development. The existing condition of the metro infrastructure must be established and agreed and considered as part of the risk assessment.

7.5 Drainage report

Where relevant Sydney Metro may request that a drainage report is prepared that details the proposed means of drainage that will be adopted to manage the collection of water, including groundwater, within basement levels of the proposed development.

7.6 Noise and vibration assessment

The developer must submit a noise and vibration impact assessment report prepared by a qualified person as part of the development application or prior to a construction certificate. The noise and vibration impact assessment report must:

- demonstrate that the development is designed, and will be constructed and maintained to avoid damage or other interference which may occur as a result of airborne and ground borne noise and vibration effects that may emanate from the rail corridor during rail construction and from the railway operations and
- determine the effects of any noise or vibration impacts on the metro infrastructure and its operations arising from the proposed development during demolition, excavation and construction (including any machinery causing heavy vibration levels) and its operation after completion and
- Assess any cumulative impacts with Sydney Metro operations, or any adverse impact to a soundscape that Sydney Metro has specifically designed for (ie. Station promenades and concourses).

Refer to Section 9.3 for further details regarding performance criteria to be considered.

Vibration impacts should be considered in the monitoring plan referred to in Section 10.

7.7 Electrolysis assessment

The developer must submit an electrolysis report as part of the development application or prior to a construction certificate, prepared by a suitably qualified consultant, to assess the requirements for electrolysis effects on the development infrastructure from metro operation and to address whether preventative measures are required.

7.8 Summary report

A summary report should be provided to demonstrate that the proposed works will not have adverse impacts on Sydney Metro infrastructure and include the supporting results from the reports described above.

7.9 Independent verification

Depending on the details of the proposed development and the proximity of planned or future metro infrastructure, Sydney Metro may request that independent verification of the engineering analysis and impact assessment be carried out. If required, this independent verification must be arranged by the developer.

The independent verification must be carried out by a Competent Person from an organisation that is independent of the organisation that prepared the engineering analysis. The independent verification organisation will be subject to the approval of Sydney Metro.

The independent verification must include detailed engineering proof checking of all aspects of the engineering analysis and impact assessment including any proposed temporary works.

The independent verification organisation must prepare a report that describes its verification activities and includes certification that the proposed development will produce no unacceptable adverse effects on existing metro infrastructure. The

independent assessment report must be submitted to Sydney Metro with the engineering assessment report.

8 Construction requirements

8.1 General

All metro property must be fully protected during construction of the development and all site work (including clearances to metro tracks and protection reserves) must comply with the requirements outlined in this guideline document, as well as other relevant TfNSW standards relating to air space developments, external developments and tunnels, and safe working requirements.

All construction carried out on metro property must comply with the requirement of the relevant authorities and legislation including workplace health and safety (WHS) requirements and environmental requirements.

8.2 Dilapidation survey

If required by Sydney Metro before construction of the development can commence and an occupation certificate can be issued, a joint inspection of the existing metro near the proposed development may be requested by Sydney Metro. If requested the survey must be carried out by representatives of the developer and Sydney Metro. The existing condition of the metro infrastructure must be agreed and recorded. Additional joint inspections may be required during construction.

The extent of metro infrastructure that must be surveyed will be determined by Sydney Metro.

Detailed dilapidation reports must be submitted to Sydney Metro describing conditions before commencement of the works and after completion of the works.

The dilapidation report must include the following as a minimum:

- details of existing visible defects
- dimensions of existing visible cracks
- photos of visible defects with labels that indicate their locations and
- signs of wetness, staining and seepage from existing visible defects.

This inspection must establish the extent of any existing exposed visible cracks, such as those observed on the surface of concrete linings which support metro tunnels and caverns. These visible cracks must be suitably marked and identified to enable any deterioration to be monitored.

8.3 Risk assessments

Prior to commencing any works, risk assessment reports issued in support of development applications must be updated based on the detailed design at construction. The updated risk assessment report must consider any modifications to the design and the impact these may have on identified risks.

Safe Work Method Statements (SWMS)s must also be prepared that include, as a minimum, the following:

- detailed work methods including the incorporation of the controls as stated in the risk assessment plan and
- an emergency response plan.

The developer must submit the SWMS and updated risk assessment report to Sydney Metro for approval.

8.4 Demolition works and construction impacts

The demolition of any existing buildings or basements must be planned in such a way that no adverse risk is imposed on existing metro underground infrastructure. The developer is required to take every possible action to minimise imposed risks and is required to meet the costs of any protection of the metro infrastructure and any incurred disruption to metro rail operations.

The impact of any proposed underground demolition work (including de-stressing, unloading and resulting ground vibrations) must be assessed to ensure that there are no adverse effects on metro infrastructure. If large-scale demolition works are involved, then the developer is required to install a vibration monitoring system to monitor vibration levels near adjacent metro infrastructure.

Hydraulic rock breakers must not be used within five metres of any existing metro infrastructure without Sydney Metro approval.

The developer is required to arrange a structural investigation by appropriately qualified person to address the impacts.

Refer to T HR CI 12075 ST for further details.

8.5 Excavation works

The developer must submit the following for Sydney Metro's approval prior to commencing excavation for the development:

- an engineering assessment report which through the use of numerical modelling techniques (if required) demonstrates that the excavation will not cause any adverse effect on the underground metro infrastructure
- design reports that detail the shoring system that support excavations must be provided to Sydney Metro prior to construction and must include evidence of independent verification certification
- a detailed monitoring plan for ground deformation, tunnel convergence, stress, crack width monitoring, vibration monitoring and reporting protocol for each party
- risk assessment and contingency plans and
- detailed work method statements which include hold points at various stages of excavation and are linked to the acceptance of monitoring results.

The following requirements apply to excavation and piling works at construction:

- the position of underground metro infrastructure (outer walls) and protection reserves must be marked clearly on the ground for easy identification
- all piling contractors must be made aware of the existing underground metro infrastructure adjacent to construction site
- Sydney Metro must be informed of the progress of piling and excavation works on a regular basis and
- the results of field monitoring undertaken during excavation or piling works must be assessed by a suitably qualified person and reported to Sydney Metro at an agreed frequency.

Depending on the requirement identified in the Impact Assessment Report, Sydney Metro will require the presence of a Competent Person during excavation to carry out visual verifications of substrata, geological mapping and an assessment of monitoring results.

The developer must submit the monitoring results together with the geotechnical consultant's assessment to Sydney Metro at agreed frequencies and stages of construction. A Sydney Metro nominated observer may be involved with the monitoring.

Monitoring must continue until construction of the building structure or superstructure is complete. With prior agreement with Sydney Metro, monitoring frequencies may be decreased when the basement construction is completed. Monitoring must continue after the completion of the construction activities, until no changes occur in three consecutive monitoring cycles. Sydney Metro must be informed before termination of the monitoring activities.

8.6 Noise and vibration

The effects of noise and vibration on existing metro infrastructure and on the proposed development must be considered as part of the design and construction of proposed developments.

The construction of the proposed development must be carried out such that the effects of noise and vibration on nearby metro structures and facilities are minimised.

During development construction vibration monitoring may be required of the underground metro support, such as concrete linings. Refer to section 9.3 for information regarding vibration Alert and Alarm levels.

If the vibration levels exceed tolerable limits, then the developer must modify the construction methodology in such a way that the vibration limits are satisfied.

8.7 Contaminants and hazardous materials

The storage of potential contaminants and hazardous materials within the protection reserves will be subject to Sydney Metro approval. A risk assessment and appropriate safety precautions must be provided for storage of potential contaminants within any of the protection reserves, where there is potential for the contaminants to migrate to or come in contact with the metro underground infrastructure. This assessment must address the potential impact on the durability of concrete, grout, resin, steel, waterproofing gaskets and membranes and any other material forming the permanent works of the metro underground infrastructure.

The storage of potential contaminants and hazardous materials may be permitted if the results from the risk assessment demonstrate that the risk to the metro underground infrastructure can be appropriately managed.

9 Performance requirements

The design and construction of the development must be carried out with full recognition of the potential effects that could be imposed on the performance of the existing metro or the feasibility of the future metro. As an overarching principle the development must not affect the stability and integrity of the metro infrastructure and its safe operation. Broadly, the developer must ensure that the development and its construction do not adversely affect the performance of metro infrastructure in respect of the following:

- amenity
- aesthetics
- structural integrity
- durability
- function
- user/customer benefits
- safety during construction and operation and
- environmental performance.

It should be noted that throughout the developer's activities, the developer must monitor the actual effects of construction against design predictions and in accordance with the project-specific construction phase monitoring requirements.

Aspects of the development and its construction which could potentially adversely affect the metro infrastructure include the following:

- loading or unloading from the development
- ground deformation resulting from excavations and external loading
- induced vibrations during construction and operation
- ground borne noise impacts
- electrolysis from earth leakage currents
- discharge of stormwater from the development
- changes to groundwater levels affecting design assumptions
- loss of support to any underground metro facility (including rockbolts and anchors)
- temporary structures and
- load from anchors.

This section details the design and performance requirements that must be adhered to by the developer in order to address these issues. Reference should also be made to documents listed in Section 3 of this guideline.

9.1 Structural integrity

Development induced load and displacements must not have any short or long term adverse effects on the support structure or support system of metro infrastructure.

The construction of development structures over and/or adjacent to metro underground structures must be suitably designed to take into account the presence

of the existing metro infrastructure and future construction of metro infrastructure. Construction work methods must be developed as part of the design process.

The effects on metro support elements and other metro infrastructure at any stage of the whole life cycle of the development must be assessed to ensure that the works must remain compliant with relevant standards. These structural elements include, but not limited to:

- concrete (precast, in-situ or sprayed) linings
- load bearing columns, walls, slabs and roof beams
- rock pillar supports
- permanent rock anchors (or bolts)
- track slabs
- drainage structure
- shafts and
- underground stations.

Of particular interest is the possibility of increases in structural actions, such as axial loading and flexural bending, to support elements and structural linings of metro underground infrastructure, as a consequence of development loading.

9.1.1 Imposed loading

Any temporary or permanent works adjacent to the metro could be subject to the influence of train loading and as such they will need to be assessed in accordance with AS 5100 for live load surcharge. Parts of the development that could be affected must be designed to comply with T HR CI 12070 ST Miscellaneous Structures, T HR CI 12075 ST Airspace Developments and T HR CI 12080 ST External Developments.

Permanent works adjacent to metro infrastructure must take into account the design actions resulting from any proposed future metro construction. Sydney Metro should be contacted to confirm the location of planned future metro infrastructure.

9.1.2 Induced movement

Displacement of metro infrastructure as induced by the development must not affect the operational functionality and durability of the metro infrastructure. Also, the developer must consider the possibility that future metro construction may induce movement on the development.

The following displacement limits apply (refer to Appendix A for infrastructure details):

- For metro cast in-situ cavern and tunnel concrete linings, the allowable total movement in any direction is 10 mm and differential movement in any plane is 10 mm or 1:2000, whichever is less.
- For metro running tunnels that are supported by a precast concrete segmental lining, the allowable total movement in any direction is 10 mm and differential movement in any plane is 10 mm or 1:2000 whichever is less. The main purpose of these limits is to ensure that the watertightness of the lining through joints is not compromised as consequence of gasket decompression and/or damage.
- Shear movement across rock bedding as induced by the development activities must not exceed 10 mm where permanent rock bolts, installed as part of the metro infrastructure support system, intersect these bedding planes.

Any development activity, whether beneath or adjacent to contained metro tracks, that has the potential to cause track displacement must comply with the requirements of SPC 207 Track Monitoring Requirements for Undertrack Excavation. The track must be monitored and managed in accordance with the requirements stated in SPC 207 for monitoring, notification and intervention levels and emergency procedures.

9.1.3 Induced cracking

The extent of dilapidation surveys undertaken (and described previously in this guideline document) of metro infrastructure must be determined based on predictions of deformation and the load influence zone imposed by the proposed development. The survey must establish the extent of any existing visible cracks, where the extent of the cracks refers to their apparent length and apparent width. Where present these cracks must be suitably marked and identified to enable any deterioration during and after the construction to be monitored.

The following technical criteria must be met regarding visible cracking, including the presence of pre-existing visible cracks on the face of metro concrete structures:

- No new visible cracking of metro concrete structures is allowed to be induced by the development and its construction. Compliance with this requirement must be confirmed by performing impact assessments during the design stage.
- Any existing visible cracks must not increase by more than 0.2 mm in width or increase in length by more than 300 mm in total over the stages of development construction.
- The configuration of visible cracks must not result in concrete spalling or affect the safe operation of the metro system.
- In the event that water seepage is observed (previously absent) through the visible cracks during development construction then Sydney Metro will, on behalf of the developer, seal the visible cracks by grouting the visible cracks until this seepage ceases.
- Engineering analysis and assessment undertaken for the development (as discussed within this guideline document) must take into account the presence of existing visible cracks of metro infrastructure.

The monitoring of existing visible cracks and critical structural elements during construction must form part of the overall monitoring plan.

9.2 Excavation and groundwater

Excavation for the development and all associated retaining works (along with other ground disturbance works associated with the proposed development) must not affect the safety and operational integrity of the metro or cause the destabilisation of metro infrastructure. The methods of excavation employed are of particular relevance in this regard, especially where methods employ chiselling, percussive pile driving or similar methods. Importantly, explosives must not be used for the splitting and removal of rock and excavation.

Typical issues associated with excavation works include slippage, slumping, creation of fissures or cracks, rock or earth falls, exacerbated ground movements, water inflows, cracking of supporting structural elements and in extreme cases structural failure. Excavation works must be undertaken in a manner that minimises the risk of such occurrences.

Sections of temporary shoring installed to support excavations for the development must have a minimum service life of 3 years, if their stability has the potential to affect

metro infrastructure. Shoring systems must be designed by a competent person and independently verified by a qualified person as approved by Sydney Metro unless Sydney Metro advises otherwise in writing. Allowance should be provided for minimum unplanned excavation in accordance with CIRIA C760 Guidance on Embedded Retaining Wall Design, 2017.

Ground anchors are not allowed within the first reserve zone. Any ground anchors within the second reserve must be assessed for their effect on metro underground infrastructure. Anchors must not be tested to the extent that the testing loads applied could cause collapse or failure, or both, in the surrounding soil and rock structure.

Assessment of metro infrastructure from development excavation must also consider the loading that cranes (including their foundation anchorage) will impose within the excavation on metro infrastructure.

Construction near metro underground infrastructure can also impact the local groundwater regime. These impacts have the potential to cause adverse loading of the infrastructure, not contemplated and thus designed for over the design life of the metro. Critically, watertightness and waterproofing must not be adversely affected or damaged.

The developer must carry out an engineering assessment of the impact of any changes to the groundwater regime that the development could cause. Issues of concern that have the potential to impact on metro infrastructure include the following:

- The development and its construction that could create a water barrier that dams groundwater flow above the metro underground infrastructure.
- Any groundwater ingress into excavations associated with the development that could cause dewatering of the local water table. Importantly, dewatering must not commence without prior approval from Sydney Metro.

Consequently, the engineering assessment must address any temporary dewatering (at any stage of the development) to demonstrate that effects on underground metro infrastructure are acceptable.

9.3 Noise and vibration

The noise from construction and rail operation must be considered against statutory and project noise vibration limit requirements. Sydney Metro does not accept liability for the generation of noise and vibration from normal railway operations (including track maintenance), or for its transmission into developments above or adjacent to rail tunnels.

When designing developments above or adjacent to rail tunnels (existing or planned), consideration must be given to operational and construction vibration; as well as ground or structure borne noise emissions in accordance with Developments Near Rail Corridor and Busy Roads – Interim Guideline, Department of Planning, NSW Government 2008 and T HR CI 12051 ST Developments Near Rail Tunnels.

Consideration should be given to whether Clause 87 of the Infrastructure SEPP is triggered for impacts of rail noise or vibration on non-rail development. If triggered measures should be outlined to ensure consistency with the requirements.

9.3.1 Considerations during development construction

In planning development construction, the following requirements apply for vibration impacts on structures and assets.

Structural damage (buildings)

Sydney Metro refers to Australian Standard AS2187: Part2-2006 'Explosives – Storage and Use – Part 2: Use of Explosives', which recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2 – 1993 'Evaluation and measurement for vibration in buildings Part 2' as they "are applicable to Australian conditions".

The Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated.

The recommended limits for transient vibration to ensure minimal risk of cosmetic damage to reinforced or framed structures and industrial and heavy commercial buildings apply to Sydney Metro infrastructure.

Sources of vibration that are considered in the standard include demolition, piling, ground treatments (e.g. compaction), construction equipment, tunnelling and industrial machinery.

Continuous rock-breaking/hammering and sheet piling, vibratory rollers, excavators and the like can give rise to dynamic magnification due to resonance.

An adjusted peak particle component velocity (PPV) of 20 mm/s at 4 Hz and above applies to any development that occurs within 25 m horizontally from first reserve of Sydney Metro infrastructure as a conservative vibration damage screening level. An Alert level of 15 mm/s shall apply for monitoring and management purposes.

Atypical construction methods should be assessed on a case-by-case basis with reference to the Standards.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) would be compared with the guidance vibration velocity limits.

Buried services

Buried structures and utilities such as gas pipelines and fibre optic cables are to be assessed on a case-by-case basis.

An acoustic consultant shall be engaged by the construction contractor and would liaise with the structure of utility's owner in order to determine acceptable vibration levels.

Vibration-sensitive equipment

Where it is has been identified that vibration sensitive scientific instruments are likely to be in use inside Sydney Metro premises, objectives for the satisfactory operation of the instrument would be sourced from manufacturer's data.

It may be beneficial for the project if baseline vibration measurements are carried out at the building where vibration-sensitive equipment is located. These baseline measurements will determine what existing ambient vibration levels are. The site-specific equipment criteria would need to be agreed with the occupant/users of the equipment as well as Sydney Metro.

9.3.2 Considerations for operational noise and vibration impacts

The developer is required to obtain accurate information to assess and appropriately mitigate operational noise and vibration impacts from rail operations. The developer is required to obtain all available information which will enable a thorough assessment of actual or potential rail noise and vibration which could affect the development site. This includes but is not limited to:

- number of train events expected in a 15hr-Day (7am to 10pm) and 9hr-Night (10pm to 7am) period, in the typical busiest weekday. This information may be obtained from the relevant Sydney Metro Environmental Impact Statement (EIS) or for operational Sydney Metro sites from the Operational Noise and Vibration Review (available from sydneymetro.info). The assessment should include future operations as well as existing operations.
- the event noise and vibration levels from each train. This information may be obtained from the relevant Sydney Metro EIS or for operational Sydney Metro sites from the Operational Noise and Vibration Review (available from sydneymetro.info), but supplementary information should be obtained from measurements at the existing rail tunnel (if it is operational), or at a similar rail tunnel (e.g. other tunnel locations in the Sydney Metro network).
- location of noise/vibration sensitive Sydney Metro equipment. This information may be obtained from the relevant Sydney Metro EIS or for operational Sydney Metro sites from the Operational Noise and Vibration Review (available from sydneymetro.info). It will include stations where staff, tenants and customers are to be protected from noise and vibration impacts.
- location of noise/vibration generating metro infrastructure. This information may be obtained from the relevant Sydney Metro EIS or for operational Sydney Metro sites from the Operational Noise and Vibration Review (available from sydneymetro.info). For operational Sydney Metro sites, a site survey and inspection would identify the location and type of noise and vibration generating items, including substations and railway stations with outdoor public address systems. For Sydney Metro corridors in development where an EIS is not available the developer will need to make informed assumptions. Government announcements about projects may assist the developer in obtaining high level information about the number of trains to expect at maximum capacity and indicative location of tunnels and stations.
- for construction assessments of impacts on sensitive receivers (for example, staff in stations), the Interim Construction Noise Guidelines (2009) shall apply for operational noise impacts, the assessment shall reference the Noise Policy for Industry (2017) and any other guidelines or policies which relate to the specific development.

9.4 Stray currents and electrolysis

When designing developments above or adjacent to underground metro infrastructure consideration must be given to operational stray currents that may be present. The risk assessment must also consider the potential presence of stray currents.

Sydney Metro does not accept liability for the generation of stray currents from an operating electrified railway.

The potential effects of stray electrical currents and electrolysis in the electrified area of the metro network must be considered in accordance with T HR CI 12080 ST and T HR EL 12002 GU during the design of the development.

A suitable test program must be established during the early design phase to quantify a stray current signature for the development site prior to undertaking enabling works. Suitable stray current mitigation strategies must be integrated into the design of the development.

Following construction, stray current testing must be carried out to verify that electrolysis mitigation strategies are proven to be effective, which includes undertaking a comparison with the pre-development stray current signature. This

information must also be used to establish maintenance baselines for the life of the development.

10 Monitoring

Monitoring is undertaken to validate design assumptions for developments and to quantify that impacts being generated are within acceptable limits.

The structural performance of the metro underground infrastructure must be monitored as necessary during construction of the proposed development to verify predicted displacements, stress levels in structural elements and vibration levels. The monitoring regime must be developed by a qualified tunnel/geotechnical engineering consultant.

Monitoring plans must be submitted to Sydney Metro for review and approval prior to the commencement of construction. The Monitoring plan must include but is not limited to:

- All vibration-generating works from demolition through excavation and landscaping (e.g. vibratory rollers) should be considered.
- Activities should be nominated which require vibration/crack/movement monitoring and where the monitoring locations will take place.
- A response regime outlining the process to manage “Alert” (coming close to the limit) and “Alarm” (equal to or over the limit) and a contingency plan/s to prevent damage to Sydney Metro infrastructure. This should include the process for how the developer’s consultant will assess the monitoring results continually and submit monitoring assessment reports to Sydney Metro for review.

The tables below indicate the circumstances where various types of monitoring are required. These requirements must be provided as a minimum.

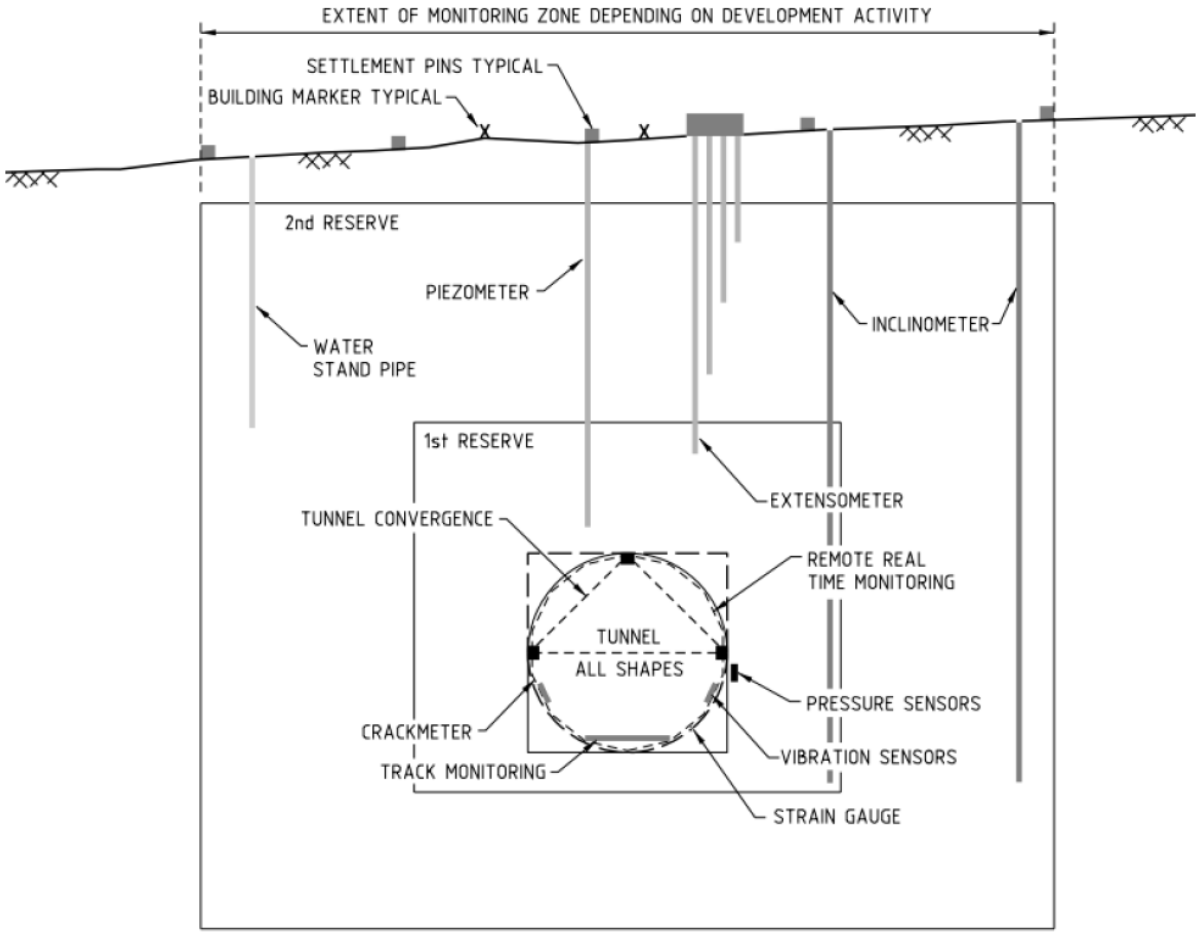
Figure 10.1 provides typical extents that monitoring must be provided in each case.

Table 10.1 Minimum monitoring requirement for development activities near rail tunnels – In ground

Type of instrument	Deep open excavations	Foundation works – shallow or deep	New underground excavation or new tunnel
Inclinometer	Yes	Yes	Yes
Water standpipe	If required by Sydney Metro	If required by Sydney Metro	If required by Sydney Metro
Piezometer	Yes	If required by Sydney Metro	Yes
Extensometer	Yes	If required by Sydney Metro	Yes
Ground settlement markers	Yes	Yes	Yes
Building settlement markers	Yes	Yes	Yes

Table 10.2 Minimum monitoring requirement for development activities near rail tunnels – within existing rail tunnels

Type of instrument	Deep open excavations	Foundation works – shallow or deep	New underground excavation or new tunnel
Tunnel convergence	Yes	Yes	Yes
Tiltmeter	Yes	If required by Sydney Metro	Yes
Crackmeter	Yes	Yes	Yes
Vibration sensor	Yes	Yes	Yes
Rail track monitoring (distortion)	Yes	If required by Sydney Metro	Yes
Strain gauges in lining	If required by Sydney Metro	If required by Sydney Metro	If required by Sydney Metro
Pressure cells in lining	If required by Sydney Metro	If required by Sydney Metro	If required by Sydney Metro
Real time monitoring such as EL beams, optical prism laser scanning	If required by Sydney Metro	If required by Sydney Metro	If required by Sydney Metro



Note: instrumentation not to intrude into the first reserve unless agreed by Sydney Metro

Figure 10.1 Typical instrumentation layout

During construction of the Sydney Metro infrastructure it may not be feasible to grant access to tunnels for the purpose of installing monitoring equipment. If access to Sydney Metro infrastructure is not granted, then the developer and Sydney Metro shall determine an alternative monitoring location which can be used to represent or derive conditions in the tunnel.

Baseline data for each monitoring parameter must be established before commencement of development construction. The developer must provide as a minimum, three sets of monitoring data to establish a baseline prior to excavation.

The equipment that is used for remote monitoring (particularly for alarm or warning systems) must have proven reliability in similar applications.

Any alarm or warning system should have a visual and audible alarm system to activate and to stop all works as necessary and notify relevant personnel, such as the site manager, geotechnical consultant and nominated Sydney Metro representative.

Depending on the project complexity, physical inspections of existing metro infrastructure may be required on a regular basis during critical stages of construction. If necessary, these inspections should be undertaken jointly with the developer and Sydney Metro representative (including a representative from the metro operator as necessary).

11 Sydney Metro contact and information for developers

Sydney Metro has a dedicated email address for queries relating to development of land in or near Sydney Metro infrastructure. The contact details and information points are outlined in Table 11.1 below.

Table 11.1 Sydney Metro contact and information points

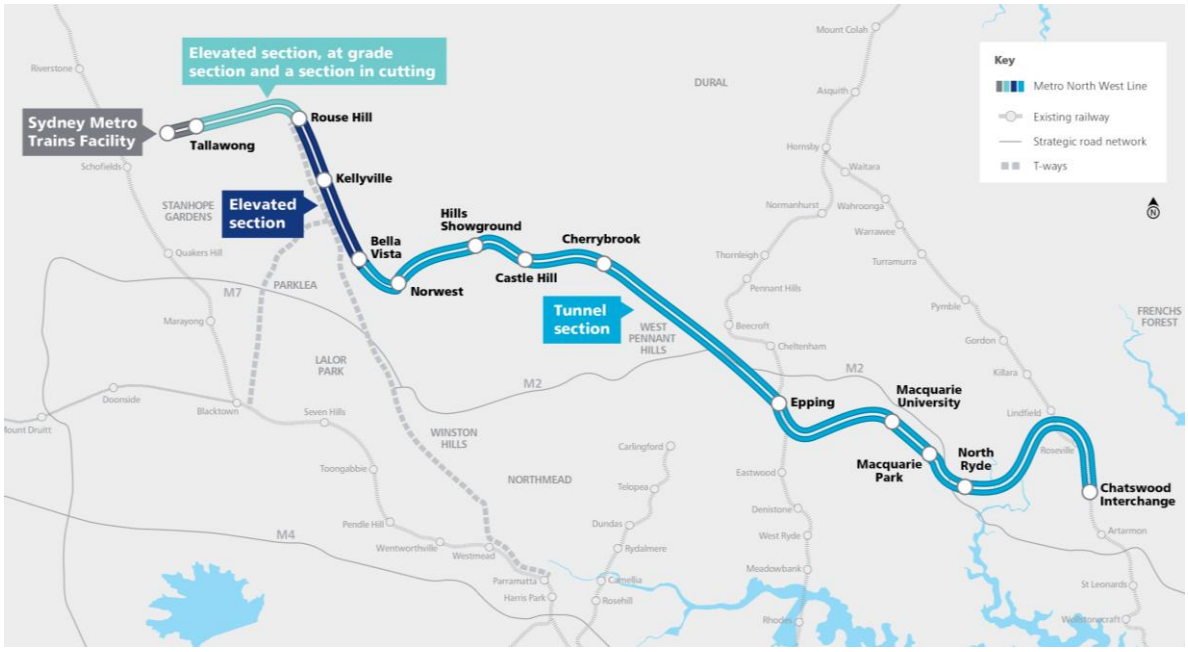
Activity	Detail
Sydney Metro email address	SydneyMetroCorridorProtection@transport.nsw.gov.au
Sydney Metro website	Sydneymetro.info
NSW Major Projects including Sydney Metro planning documents	https://www.planningportal.nsw.gov.au/major-projects

Appendix A – Sydney Metro infrastructure details

Metro North West Line

Sydney's Metro North West Line is the first dedicated metro line to be constructed for the metro and extends for 36 kms from Chatswood through to the north west. The Metro North West Line incorporates 13 km of track and rail infrastructure between Epping and Chatswood that has been modified and segregated to form part of the Sydney Metro.

This Guideline is relevant for the 28 km tunnel section of the Metro North West Line from Chatswood to Bella Vista and Metro underground infrastructure in other locations.



The following are key features of the Metro North West Line.

Epping to Tallawong

- 23 km of new track and rail infrastructure delivered through approximately 15 km of twin tunnels and 4 km of elevated structure, with the remaining 3 km of rail infrastructure provided at-grade with some sections in cutting.
- Eight new stations are located at Cherrybrook, Castle Hill, Hills Showground, Norwest, Bella Vista, Kellyville, Rouse Hill and Tallawong.
- The stations at Castle Hill, Showground and Norwest are contained within cut and cover concrete boxes, whilst stations at Cherrybrook and Bella Vista follow an open cut station configuration. Stations at Kellyville and Rouse Hill are elevated. Tallawong station is the only station that is at grade.
- The approximately 15 km of twin running tunnels have an internal diameter of approximately 6.2 m and an external diameter of approximately 7.0 m and have been excavated predominantly through shale and sandstone mostly using tunnel boring machines (TBMs). The tunnels are supported using a precast concrete segmental lining except for the mined tunnels between the Epping Service Facility and Epping Station where in-situ concrete has been used.

- There are 61 cross passages between running tunnels at approximately 240m centres. These cross passages have been mined and are supported using a permanent cast in-situ concrete lining.
- There are services shafts at Epping and Cheltenham area which are cut and cover structures. These shafts are supported using permanent cast in-situ concrete lining.
- Other structures includes nozzle enlargement at the ends of stations at Castle Hill, Hills Showground and Norwest. These have been mined and are supported using a permanent cast in-situ concrete lining.
- A 159 m long mined crossover cavern is immediately east of Castle Hill Station. The cavern has a span of 21 m wide and has a height that varies from 14 m to 17 m. The cavern is supported by a permanent cast in-situ concrete lining.

Epping to Chatswood (Existing ECRL)

- The 13 km length of existing track and rail infrastructure between Epping and Chatswood, previously known as the Epping to Chatswood Rail Link (ECRL), has been converted to form part of the Sydney Metro system.
- The underground infrastructure comprises twin single track tunnels with an excavation diameter of 7.2 m and four underground stations completed in 2008.
- The underground station structures at North Ryde, Macquarie Park and Macquarie University consist of large span platform caverns typically of about 19 m in span and 13 m in height, together with concourse caverns, access tunnels, adits, shaft and associated plant and equipment rooms. The station caverns have been excavated in mainly competent, horizontally bedded sandstone and shales permanently supported using composite linings consisting of rock reinforcement in the form of rock bolts and shotcrete.
- Epping Station comprises two platform caverns connected by cross passages and accessed through escalator tunnels, lift shafts and two large plant room ventilation shafts. This station is located beneath the existing surface station.
- The running tunnels were excavated by rock tunnel boring machines (TBMs) and underground stations and associated structures were excavated using roadheaders, rock hammers and rock saws. The running tunnel support consists of temporary primary support using rock bolts and shotcrete, and final support using unreinforced cast-in-situ concrete lining, nominally 200 mm thick. A section of the running tunnels was lined with shotcrete for construction reasons. The invert of the tunnel consists of precast reinforced segments with a floating track slab.

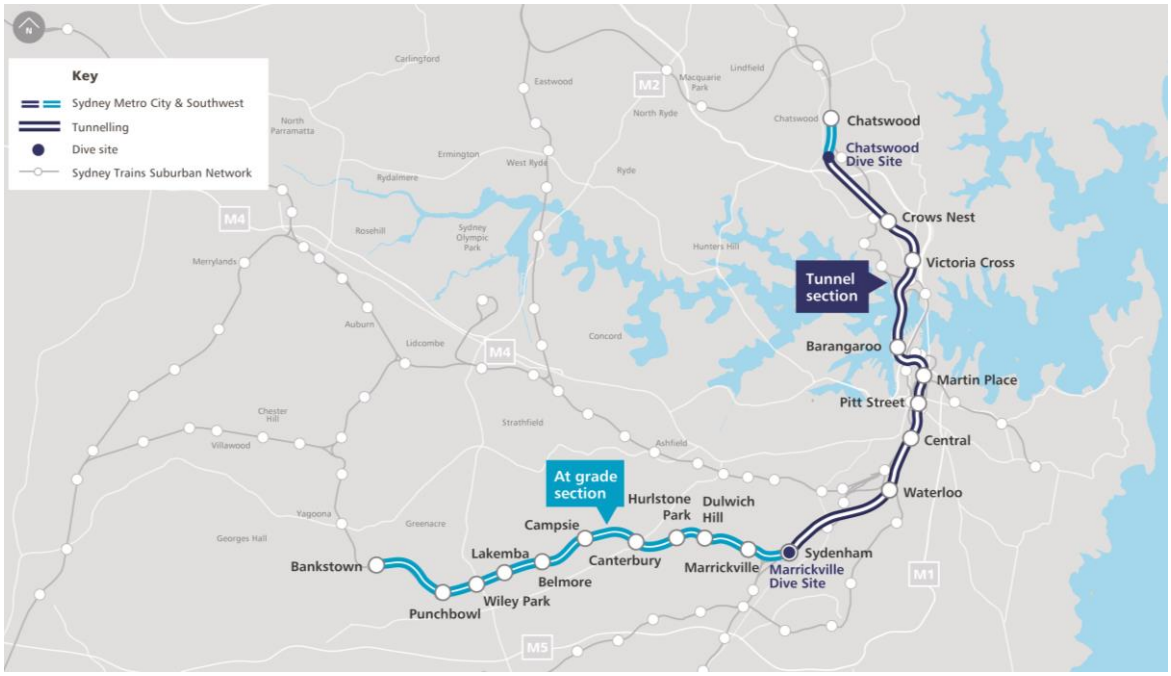
Sydney Metro – City & Southwest

The Sydney Metro City & Southwest project includes a new 30km metro line extending metro rail from the end of the Metro North West Line at Chatswood, under Sydney Harbour, through new CBD stations and southwest to Bankstown.

Sydney Metro City & Southwest will deliver new metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street, Waterloo and new underground metro platforms at Central Station. In addition it will upgrade and convert all 11 stations between Sydenham and Bankstown to metro standards.

A future extension of Sydney Metro - City & Southwest is proposed from Bankstown to Liverpool.

This Guideline is relevant for the underground sections from Chatswood to Sydenham and Metro underground infrastructure in other locations.



The following are key features of this planned section of the metro system.

Sydney Metro – City

- The city section consists of a short section of surface track from Chatswood Station to the dive and portal structure then underground infrastructure that extends under St Leonards, Crows Nest, North Sydney and Sydney Harbour and then beneath the Sydney CBD to Central and Waterloo and through to Sydenham where the metro comes to the surface at a portal and dive structure at Marrickville.
- New stations will be located at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street and Waterloo. New underground metro platforms will be built at Central Station.
- Twin running tunnels of approximately 14 km in length (portal to portal) were excavated using TBMs and supported using a precast concrete segmental lining to create a watertight environment. The tunnels predominantly align through siltstone and sandstone, except below the Sydney Harbour where TBM tunnelling was required through marine ground sediments for a length of around 170 m.

- A total of 57 mined cross passages are located between running tunnels at regular intervals, with spacing of around 240 m centres. The cross passages were excavated using mechanical methods and supported using a tanked permanent lining, formed using cast in-situ concrete. A services shaft connects with a cross passage at Artarmon. The shaft is supported by permanent cast in-situ concrete lining.
- Waterloo Station, Barangaroo Station, Crows Nest Station and the underground metro platforms at Central Station are cut and cover box structures that contain island platforms. The station is typically 24 m in width and range from 200 m to 215 m in length. Pitt Street Station and Martin Place Station have binocular platform caverns that connect with two entrance and services shaft structures, whilst Victoria Cross Station has a single span cavern with an island platform, which also connects with two entrance and services shaft structures.
- At Martin Place Station and Pitt Street Station the platform caverns range in length from 193 m to 246 m and have spans of approximately 12 m with an approximate height of 11 m. At the Victoria Cross Station, the platform cavern is approximately 174 m in length and has a span of 23 m with a height of 13 m. All the caverns and adits were excavated using mechanical methods and supported using a tanked permanent lining, formed using cast in-situ concrete.
- A mined cross over cavern which is 226 m in length was constructed immediately north of Barangaroo Station. This cavern has an internal span of 23 m wide and a height that varies from 14 m to 17 m. The cavern will be supported using a tanked cast in-situ concrete lining.
- Mined tunnel enlargements that are up to around 17 m in length are provided to house tunnel ventilation equipment at either end of the Victoria Cross Station caverns, the northern end of the rail crossover at Barangaroo, the southern end of Waterloo Station and at the northern end of Crows Nest Station. The nozzle enlargements were excavated using mechanical methods and supported using a tanked permanent lining, formed using cast in-situ concrete.
- Dive structures and portal structures are located at Marrickville and Chatswood. A stabling yard is located at the Marrickville portal site.

Sydney Metro – Southwest (all infrastructure is at grade or elevated)

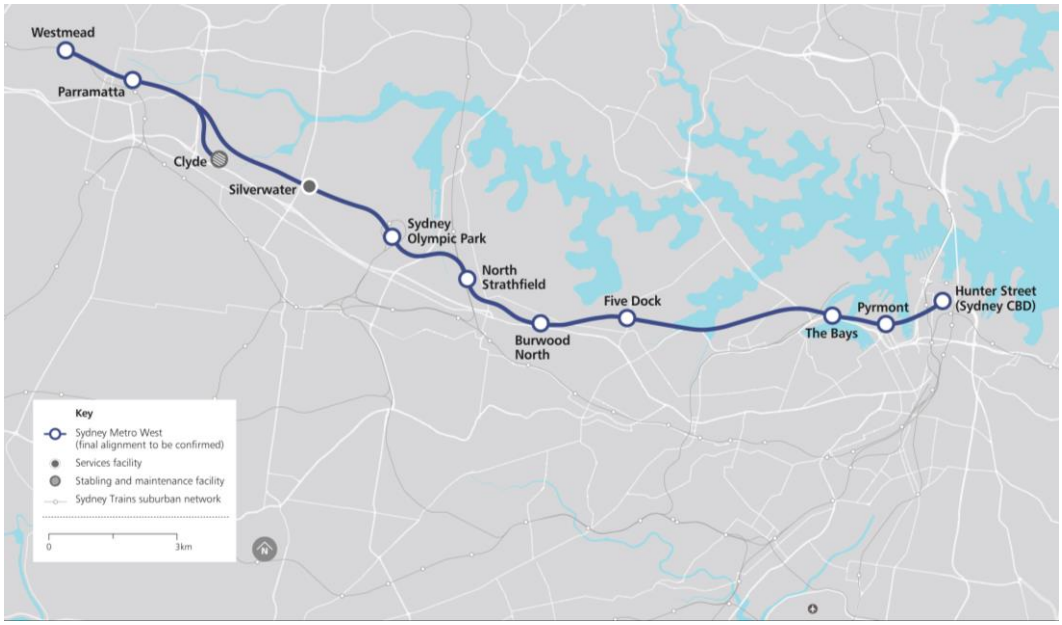
- This section of the metro is currently part of the T3 Bankstown Line, but will be converted to metro standards from Sydenham to Bankstown.
- The extension of Sydney Metro in the south west will involve upgrading the existing Sydney Trains operated T3 Bankstown Line and associated rail corridor from just beyond Sydenham Station through to Bankstown Station to enable the conversion to Sydney Metro operations.
- Eleven existing stations at Sydenham, Marrickville, Dulwich Hill, Hurlstone Park, Canterbury, Campsie, Belmore, Lakemba, Wiley Park, Punchbowl and Bankstown will be upgraded to improve accessibility for customers and meet the standards required for metro operations.
- Reference should be made to the Sydney Metro At Grade and Elevated Sections Corridor Protection Guidelines for protection requirements regarding Sydney Metro – Southwest.

Sydney Metro – West

The Sydney Metro - West project will support a growing city and deliver world-class metro services to more communities. This new underground railway will connect Greater Parramatta and the Sydney CBD. This once-in-a-century infrastructure investment will transform Sydney for generations to come, doubling rail capacity between the two CBDs, linking new communities to rail services and supporting employment growth and housing supply.

The locations of nine proposed metro stations have been confirmed at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays, Pyrmont and Hunter Street in the Sydney CBD. Further planning and design work is underway to determine the location of new metro stations at Pyrmont and in the Sydney CBD.

This Guideline is relevant for the entire Sydney Metro West alignment as it is all underground.



The following are currently key features of this planned section of the metro system.

Westmead to The Bays

- It is anticipated that tunnelling would occur from two Tunnel boring machine (TBM) launch and support sites at Westmead metro station construction site and The Bays Station construction site. Two TBMs would be launched from each of these construction sites to be dismantled and retrieved at the Sydney Olympic Park metro station construction site.
- Twin running tunnels more than 20 km in length would be excavated using TBMs and supported using a precast concrete segmental lining to create a watertight environment. The tunnels would have a circular cross-section with an internal lined diameter of about six metres and an excavated diameter of about seven metres.
- Cross passages would be provided between running tunnels at regular intervals, with a maximum spacing of around 240 m. The cross passages will be excavated

using roadheaders and rock hammers and supported using a watertight permanent lining, formed using cast insitu concrete.

- Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North and The Bays would be cut-and-cover stations.
- Five Dock would be constructed as a binocular mined cavern station.
- A dive structure and tunnel portal would be constructed at Rosehill within the Clyde stabling and maintenance construction site to provide for a future connection from the Clyde stabling and maintenance facility to the mainline tunnels. Underground connecting tunnels would be excavated by road header from the tunnel portal to the mainline tunnels.

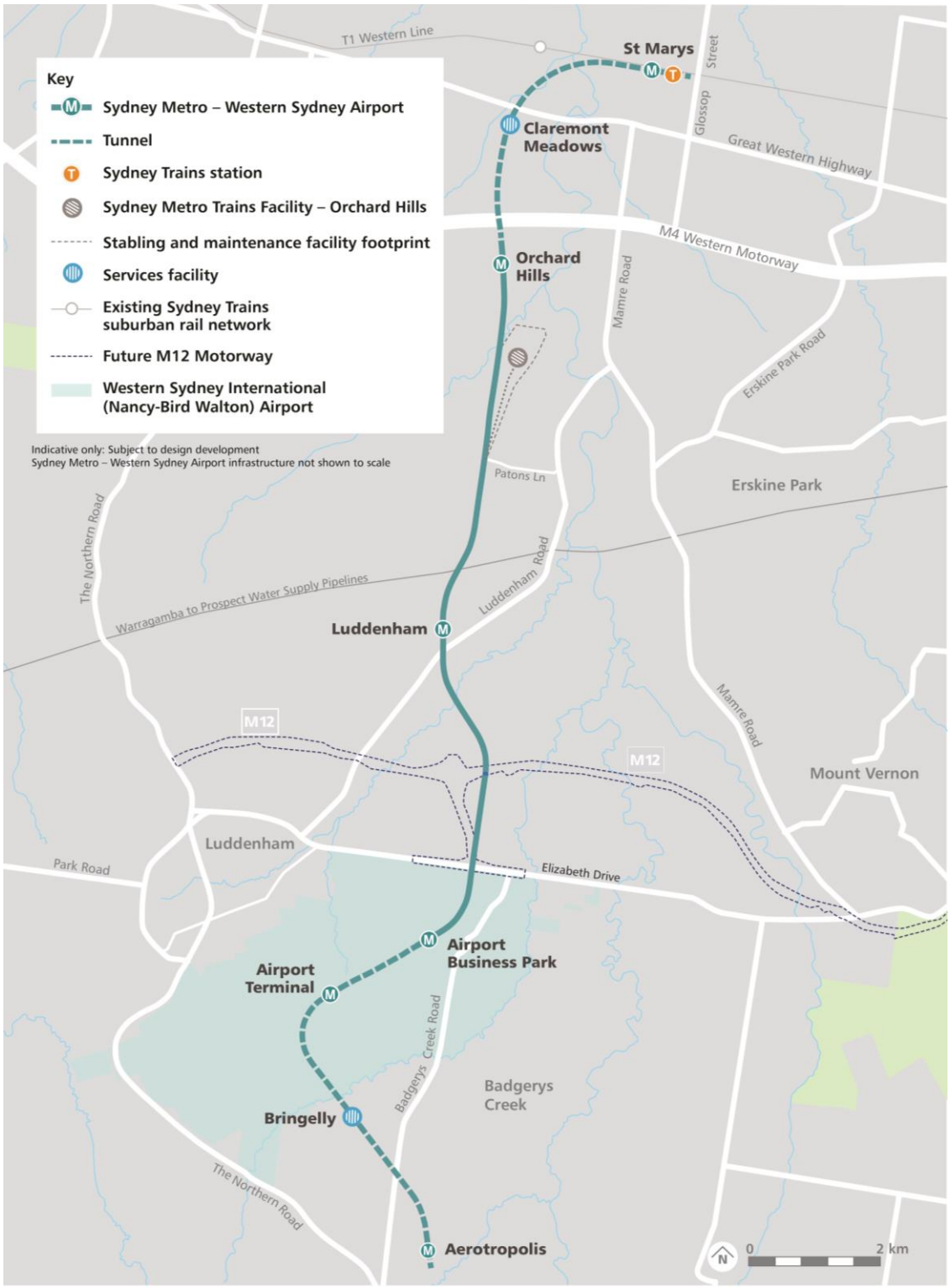
Sydney Metro – Western Sydney Airport

Sydney Metro - Western Sydney Airport will extend from St Marys in the north connecting to stations at Orchard Hills, Luddenham, Airport Business Park, Airport Terminal and the Western Sydney Aerotropolis (the area proposed to be named Bradfield). The new metro railway line would include a combination of tunnel, surface and viaduct sections.

These Guidelines are relevant for the underground sections as shown below and Metro underground infrastructure in other locations.

The following are key features of this planned section of the Metro system.

- The new metro railway line would be approximately 23 kms in length.
- Twin running tunnel excavation is likely to be carried out using TBMs and supported using a precast concrete segmental lining to create a watertight environment. The tunnels would have a circular cross-section with an internal lined diameter of about six metres and an excavated diameter of about seven metres.
- Cross passages will be provided between running tunnels at regular intervals, with a maximum spacing of around 240 m. The cross passages will be excavated using roadheaders and rock hammers and supported using a watertight permanent lining, formed using cast insitu concrete.
- A stabling and maintenance facility would be required and will be located in Orchard Hills to the south of Blaxland Creek and east of the proposed project alignment with access via Patons Lane.
- A dive structure and tunnel portal would be required at any location where the rail line transitions from below ground to surface and is subject to design development.


Key
Sydney Metro – Western Sydney Airport
Tunnel
Sydney Trains station
Sydney Metro Trains Facility – Orchard Hills
Stabling and maintenance facility footprint
Services facility
Existing Sydney Trains suburban rail network
Future M12 Motorway
Western Sydney International (Nancy-Bird Walton) Airport
Indicative only: Subject to design development
Sydney Metro – Western Sydney Airport infrastructure not shown to scale
T1 Western Line
St Marys
Claremont Meadows
Orchard Hills
Glossop Street
Great Western Highway
M4 Western Motorway
Mamre Road
Erskine Park Road
Erskine Park
Patons Ln
The Northern Road
Warragamba to Prospect Water Supply Pipelines
Luddenham Road
Luddenham
M12
Mount Vernon
Park Road
Elizabeth Drive
Airport Business Park
Airport Terminal
Badgerys Creek Road
Badgerys Creek
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0
2 km

Proposed future extensions would connect Sydney Metro - Western Sydney Airport with Tallawong in the north west, Macarthur in the south and Westmead to the Northeast.

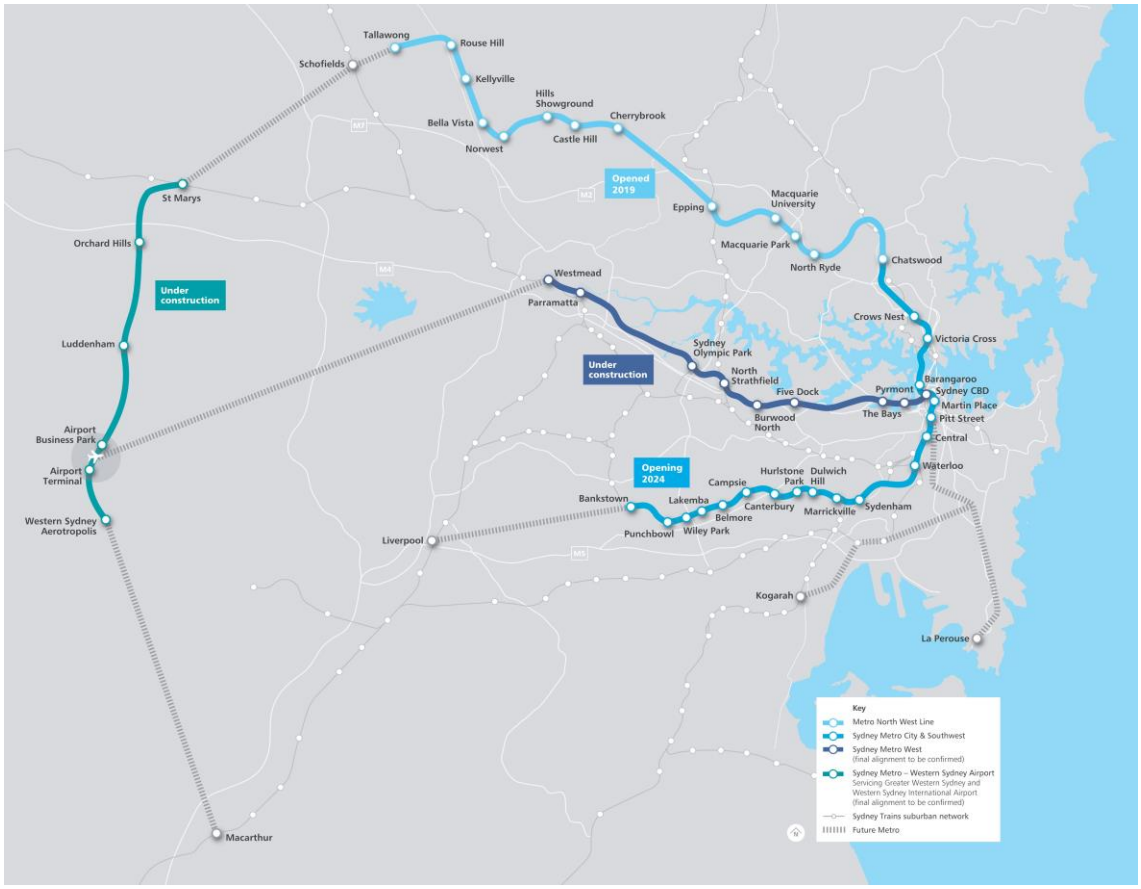

Figure A.1 Sydney Metro network – existing and future

It is intended that these Guidelines will be applicable to future Sydney Metro corridors located underground as they are announced. The Sydney Metro website [4]has further information about future Sydney Metro corridors.

[4] www.sydneymetro.info

Appendix B – Development application lodgement checklist

Where legislation requires referral or concurrence in relation to Sydney Metro rail corridors for proposed developments the developer must lodge the following documents as part of their development application package:

Item	Description	Check
Survey		
1.	Detailed survey plan prepared by a NSW registered surveyor, which accurately defines the boundaries between the development, the rail corridor (including first and second reserve), rail infrastructure and any Sydney Metro easements (including right of ways) or stratums, covenants and caveats.	☐
2.	Copy of the current land title including all easements (including rights of way), covenants and caveats.	☐
Architectural and Engineering Drawings		
3.	Geotechnical and structural reports/drawings that meet the Standards and requirements of Sydney Metro. The geotechnical report must be based on actual borehole testing conducted on the portion of the site that is closest to the rail corridor and include: • an analysis of the potential impact of demolition, excavation and operation of the development; • demolition and excavation induced vibration impacts on the rail corridor and rail infrastructure; and • potential loadings of the development on the rail corridor and rail infrastructure.	☐
4.	Structural design documentation for the development which demonstrates that: • the foundation design ensures that all loads from the development are transferred and induced effects on the underground rail infrastructure are acceptable to Sydney Metro; and • any deformation induced by bulk excavation will not have adverse impacts on the rail corridor, rail infrastructure or rail easements.	☐
5.	Cross sectional drawings showing the rail corridor (including first and second reserve), sub soil profile, proposed basement and/or foundation excavation and structural design of the development's sub-ground support adjacent to the rail corridor. All measurements contained within the cross sectional drawings must be verified by a registered surveyor.	☐
Engineering reports		
6.	Geotechnical investigation report with details in accordance with Section 7.1 of this guideline document.	☐

Item	Description	Check
7.	Impact assessment report with details in accordance with Section 7.2 of this guideline document.	☐
8.	Construction methodology for the development, including details of the structural support to be provided to the development and rail corridor during excavation and operation of the development. The construction methodology must not propose any rock anchors/bolts (whether temporary or permanent) within Sydney Metro's land or easements during construction or operation of the development.	☐
9.	Risk assessment report in accordance with Section 7.3 of this guideline document.	☐
10.	Noise, vibration and electrolysis studies and control measures in accordance with Section 7.6 if available otherwise these will be required prior to construction certificate.	☐
Additional Information (depending on impact assessment, or prior to construction)		
11.	Detailed ground and vibration monitoring plan including trigger levels, action plans and remedial measures, details of the instrumentation and baseline monitoring readings (refer to Section 10).	☐
12.	Construction schedule, construction management plan including sequence plan identifying impact.	☐
13.	Construction layout of equipment relative to metro infrastructure.	☐
14.	Final detailed Safe Work Method Statements (refer to Section 8).	☐
15.	Temporary safety plans and measures.	☐
16.	Temporary works plan, temporary access, vehicle, plant and equipment such as cranes (including mobile cranes) and stockpiling.	☐
17.	Rail related risk assessment and management plan.	☐
18.	List of machinery to be used during excavation/construction.	☐
19.	Groundwater control plans, environmental aspects including contamination.	☐
20.	Design loadings and certified drawings for construction related works that affect metro infrastructure.	☐
21.	Agreed interface activities plan with Sydney Metro.	☐
22.	If required by Sydney Metro, detailed dilapidation survey report in accordance with Section 7.4 of this guideline document.	☐
23.	If required by Sydney Metro, condition and dilapidation survey reports of all metro infrastructure affected by the development (refer to Section 8.2).	☐

Appendix C - Glossary

Abbreviation	Explanation
Alarm	Equal to or over the limit.
Alert	Coming close to the limit.
Competent Person	Refer to Appendix D for the process to determine a Competent Person. An individual who has the means and ability to undertake design, checking and verification activities to a recognised standard with the appropriate combination of technical knowledge, skills and relevant experience. A Competent Person will be required to provide a factual curriculum vitae, statement of qualifications, experience and supporting documentation that provides evidence of competence which will be subject to review and acceptance by Sydney Metro.
Designer	Competent Person responsible for undertaking a detailed design and analysis that demonstrates the effects of changed conditions on Sydney Metro Infrastructure arising as a consequence of a proposed Development. Competence definitions for Designer are set out in Appendix D.
Design Checker/Designer	Competent Person responsible for checking that a design is correct. Competent Person responsible for preparing a design solution to meet specified requirements. Competence definitions for Design Checker/Designers are set out in Appendix D.
Design Verifier/Design Checker	Competent Person responsible for independently verifying a discipline-specific design complies with relevant standards and is safe and fit for purpose. Competent individual responsible for checking that the design is correct. Competence definitions for Design Verifier/Design Checker are set out in Appendix D.
Developer	The person or organisation responsible for the new construction and/or alteration works.
Development	The term “Development” in this document means new construction and/or alteration works that change the existing asset configuration and could affect existing or future underground metro infrastructure. These works may include demolitions, alterations of existing structures, basements, foundations, anchors, temporary and permanent groundwater drawdown, pipe jacking, site investigations, tunnel and retaining wall constructions.

Abbreviation	Explanation
Infrastructure SEPP	State Environmental Planning Policy (Infrastructure) 2007
IV	Independent Verification
Metro underground infrastructure	For the purpose of assessing the effects of adjacent proposed developments, underground metro infrastructure includes, but is not limited to, the following: • running tunnels and interconnecting cross passages • station caverns and adits • crossover caverns • station boxes and shafts • nozzle enlargements • ventilation shafts and • dive and portal structures.
MIC SEPP	State Environmental Planning Policy (Major Infrastructure Corridors) 2020
NSW	New South Wales
Qualified Person	A person who is registered as a professional engineer or an architect or a surveyor under any law relating to the registration of engineers or architects or surveyors, as the case may be, and who under law is allowed to practice of carry on the business of a professional engineer or architect or a surveyor.
SEPP	State Environmental Planning Policy
Stratum	A right to use for a specific purpose land owned by others. The easement can be limited in either height or depth or width or all. This is also referred to as easement land.
Substratum	Land owned by Sydney Metro which is below surface level.
Support Zone	Zone where tunnel supports are located. Tunnel support can comprise permanent concrete linings, rockbolts and anchors, ground improvement measures such as grouted zones, rock pillar stich bolts, steel sets, lattice girders, brick lining, cast-in-situ lining, shotcrete lining and waterproof membranes.
SWMS	Safe Work Method Statement
TBM	Tunnel boring machine
Temporary works	Mobile cranes, scaffolding and other items which may exert temporary loading.

Abbreviation	Explanation
TfNSW	Transport for NSW
Underground Structures	Any engineering works below the surface of the ground
WSA SEPP	State Environmental Planning Policy (Western Sydney Airport) 2020

Appendix D – Competent Person

The tables below are based on the Sydney Metro Competency Management Plan and are provided to indicate the levels of competency that would be acceptable to Sydney Metro.

Minimum competency levels

Role	Straightforward /Low risk	Moderately complex Moderate risk	Complex/ High risk	Extremely complex/Very high risk
Engineering assurance	Level 3	Level 3	Level 4	Level 4
Design verifier	Level 2	Level 4	Level 4	Level 4
For Design Checker	Level 1	Level 2	Level 3	Level 3
Designer	Level 1	Level 2	Level 2	Level 3
Technical Manager	Level 2	Level 2	Level 2	Level 2

Levels of Complexity and Risk shall be approved by Sydney Metro.

Competence Levels

Four competence levels are identified from Level 1 – the most junior to Level 4 – the most experienced. Criteria and definition of each level is described below.

Level	Description
Level 1 – Qualified practitioner (supervised)	The Qualified Practitioner possesses basic knowledge of at least 80% of the systems within the practice area, including the principles around functional analysis, design, acceptance and application. They shall have received formal education and will work under the supervision of a designated Practitioner at a greater level of proficiency. Minimum requirements are discipline specific tertiary degree or equivalent Industry Certification within the Australian Qualifications Framework (AQF) and five years general work experience relevant to the discipline.
Level 2 – Experienced practitioner	The Experienced Practitioner possesses the basic knowledge of a Qualified Practitioner, with additional detailed knowledge and understanding of one or more practice areas. Knowledge must include safety implications and key functional aspects, failure mechanisms across multiple modes of operation and use, and lifecycle considerations such as maintainability, availability and reliability. They shall have had direct experience of applying their knowledge in a number of projects, preferably including in the rail sector. Minimum requirements are as a Qualified Practitioner, with additional five years' experience relevant to one or more practice areas, and evidence of relevant continued professional development equivalent to the requirements of Engineers Australia Continuing Professional Development (CPD) requirements or equivalent professional body.
Level 3 – Senior practitioner	The Senior Practitioner possesses the knowledge and experience of an Experienced Practitioner, with additional experience supervising or guiding less experienced practitioners, and/or a leadership role in the area(s) of practice. Minimum requirements are as an Experienced Practitioner with additional five years' experience relevant to one or more practice areas, with Chartered professional accreditation such as Chartered Professional Engineers (CPEng), as conferred by Engineering Australia or ability to demonstrable equivalent level of relevant and continued professional development.
Level 4 – Expert practitioner	The Expert Practitioner possesses the technical knowledge, experience and accreditation of a Senior Practitioner, with additional substantial experience applying domain knowledge across a range of comparable projects and a demonstrable record of successfully leading other engineers or practitioners, of managing technical risk, and leading safety in engineering practice in their area or specialisation. The Expert Practitioner will have established a recognised profile within a relevant industry association. Minimum requirements are as a Senior Practitioner with additional five years' experience relevant to one or more practice areas, and evidence of relevant, continued professional development or maintaining professional accreditation.